THE COLLABORATIVE RESEARCH SUPPORT PROGRAM
ON
FOOD INTAKE AND HUMAN FUNCTION

KENYA PROJECT

FINAL REPORT

Submitted to the United States Agency for International Development
Grant # DAN-1309-G-SS-1070-00

15 November 1987

School of Public Health
University of California,
Los Angeles, California 90024

College of Health Sciences
University of Nairobi,
Nairobi, Kenya

PREFACE

This report documents the Nutrition CRSP Kenya Project's activities, data collection and analysis procedures, and preliminary findings.

Analysis of the data collected by the Nutrition CRSP Kenya Project, an immense and extraordinarily complex research project, does not end with this "final report". This document presents the work that funding and time have permitted to date. Numerous important and detailed analyses remain to be conducted, and it will likely be several years until the potential of the data is fully realized. It is hoped that investigators at the University of Nairobi and the University of California, especially, will continue to "mine" this invaluable collection of information so that we can enhance our understanding of the problems of marginal malnutrition and offer sound information upon which to base development programs and policies.

This report is an acknowledgement of a successful collaborative research effort. The government of Kenya, particularly the Office of the President and Ministry of Health, gave its official sanction and active cooperation to ensure the success of the project. The University of Nairobi (College of Health Sciences), the University of California at Los Angeles (School of Public Health), and the University of California at Berkeley (Management Entity, Nutrition CRSP) shared in providing the necessary scientific and administrative inputs, and are equally responsible for the project's success. The report is a tribute also to the local community leaders and people of Kyeni South Location (Embu District) who recognized the importance of the research and allowed their community and homes to be intruded upon for over three years. The generous cooperation afforded by the chiefs and the study households went beyond the project's hopes and expectations.

This report is a reflection of the dedication, hard work and sacrifice of numerous individuals (see Chapter 3). Fieldwork, in particular, required a phenomenal effort by all involved. The senior field staff from the University of California and University of Nairobi often worked seven-day weeks and twelve-hour days to meet deadlines and ensure high quality data collection. The young men and women from Embu District who made up the bulk of the field staff proved to be exceedingly devoted and reliable workers who were eager to learn and anxious to carry out complex and highly responsible data collection tasks. The meticulous work of a devoted data management team ensured the flow of reliable data from collection in the household to entry onto computer tape.

Finally, this report is an acknowledgement of the support and sacrifice of the families of the investigators and senior field staff who endured difficult circumstances in order that the project would succeed.

Although many individuals assisted in the preparation of this report, three individuals -- Michael Baksh, Terry Silberman, and Murray Trostle -- deserve special mention for their writing and editing contributions.

Charlotte G. Neumann, MD, M.P.H.
Prof. of Public Health and Pediatrics
School of Public Health
University of California, Los Angeles

Nimrod Bwibo, MBChB, M.P.H.
Principal and Prof. of Pediatrics
College of Health Sciences
University of Nairobi

ASSOCIATIONS BETWEEN ILLNESS AND SUBSEQUENT BAYLEY SCORES

The description of illness measures is provided in Chapter 8. Pearson product moment correlations were computed between two illness measures (low grade illnesses and severe illness indices) and the three Bayley scores.

There are only a few significant correlations between illness and outcome. Toddlers who had more low grade and severe illnesses between 18 to 24 months of age had lower Bayley Mental scores at 30 months (r's = -.27 and -.25, respectively). There was also a negative association between low grade illness in this age period and Bayley Motor Score at 30 months (r = -.20). Illness during this period had very little immediate impact on development except that verbal skills at 24 months were negatively associated with severe illness in the previous six months (r = -.19) (see Table 24.2).

Illness during the period from 24 to 30 months had no association with mental or motor development.

It is not clear why early illness had so little immediate effect nor why the 24 to 30 month period was so unimportant in terms of the effects of illness on mental and motor development. The continuity in health conditions must be thoroughly researched. This is clearly an area where more refined analyses are needed to clarify interpretations of the results.

ASSOCIATIONS BETWEEN PHYSICAL STATURE AND SUBSEQUENT BAYLEY SCORES

The description of anthropometric measures is presented in Chapter 7. Pearson product moment correlations were computed between two anthropometric measures (height and weight) and the three Bayley scores (Table 24.3).

TABLE 24.2
Correlations between illness indices and Bayley score at 30 months of age.*

Illness 18-24 months	n	30 months Bayley Mental	30 months Bayley Motor
Low grade	105	-.27	-.20
Significant	105	-.25	--

* All correlations shown are significant, p < 02.

5. Slope of length (rate of linear growth from 18 to 30 months)
6. Slope of weight (rate of weight gain from 18 to 30 months)

Multiple regression analyses were performed for each of the six dependent growth variables using the forced entry of all ten food intake variables. The results of those analyses are presented in Table 25.11.

Attained length at 30 months gave the only significant R^2 value. Within the subset of intake variables for this specific analysis, only animal protein per Kg (A) was significant. Table 25.12 gives the correlations between the ten food intake variables. There are some very strong correlations among the independent variables that need to be considered when examining the results of multiple regression analyses.

TABLE 25.11
Multiple regression analyses on growth outcome variables using the subset of food intake variables.

Growth variable	Multiple R^2	p value
Weight increment	.0583	.9407
Length increment	.1703	.2427
Attained length at 30 mos	.2317	.0208
Attained weight at 30 mos	.1313	.3387
Slope of length	.1225	.3020
Slope of weight	.1204	.3172

TABLE 25.12
Correlation* matrix for the toddler food intake variables.

	KCALKGA	KCALKGB	FATKGA	FATKGB	PROTKGA	PROTKGB
KCALKGA	1.00					
KCALKGB	.48	1.00				
FATKGA	.63	.38	1.00			
FATKGB	.32	.46	.61	1.00		
PROTKGA	.91	.44	.66	.35	1.00	
PROTKGB	.45	.88	.25	.37	.49	1.00
APROTKGA	.46	.92	.65	.53	.19	.28
APROTKGB	.14	.43	.67	.18	.16	.09
IRONKGA	.75	.13	-.04	.74	.43	.32
IRONKGB	.38	.07	.06	.40	.89	.78

	APROTKGA	APROTKGB	IRONKGA	IRONKGB
APROTKGA	1.00			
APROTKGB	.55	1.00		
IRONKGA	-.04	-.10	1.00	
IRONKGB	-.03	-.21	.48	1.00

* Correlation coefficients all stat. sig. at $p<.05$ - .0000

5. Slope of length (rate of linear growth from 18 to 30 months)
6. Slope of weight (rate of weight gain from 18 to 30 months)

Multiple regression analyses were performed for each of the six dependent growth variables using the forced entry of all ten food intake variables. The results of those analyses are presented in Table 25.11.

Attained length at 30 months gave the only significant R^2 value. Within the subset of intake variables for this specific analysis, only animal protein per Kg (A) was significant. Table 25.12 gives the correlations between the ten food intake variables. There are some very strong correlations among the independent variables that need to be considered when examining the results of multiple regression analyses.

TABLE 25.11
Multiple regression analyses on growth outcome variables using the subset of food intake variables.

Growth variable	Multiple R^2	p value
Weight increment	.0583	.9407
Length increment	.1703	.2427
Attained length at 30 mos	.2317	.0208
Attained weight at 30 mos	.1313	.3387
Slope of length	.1225	.3020
Slope of weight	.1204	.3172

TABLE 25.12
Correlation* matrix for the toddler food intake variables.

	KCALKGA	KCALKGB	FATKGA	FATKGB	PROTKGA	PROTKGB
KCALKGA	1.00					
KCALKGB	.48	1.00				
FATKGA	.63	.38	1.00			
FATKGB	.32	.46	.61	1.00		
PROTKGA	.91	.44	.66	.35	1.00	
PROTKGB	.45	.88	.25	.37	.49	1.00
APROTKGA	.46	.92	.65	.53	.19	.28
APROTKGB	.14	.43	.67	.18	.16	.09
IRONKGA	.75	.13	-.04	.74	.43	.32
IRONKGB	.38	.07	.06	.40	.89	.78

	APROTKGA	APROTKGB	IRONKGA	IRONKGB
APROTKGA	1.00			
APROTKGB	.55	1.00		
IRONKGA	-.04	-.10	1.00	
IRONKGB	-.03	-.21	.48	1.00

* Correlation coefficients all stat. sig. at $p < .05$ - .0000

PREFACE

This report documents the Nutrition CRSP Kenya Project's activities, data collection and analysis procedures, and preliminary findings.

Analysis of the data collected by the Nutrition CRSP Kenya Project, an immense and extraordinarily complex research project, does not end with this "final report". This document presents the work that funding and time have permitted to date. Numerous important and detailed analyses remain to be conducted, and it will likely be several years until the potential of the data is fully realized. It is hoped that investigators at the University of Nairobi and the University of California, especially, will continue to "mine" this invaluable collection of information so that we can enhance our understanding of the problems of marginal malnutrition and offer sound information upon which to base development programs and policies.

This report is an acknowledgement of a successful collaborative research effort. The government of Kenya, particularly the Office of the President and Ministry of Health, gave its official sanction and active cooperation to ensure the success of the project. The University of Nairobi (College of Health Sciences), the University of California at Los Angeles (School of Public Health), and the University of California at Berkeley (Management Entity, Nutrition CRSP) shared in providing the necessary scientific and administrative inputs, and are equally responsible for the project's success. The report is a tribute also to the local community leaders and people of Kenyi South Location (Embu District) who recognized the importance of the research and allowed their community and homes to be intruded upon for over three years. The generous cooperation afforded by the chiefs and the study households went beyond the project's hopes and expectations.

This report is a reflection of the dedication, hard work and sacrifice of numerous individuals (see Chapter 3). Fieldwork, in particular, required a phenomenal effort by all involved. The senior field staff from the University of California and University of Nairobi often worked seven-day weeks and twelve-hour days to meet deadlines and ensure high quality data collection. The young men and women from Embu District who made up the bulk of the field staff proved to be exceedingly devoted and reliable workers who were eager to learn and anxious to carry out complex and highly responsible data collection tasks. The meticulous work of a devoted data management team ensured the flow of reliable data from collection in the household to entry onto computer tape.

Finally, this report is an acknowledgement of the support and sacrifice of the families of the investigators and senior field staff who endured difficult circumstances in order that the project would succeed.

Although many individuals assisted in the preparation of this report, three individuals -- Michael Baksh, Terry Silberman, and Murray Trostle -- deserve special mention for their writing and editing contributions.

Charlotte G. Neumann, MD, M.P.H.
Prof. of Public Health and Pediatrics
School of Public Health
University of California, Los Angeles

Nimrod Bwibo, MBChB, M.P.H.
Principal and Prof. of Pediatrics
College of Health Sciences
University of Nairobi

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

Chapter 1

INTRODUCTION

This report is a culmination of over a decade of planning and preparation, field research, data analysis and writing. This first chapter provides background information useful for understanding the project's development and design, and a description of how this report is organized.

More specifically, this chapter begins by summarizing the research objectives and events that led to the conception of the project. This summary is followed by a presentation of the core hypotheses that directed the project's research efforts. Several "non-core" research activities were also conducted by the Kenya Project, and these are reviewed. Several other nutrition related research projects have been conducted in Kenya, and some of these are noted. A chronology of the major project events is then outlined, and finally, the objectives and organization of the report are discussed.

BACKGROUND TO PROJECT AND OVERALL OBJECTIVES

The Nutrition Collaborative Research Support Program (CRSP) is an outgrowth of a recommendation by President Gerald Ford to the National Academy of Sciences in 1974 to consider what the research community could do to alleviate the pervasive problem of world undernutrition. The National Academy of Sciences convened expert groups to assess nutrition research priorities, and the consensus was that highest priority should be assigned to investigating the degree to which individuals' food intake maintains, enhances, or inhibits their functional performance. In 1977, at the request of the U.S. Agency for International Development (USAID), the Committee on International Nutrition Programs of the Food and Nutrition Board of the National Research Council concluded that five major areas of function needed to be investigated: disease response, reproductive competence, work output, cognition, and social and behavioral performance.

Under a USAID planning grant to the University of California, Berkeley, a series of workshops were convened in 1978 to further identify specific research areas and research approaches, and to establish a collaborative research program. More than 100 scientists, many from developing countries, participated in workshops focused on the five functional areas. In a final workshop, senior foreign investigators reviewed the reports of the earlier workshops and considered the relevance, importance, feasibility, and acceptability of the research for implementation in developing countries. Their synopsis made several important points, which have been summarized elsewhere (1) as follows:

> 1) the unit of study should be the household; 2) the mother-child dyad was the logical focal point; 3) food intake should be represented by energy intake encompassing a range of habitual mildly to moderately restricted intakes; 4) data produced should be generalizable to nutrition problems in less developed countries, not country specific, and therefore relying on replication across countries; 5) certain core research determinants would have to be common to all projects; 6) food intake would be the major independent variable; 7) nutritional status measurement would be seen as an explanatory intermediate variable; 8) selected study communities should be stable with low migration rates; 9)

specific research topics should have potential policy and program application; 10) U.S. standards for human research should be maintained, including informed consent; and 11) beneficial services provided during the course of the projects should be maintained upon conclusion of the projects. [The report also] took a very strong stand on the position that both for scientific and ethical reasons a "naturalistic" rather than an "intervention" design would be the preferred approach to the questions being addressed.

Specific proposals were submitted by collaborating institutions to the University of California at Berkeley, in 1979, and an integrated proposal was submitted to USAID in May 1980. A "Collaborative Research Support Program" plan was approved by USAID in September 1981, for research to be conducted in Kenya, Egypt, and Mexico. The collaborating institutions were the University of California at Los Angeles and Berkeley and the University of Nairobi, for Kenya; the Universities of Purdue, Arizona and Kansas, and the National Nutrition Institute, Ministry of Health, for Egypt; and the University of Connecticut and the National Institute of Nutrition in Mexico, for Mexico.

This is a report of the Kenya Project. It is important, however, to emphasize that the major research activities of the entire Nutrition CRSP Project (i.e.. all three country projects) were directed by a common design and shared sets of hypotheses to be tested and variables to be measured.

NUTRITION CRSP CORE HYPOTHESES

The original hypotheses that directed the Nutrition CRSP research were:

1.A. Maternal food intake during pregnancy and lactation influences infants' endowment at birth and growth and development during the first six months of breast feeding.

B. Maternal intake during pregnancy and lactation influences maternal child care and sanitation practices in relation to infants.

2.A. Food intake of toddlers during the period from 18 months through 29.99 months affects their morbidity, growth and psychological development.

B. Maternal intake during this period affects maternal child care and sanitation practices in relation to toddlers.

3.A. Food intake of 7-9 year-old children affects their morbidity, growth, cognitive function, and behavior (including school performance).

B. Food intake of the mother and father influences their interaction toward 7-9 year-old children and hence their morbidity and behavior.

4.A. Food intake of adults influences their morbidity, their social-emotional responsiveness, and their performance of usual responsibilities.

B. These functional outcomes impact upon other members of the household (as stipulated in previous hypotheses).

5. In adults and schoolers, a reduction of resting metabolic rates provides a major path of adaptation to restore energy equilibrium in the face of decreased energy intake.

6. Household food intake affects household morbidity and sanitation.

The Kenya Project collected the data necessary to test these hypotheses, but limitations of time and money have prevented the data from being analyzed completely and presented in this report. Indeed, all three country projects, in consultation with Management Entity and USAID, agreed in December 1986 that all three final reports would at a minimum present analyses and findings on a set of three specific research topics. The three major hypotheses that have guided and consumed the bulk of analysis to date, and which are reported here, are drawn from Hypotheses 1.A and 2.A above. In summary form, they are as follows:

1. Maternal food intake during pregnancy influences weight gain and/or changes in body composition during pregnancy and birth size of the infant. Intake during lactation affects changes in infant size from 0-6 months and maternal weight or body composition at 90-195 days postpartum.

2. Toddler food intake influences toddler cognitive performance.

3. Toddler food intake influences toddler growth and morbidity.

It must be noted that, due largely to the extreme wealth of data available, the analyses and findings of these hypotheses are only a start. Numerous important research questions related to these hypotheses remain to be answered and, needless to say, additional funding and work are required to address the remaining original hypotheses or new hypotheses that have been raised since inception of the project.

KENYA-SPECIFIC RESEARCH INVESTIGATIONS

In addition to collecting the data required to test the hypotheses to which the Nutrition CRSP Project addressed itself from the outset, the Kenya Project investigated several other research topics. Included among these additional topics were a socioeconomic ranking of households by community subchiefs, a survey of household income and expenditures, a time allocation study, an agricultural production study (including detailed measurements of garden area and crop yields), a study of the energy expended by adults during activity, an adult literacy test, a study of anxiety and depression among adults, a study of alcohol consumption among adults, and an investigation of food consumption and agricultural and other behavioral changes adopted by the population during and immediately proceeding the 1984 drought.

Several analyses have been conducted of these data sets and the findings are presented in this report. Again, however, considerable additional work is necessary to analyze these data thoroughly.

PREVIOUS RESEARCH

Research on Mild to Moderate Malnourishment

Although the majority of the world's population is mildly to moderately malnourished, little is known of the consequences of this situation -- hence the purpose for the Nutrition CRSP. The major shortcomings of research to date are that specific projects 1) have not been holistically designed, i.e. they have addressed very few topics, such as food intake and health, without looking simultaneously at socioeconomic conditions, sanitary practices, or cognition; and/or 2) have not been longitudinal. The current state of knowledge has recently been summarized by one observer as follows: "...virtually nothing that the scientific community has discovered about nutrition in this century has altered the prevalence or severity of the dominant forms of malnutrition. We know a great deal about protein-energy malnutrition, almost everything in fact, except what causes it, how to prevent it, and what it costs society not to do so" (2).

Nutrition-Related Research Activities in Kenya

Several nutrition-related research projects have recently been conducted in Kenya, and are of great relevance to issues addressed by the Nutrition CRSP Project.

A longitudinal nutrition and health research study was conducted in Machakos District from 1971 through 1981 (3). The objectives of this project were to obtain data on morbidity, mortality, acute infectious childhood diseases, pregnancy outcome, nutritional status, and several social, biological, and physical factors. Data were collected on approximately 4,000 households.

The most important findings of the Machakos Study include the following:

1. Food and energy intake were insufficient prior to harvests -- the per capita amount of food consumed in larger families was especially low.

2. In spite of low energy and nutrient intake and low weight gain (5.8 kg) during pregnancy, women produced healthy babies (average birth weight of 3.1 kg).

3. Energy and nutrient intakes fell short of recommended levels during lactation, but satisfactory amounts of breast milk were produced.

4. Labor complications were the single largest cause of perinatal mortality among mature infants, followed by sequelae of low birth weight and/or ante-partum hemorrhage. Both perinatal and neonatal mortality were found to be associated with obstestrical complications, maternal age 34 years, parity 10+, primagravidity, maternal height 150 cm., being unmarried, and a history of previous perinatal death. Low birth weight also had a particularly strong impact on neonatal mortality.

5. Mothers of low-birth-weight (LBW) infants were shorter and lighter and consumed less food during pregnancy than mothers of normal-birth-weight (NBW) children.

6. LBW infants received less breast milk that NBW children, and LBW children did not catch up in growth in the first year of life.

7. The mean energy and nutrient intake for toddlers 14 to 18 months old fell below the WHO/FAO recommendations. After 18 months the diet and energy intake were qualitatively and quantitatively acceptable.

8. Postneonatal and infant mortality averaged 26.0 and 49.1 per 1000 live births, respectively, and childhood mortality averaged 7.0 per 100 children under age five. The largest proportion of deaths occurred among children under one year old.

9. The leading causes of death in infancy and childhood (excluding the neonatal period) were pneumonia, diarrhea, vomiting, and measles. The prevalence of schistosomiasis was also high (82%), with intense infection common among the younger age groups.

10. Agricultural, socioeconomic, and hygiene variables were generally inversely related to infant and child mortality, although not all relationships were statistically significant.

In Embu District, within a few kilometers of the Nutrition CRSP field site, research on the processes of rural economic differentiation was undertaken by A. Haugerud from 1977-1979 (4). Qualitative and quantitative data were collected on 82 rural households in two ecological zones relating economic pressures to ecologic variation, the history of local social and political organization, and to external influences. Haugerud found that the principal avenues to wealth accumulation in Embu District lie outside of agriculture. Education, salaried employment and businesses are the major means of accumulation of land, cash, and material possessions; wage employment is the agent as well as the product of rural differentiation.

The International Food Policy Research Institute (IFPRI), with the National Council for Science and Technology and Kenyatta University, conducted a study examining the income and nutritional effects of commercial agriculture in South Nyanza District in 1984-1985 (5). The objective was to evaluate the effects of shifting from maize to sugarcane production on household income, expenditure, consumption, health and nutritional status. A total of 504 households including both sugar and non-sugar farmers, as well as merchants and landless individuals, were investigated. It was found that incomes of sugarcane farmers were significantly higher than the nonsugar farmers, but much of this "additional" income was spent on nonfood expenditures (e.g., housing and education). There was an overall positive effect on caloric consumption in sugar producing households, but preschoolers appeared not to benefit. Seasonality is one of the biggest determinants of morbidity patterns in the population, with the greatest prevalence of illness in women and children in the preharvest, rainy season. While high household income was found to have a small beneficial impact on total morbidity of preschoolers, increased participation in commercial agricultural was found to have a very significant negative effect on total illness and the amount of time that preschoolers and women were sick with diarrhea. There was a high prevalence of illness in the community with 60-70% of the women and children sick at any given time. Illness had a significant negative effect on anthropometry.

The socioeconomic determinants of child nutrition in Taita District were assessed by P. and A. Flueret from February 1981 to May 1982 (6). Data were collected on household size and structure, sources of income, landholdings, agricultural patterns of expenditure, diet, time and labor allocation, and other socioeconomic variables. Anthropometric assessments of children aged 6-60 months were conducted three times during different seasons. Commercial production of coffee and vegetables was associated with better anthropometric status of children, as the results suggested a relationship between cash income from sales of crops or labor, and good nutrition.

D. Brokensha and B. W. Riley conducted fieldwork in Mbere Division (Embu District) to assess the effects of the introduction of cash crops (7). Mbere is classified as a marginal area because much of it is unsuitable for traditional rainfed agriculture, and the area ranks low relative to the rest of Kenya in its degree of development and modernization. A project initiated in 1970 in Mbere emphasized an increase in crop production of cotton, Mexican 142 beans, tobacco, castor, and katumani maize. The program was unsuccessful in meeting its goals. Only the wealthier farmers could afford to make the required investments to adopt innovations. Some households neglected subsistence crops in favor of cash crops, resulting in a deterioration of nutrition. Cash cropping along with changes in education, occupation, and landownership were contributing to increasing social stratification.

The Kenyan Central Bureau of Statistics (CBS) of the Ministry of Finance and Planning carried out major child nutrition surveys of Kenyan children in 1977 (8), 1979 (9), and 1982 (10). The studies pointed out the widespread presence of stunting and moderate and mild forms of protein-energy malnutrition (PEM). In Eastern Province, stunting affected 23% of children under five years of age in 1982. Only 3% were found to be wasted, or with severe PEM.

The CBS studies also showed that the situation improved somewhat for Eastern Province. For stunting, 34%, 24%, and 27% of children under five were found to be stunted (80-90% of median ht/age) in 1977, 1979, and 1982, respectively. For Embu District, specifically, 22% of one to four year-old children were found to be stunted in 1982 (10). The prevalence of stunting increased with age: 31.9% of children 3-11 months were stunted; 61.9% of children 24-36 months were stunted; and 54% of children 36-48 months were stunted. In Embu District in 1982, 17% of children were mildly-moderately malnourished, 2% were severely malnourished or wasted, and 1% were both stunted and wasted.

CHRONOLOGY OF MAJOR PROJECT EVENTS

By the time the Nutrition CRSP project was funded in September 1981, several trips had already been made by Dr. Charlotte Neumann and other investigators to Kenya to establish collaboration with Kenyan investigators and the Kenyan government. Indeed, the Office of the President granted permission for the project to be conducted within a month of funding, and the USAID Kenyan Mission granted their approval in November 1981. Dr. Neumann and Drs. Eric Carter and Dorothy Cattle went to Kenya in February 1982 to start the project, and operations in Embu commenced in June. The University of Nairobi was temporarily closed in 1982 due to an attempted coup, and so approval of the Subcontract by the University was delayed until December 1982.

The latter half of 1982 and all of 1983 were primarily devoted to establishing project logistics, hiring and training staff, selecting households, and designing and pilot testing the research methodologies. Collection of data for the "main study" commenced in January 1984, with the objective of terminating in December 1985. Early in 1984, Dr. Nimrod Bwibo assumed the role of Kenyan Principal Investigator, replacing Dr. James Kagia, who remained as a co-investigator.

In January 1985, the project held an annual review meeting, which was attended by numerous researchers, government officials, USAID staff, and other interested parties from around Kenya.

Also in January 1985 were three key staff changes: Dr. Michael Baksh replaced Dr. Eric Carter as the Field Director; Dr. Michael Paolisso replaced Dr. Dorothy Cattle as the Field Anthropologist; and Dr. Mark Marquardt replaced Dr. Amrullah Khelghati as the Field Physician. As a result of these changes, and because the collection of "core" data was well under control, several new non-core, Kenya-specific, research investigations were designed and implemented during 1985 and early 1986. These studies are described in this report.

The 1983-84 drought in East Africa had a major impact on the study site and the functioning of the project. The drought reached its peak in mid-1984, and famine peaked in the latter half of 1984. Another period of food shortage occurred in May and June of 1985 before the first significant harvests became available. Project staff participated in famine relief activities and the rehabilitation of severely malnourished children.

While the "main study" terminated in December 1985, fieldwork was conducted through March 1986, primarily as a result of the Time Allocation and Agricultural Production Studies, each of which required an entire year of data collection.

The project ceased all operations in Embu on April 30, 1986, and on the following day, Meals For Millions, an international development organization, commenced operations in the Nutrition CRSP study site.

The last data tapes were sent from Kenya to UCLA in mid-1986, and research efforts over the past year have concentrated on data editing and analysis, and preparation of this report.

REPORT OBJECTIVES AND ORGANIZATION

The objectives of this report are, first and foremost, to address the three important hypotheses described above; second, to relate, as thoroughly as possible in the space and time allowed, the nature of the data available and how they were collected (including a feel for how food intake and/or other variables [e.g., work, health, cognition, etc.] interact with one another); and third, to draw policy implications from the findings and make suggestions regarding future research. See Appendix A for additional project outputs.

To meet these goals in a logical manner, the report is organized into four parts: Background; Sampling, Methods, and Descriptive Findings; Results of the Project-Common Analyses; and Summary and Policy Implications.

The remaining two chapters of Part I describe the research site, and the project's development and operations in the field, respectively. This backg ound information provides a contextual setting for which the report's findings and other discussions can be better interpreted and understood.

Part II commences with a summary of the core and Kenya-specific investigations, including the major variables that were measured. Chapter 5 then describes the sampling universe, the process of household selection, and the bias between the universe and study samples. Chapters 6 through 20 summarize the methods and descriptive findings of each data topic. More specifically, each chapter describes the objectives for investigating a particular topic; the sample; the development of data collection techniques and the staff training; the actual techniques of data collection; the quality control measures employed; preparation of the data for analysis; and the available descriptive statistics and findings. Chapter 21 describes the 1983-84 drought and its impact on the study population, the response of the community and the project to the famine, and the impact of the drought on the study design. Chapter 22 describes the project's data management system.

Part III is devoted to the results of the testing of three major hypotheses being conducted by all three Nutrition CRSP country projects. Chapters 23, 24, and 25 discuss the effects of food intake on pregnancy outcome, toddler cognition, and toddler health and growth, respectively.

Finally, Part IV summarizes the policy implications from the findings of the report.

REFERENCES

1. Calloway, D., et. al. Collaborative Research Support Program on Nutrition. Report to the External Evaluation Panel, 1982.

2. Calloway, D., et. al. Collaborative Research Support Program on Nutrition. Final Report to USAID on Contract No. AID/DSAN-C-0002 University of California, Berkeley, 31 May 1980.

3. Ginneken, J. K. V., and A. S. Muller, eds. Maternal and Child Health in Rural Kenya: An Epidemiological Study. London: Croom Helm Ltd., 1984.

4. Haugerud, A. Household Dynamics and Rural Political Economy among Embu Farmers in the Kenya Highlands. Ph.D. Dissertation, Northwestern University, Evanston, Illinois, 1984.

5. Kennedy, E. T., and B. Cogill. Income and Nutritional Effects of the Commercialization of Agriculture: The Case of Kenya. Final Report Submitted to International Fund for Agricultural Development, Rome, Italy. Washington, D.C.: International Food Policy Research Institute, 1986.

6. Fleuret, P., and A. Fleuret. Socio-Economic Determinants of Child Nutrition in Taita, Kenya: A Call for Discussion. Culture and Agriculture. Spring 1983, pp. 8, 16-20.

7. Brokensha, D., and B. W. Riley. Introduction of Cash Crops in a Marginal Area of Kenya. In: Agricultural Development in Africa: Issues of Public Policy, edited by R. H. Bates and M. F. Lofchie, New York: Praeger Publishers, 1980.

8. Republic of Kenya. Social Perspectives: The Rural Kenyan Nutrition Survey February - March 1977, 2:4. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, 1977.

9. Republic of Kenya. Report of the Child Nutrition Survey 1978 - 1979. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, 1979.

10. Republic of Kenya. Third Rural Child Nutrition Survey 1982. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, December 1983.

Chapter 2

THE SITE

The Nutrition CRSP Kenya Project was conducted in Kyeni South Location, Embu District. The objectives of this chapter are to 1) summarize the criteria that led to the selection of Kyeni South Location as the project site, 2) describe the site's major geographical and climatic characteristics, and 3) present basic sociocultural background information on the study population. The chapter, in short, provides contextual information useful for understanding the study site and population, and for interpreting the study's findings.

THE SELECTION OF KYENI SOUTH LOCATION, EMBU DISTRICT

Several research and other criteria led to the selection of Kyeni South Location as the study site for the Nutrition CRSP Kenya Project. Before discussing these criteria, it is important to point out that the project benefited immensely from the cooperation of the study population and from individuals and bodies of the Kenyan government. The community of Kyeni South Location in general, and study households in the sub-locations of Kathanjure, Kathangure, and Karurumo in particular, exceeded the project's expectations and hopes of cooperation throughout the study. The project's success was also made possible by the assistance of officials at all levels of government. Of immediate importance, the Provincial Medical Officer made available several office and other facilities (described below), and the Embu District Commissioner and Runyenjes Division Officer lent moral support and encouragement throughout the period of fieldwork. At the local level of government, the Chief and Sub-Chiefs of Kyeni South Location not only offered freely all assistance requested of them by the project, but went out of their way to ensure that, at the community level, nothing impeded orderly progression of the project from its beginning to end.

Criteria for Community Selection

The characteristics desired of each project's selected study community were identified in the initial Nutrition CRSP planning documents and later expanded by the Technical Advisory Group (TAG) on Statistical Design and Data Management that met at the Harvard School of Public Health in January, 1982. These criteria included the following: 1) population stability, 2) population homogeneity, 3) adequate size of population base, 4) proper range of nutritional status, 5) adequate representation of target individuals within the population, and 6) adequate community infrastructure.

In addition to these criteria, the Kenya project was guided by the development priorities and special needs of the Kenyan Government. In particular, the Ministry of Health expressed a strong desire to raise the level of nutrition awareness in Eastern Province, and the Nutrition CRSP project provided a focus of attention on nutrition issues that would facilitate this policy objective. Thus, after taking into account both the criteria recommended by the TAG for an adequate research site and the recommendations of the Kenyan Ministry of Health and the Department of Community Health (Faculty of Medicine) at the University of Nairobi, the community of Kyeni South Location in Embu District (Eastern Province) was tentatively selected as a suitable research site. In response to this recommendation, the Nutrition CRSP project staff undertook a detailed site assessment to establish the research suitability of Kyeni South Location.

The Nutrition CRSP Kenya Project staff utilized several sources of information to assess the suitability of the Kyeni South Location site. These included the 1979 National Census, the Central Bureau of Statistics Nutrition Survey of 1979, and the records of the Runyenjes and Karurumo health centers and Consolata and Embu hospitals. To supplement this information the project staff conducted a pilot survey in the Fall of 1982. This survey covered 143 households and collected preliminary data on household demographics, anthropometry, reproduction, morbidity, mortality, cultural and ethnic composition, and community infrastructure. All data were carefully examined in light of the selection criteria. This information has been archived but will not be reported in this report since it does not necessarily represent main study households.

Population Stability

Because the project was longitudinal, it was essential that the study area have a stable population so that regular contact with participants could be maintained. The primary factors for consideration with regards to population stability were 1) a low migration rate, particularly emigration, and 2) low to moderate labor translocations for adult males.

Population stability was assessed in several ways and all findings pointed to low migration and low labor translocation. Of the households identified by the Nutrition CRSP pilot survey in 1982, 84% were found to have been present in Kyeni South Location during the 1979 National Census. Additionally this pilot survey reported that the average household in this area had been in existence for 10.7 years. Discussions with Chiefs and other local leaders indicated that very few households ever left the area. In light of this information it was apparent that out-migration would not be a problem with regard to attrition.

Additional evidence indicating the stability of the population was gained through the Nutrition CRSP Preliminary Survey of 1983. In particular, it was learned that relatively few individuals spent substantial time out of the location. Within the year prior to the survey 93.9% of the male heads of household reported spending no time out of the location, 4.6% spent up to one month elsewhere, and only 1.5% were out of the location for more than one month.

In addition, Kyeni South Location is about 160 kilometers northeast of Nairobi. This distance was great enough to preclude a large percent of the heads of households or adult males from working in Nairobi.

It was determined, therefore, that the population of Kyeni South Location was for all practical purposes stable; both out migration and time spent out of the location appeared to be negligible.

Population Homogeneity

The primary concerns with regard to population homogeneity were that the degrees of genetic, ethnic, and cultural diversity be minor, and that households have relatively equal access to such basic needs as water and health facilities. Such factors otherwise stood a likelihood of confounding variables more basic to the research hypotheses.

The Nutrition CRSP pilot survey showed very little tribal diversity: 98% of all individuals in each sublocation belong to the Embu tribe. Virtually all spoke Kiembu as the first language, although Kiswahili, Kikuyu, and English were found to be widely understood. No other important factors were identified which might have significantly impacted on the study findings.

Size of Population Base

In any research study the population base must be large enough to provide an adequate sampling frame to yield a study sample. The population figures from the 1979 National Census indicated that there were 11,469 individuals in the study area (1), providing an adequate base from which to select the required number of target individuals for the main study.

Range of Nutritional Status

On the basis of discussions with local health personnel, and from anthropometric measurements from both the 1982 pilot survey and a special survey of several local schools, the possible site of Kyeni South Location was found to contain an appropriate range of nutritional status and adequate numbers. The anthropometry data indicated that 1) relatively few individuals, about 2.4% of the population, were experiencing severe Protein Energy Malnutrition (PEM); 2) about 30-37% of children between the ages of 0-59 months were moderately stunted with about 20-30% showing mild to moderate wasting (based on weight-for-height and weight-for-age measures), and 3) about 30-48% of all children were in the normal range.

Representation of Target Individuals Within the Population

Since the project was primarily concerned with specific target individuals it was necessary to determine if those individuals existed in the proper numbers to allow for an adequate sample size. The specific groups of interest were reproductively-active females, infants, pre-school children and school-age children. The goal was to have at least 100 individuals from each group in the main study sample. The 1979 National Census population figures showed that adequate numbers of individuals existed in all desired categories and, in addition, results from the pilot survey indicated that 70% of all households had at least one child in the 0-2 year age group, 50% had at least one child 2-7 years old, and 59% had both a child 0-2 years old and one 7-10 years old (1).

Community Infrastructure

Although it was critical that the community itself express a desire to cooperate with the project, it was also important that a local infrastructure exist to facilitate data collection and staff needs. It was especially important that 1) the local administration (Chief and Sub-chiefs) be well-organized and sypathetic to project needs; 2) local health facilities be available for consultation and other support; 3) structures be available for field offices and laboratories; 4) households be accessible by foot if not vehicle; and 5) housing be available for staff.

The Chief of Kyeni South Location, as discussed above, was found to be a remarkably cooperative, insightful, and influential leader. Equally important, he was highly respected by community members. These and other traits contributed towards his ability to coordinate community affairs. Through his staff he was able, for example, to mobilize the community on short notice for important meetings with project personnel. These characteristics indicated that the local administration would be capable of solving any potential difficulties between the project and the community that might lead to household attrition.

Health facilities in Kyeni South Location include both a Rural Health Training Center (in Karurumo), under the Provincial Medical Officer (PMO) of the Ministry of Health, and a missionary hospital (in Kyeni). The PMO was strongly interested in nutrition and offered to assist the project in many ways, including office and laboratory space at the Karurumo Clinic. The staff of Kyeni Hospital were also enthusiastic and supportive of the possibility of establishing a nutrition research project in the local area.

Although permanent, well-constructed structures are not plentiful in Kyeni South Location, a few do exist and landlords indicated that they could be leased for use as offices rather inexpensively. In addition, the Karurumo Health Clinic committed to the project a house-like building for use as a clinic, and an office for use as a laboratory.

Since the project proposed a study area of a few dozen square kilometers, it was essential that access to households and transportation in general not be difficult. Kyeni South Location was found to be blessed with an intricate system of remarkably well-maintained rural access roads, and most households in the area were within a few minutes' walk of one another.

Finally, there was the concern that fieldworkers and other staff be able to locate suitable housing. Since the project intended to employ the majority of field staff from the local vicinity, it was anticipated that housing would not prove to be a problem.

In summary, taking into account all concerns of research criteria and government and community cooperation, the site of Kyeni South Location in Embu District was anticipated to be suitable for the study. To this day the belief is maintained that a more appropriate site could not have been selected.

PHYSICAL SETTING

Location

As mentioned above, the Nutrition CRSP Kenya Study took place Kyeni South Location in Embu District (Eastern Province), which is located in Central Kenya on the southeastern slopes of Mt. Kenya. Embu District is made up of three Divisions: Runyenjes, Siakago, and Gachoka. Runyenjes Division, in turn, comprises six locations, one of which is Kyeni South Location. The center of the study area, which roughly corresponds to the center of Kyeni South Location, is situated at approximately 0°27' S latitude and 37°39' E longitude (Map 2.1).

Within Kyeni South Location, three of five sublocations -- Kathanjure, Karurumo, and Kathunguri -- were targeted for research activities. To maximize logistical convenience, the area comprised by these three sublocations was divided by the project into four clusters prior to the start of the main study. Each cluster has a nearly equal number of study households. The cluster boundaries do not consistently correspond with any political boundaries.

Geography

The study area is part of the "highlands" of Kenya, an area with fertile volcanic soil covering the southwest quadrant of Kenya.

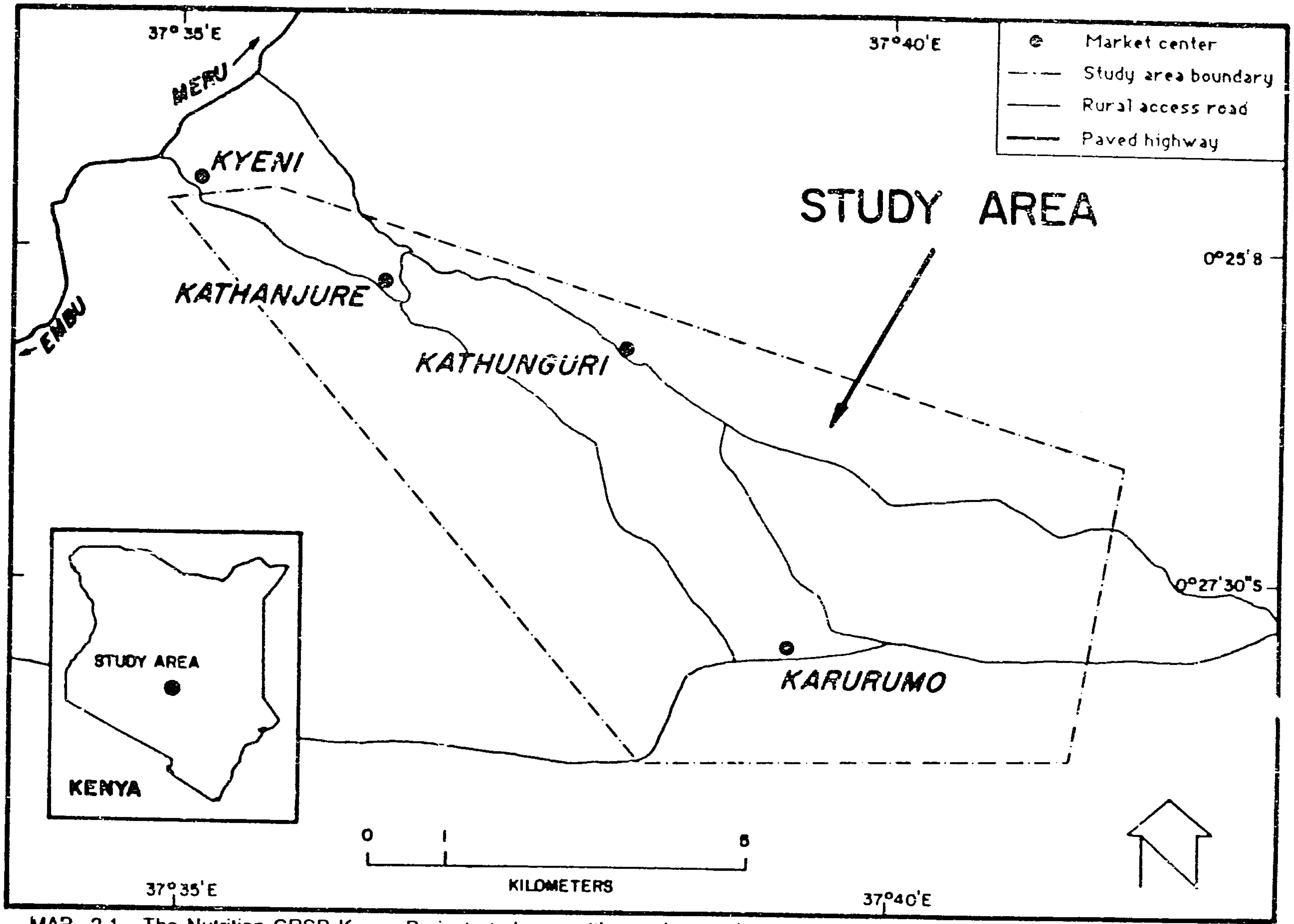
The study area can be divided into two distinct geographical areas, the upper and lower zones. The upper zone covers Kathanjuri, Kinthithe, and part of Kathunguri, at an altitude of 4,000 - 5,000 ft., while the lower zone, covering Karurumo and part of Kathunguri, ranges between 3,000 - 4,000 ft. above sea level. While the land drops gently from the upper zone to the lower, the terrain is interrupted by ridges and valleys.

The upper zone is covered with different types of loamy and clay soils. Most of the lower zone soils contain sand. The area contains a few permanent streams whose volume varies by season.

Climate

The two primary rainy seasons include the "long" rains, from March to May, and the "short" rains, from October to December. The heaviest rainfall is in April and November. The upper zone normally receives over 1000 mm of rain annually, while the lower zone is semi-arid and normally receives an average of 550 mm per year. The coldest months of the year are June and July, while January, February and October are the hottest months. The average mean maximum temperature is 24.6 C; the average minimum is 12.1 C.

Because the upper zone is generally cooler, receives more rainfall, and is more agriculturally productive, this zone is more densely populated than the lower zone.



MAP 2.1. The Nutrition CRSP Kenya Project study area (the study area is comprised of the Kyeni South Sublocations of Kathanjure, Kathunguri, and Karurumo; the Kenyi South Sublocations of Kigumo and Kasafari lie to the north and east of the study area, respectively).

THE POPULATION

Ethnic Affiliation and Historical Background

The Embu are members of a larger ethnic group known collectively as Bantu. This larger group is comprised of various tribes who at a general level, due to centuries of trade, warfare, migration, and inter-marriage, are culturally and linguistically related (2). There are, however, important ethnic differences between Bantu tribes due to historical factors and local adaptations. This is clearly the case for the Embu and their Bantu neighbors – the Kikuyu, Meru and Mbeere (3, 4).

The actual origin of the Proto-Embu is unclear. Oral histories recount either that the Embu always lived in their present location or that they came from far away and incorporated the original inhabitants of the area, the Gumba (4). To date, researchers speculate that the Proto-Embu were part of a series of Bantu migrations of multiple origins from either the northeast or east (5), or the southeast (2).

The ancestors of the present-day Embu were hunters and gatherers who exploited game and other wild foods found in the once extensively forested areas of Embu District. These distant ancestors stayed in the forested areas because of the rich resources and for the protection the forest provided from raids launched by neighboring tribes. Perhaps during the 16th and 17th centuries, the Embu began to practice horticulture in addition to hunting and gathering. Slowly, as population increased and exchange with other groups intensified, the Embu became more reliant on agriculture and livestock obtained through trade. Today this process of intensification continues with households primarily dependent on agriculture and animal husbandry for subsistence.

In the late 19th century, the Embu began to barter, albeit on a seemingly irregular basis, with Arab/Swahili traders from the coast (4). The Embu traded ivory and occasionally slaves in exchange for cattle, goats, clothing, ornaments, etc. These exchanges with professional traders were soon followed by permanent contact with the British, who by 1906 had expropriated the Embu territory (4). The Embu remained under British rule until Kenya's independence in 1963.

Demographic Characteristics of the Study Area

Similar to other rural indigenous groups in Kenya, the Embu population is growing rapidly. Using available census data, Haugerud (3) calculated that Embu population has tripled over the past 60 years: the population was estimated to be 53,000 in 1918; 95,647 in 1962; 156,333 in 1969; and 180,400 in 1979.

Another characteristic of the Embu population is a low migration rate. In 1962, 6.6% of the Embu population lived outside Embu District. By 1969, the number of migrants had declined slightly, with 6.4% living outside the district. In 1979, however, there had been a slight reversal, with 8.8% of the population living outside Embu (3).

As is characteristic of developing countries, a large percentage of the Embu population is under 15 years of age. In 1969 those under 15 years constituted 34.3% of the population, while in 1979 that percentage had jumped to 51% (3).

Finally, as expected with increasing population in circumscribed areas, population density is also rising. In Embu District average population density increased from 162 to 251 persons per square mile during the period of 1969 to 1979. Population density is even higher in the Runyenjes Division of Embu District: 861 persons per square mile in 1979 (3).

General Subsistence and Economic Features

The Embu of Kyeni South Location are small-holder agriculturalists producing both subsistence and market crops. The principal food crops are maize, beans, millet, sorghum, arrowroot, bananas, potatoes and cassava. The main cash crops are coffee, tobacco and cotton, and occasional surpluses of foodstuffs. Although agriculturalists, Embu households keep small numbers of cattle, goats and chickens. These livestock are particularly valuable during times of famine due to drought or pest infestation.

In addition to agriculture and animal husbandry, the Embu also engage in both temporary and permanent remunerative labor. Most cash labor involves work in either the agricultural fields of larger landowners, the local industries such as carpentry, blacksmithing, tailoring, or the rural service sector of shops, hotels, restaurants, etc., either as proprietor or employee. Other cash-earning opportunities exist in the informal economic sector (inter-household outside market-place), principally consisting of the selling of locally-produced commodities such as charcoal, milk, wood, honey, etc.

A number of economic institutions organize the production and distribution activities of Embu households. Of paramount importance are the local marketplaces that regularly serve as exchange places for food and material goods.

In addition to these established marketplaces, three government/corporate institutions structure the selling of coffee, tobacco and cotton. Because most Embu farmers grow coffee as the principal cash crop, the New Kyeni Cooperative Farmer's Society is of extreme importance. This Cooperative functions as the purchasing and marketing center for locally produced coffee, and also provides credit and technical assistance. All coffee growers in the study area are members of this cooperative body.

For those farmers involved in the cultivation of tobacco and cotton, the British American Tobacco Company and the Cotton and Lint Marketing Board, a parastatal organization, function in a similar capacity as the coffee cooperative. Most of the cotton and tobacco grown locally are sold to these institutions.

General State of Health

Based on a cursory review of records available at the government health institutions in the study area (see below), the most prevalent diseases in the location are malaria, diarrhea, intestinal parasites, upper respiratory tract infections, and eye, ear and skin infections.

This morbidity pattern in Kyeni South Location appears to be generally consistent with the disease situation in Eastern Province. A discussion of the latter is insightful since summary morbidity statistics are available, which in time can be compared with project-generated statistical data on the Embu household morbidity.

The infant mortality rate for Eastern Province is 77/1000 live births, of which 52% are neonatal deaths. The five most common diseases in infants and children are pneumonia, diarrhea, measles, malaria and acute respiratory infections (6). The leading cause of death among infants are pneumonia (31%), tetanus (17%), diarrhea (12%), measles (8%) and malnutrition and other (32%) (6). The percentage of stunted children under 5 years of age in Embu is 22%, while the average for Eastern Province in 27% (6). Life expectancy for adults is 53 years at birth (7), and maternal mortality is approximately 32.9 per 10,000 (8).

Current Political and Social Organization

Contemporary Embu political and social life reflects changes instituted due to British rule which modified the traditional socio-political structures. Prior to British incorporation at the beginning of this century, Embu society was characterized by a decentralized polity, consisting of clans, subclans, and local residence groups, all organized around principles of descent and kinship, which in turn were crosscut by age-groups, generation groups and councils of elders (3,4). The principal unit of residence was the extended family homestead with authority resting principally with senior male elders. Land was inherited patrilineally and marriage involved women joining their husbands' residence. Exchanges between clans were common, and best exemplified by the practice of marriage outside one's clan that initiated exchanges of material goods through brideprice and dowry.

The British employed a practice of indirect rule of the native territories. As in other areas of East Africa, when the British obtained control of the Embu they instituted two important changes. First, the British requested each group to send their chief to the local administrative center. The Embu, not having chiefs in their traditional society, were confused, and local groups responded differently. Some sent their de facto local leaders, while others sent fools, outcasts or their physically largest male (the British had used the Kiembu term munene for chief; this term literally translates as "physically big") (3). The office of chief became institutionalized by the British, and these chiefs, of varying quality of leadership, became extremely powerful individuals due to their connections with the British. The chiefs, and their subchiefs, usurped the power and authority of the council and clan elders, and functioned as conduits for their clients' accumulation of wealth, in the form of market permits, land, material goods, technical assistance and information (3).

The second institution instituted by the British was the Local Native Councils (LNC). These administrative mechanisms consisted of the new chiefs under the authority of the British administrative officers (District Commissioner, District Officer, etc.). The LNC funneled development assistance into communities and provided the administration control over the local economy.

A major consequence of the development of chiefs and the LNC was the collapse of the age-sets and generation-sets that had integrated the various Embu homesteads. Moreover, as stated above, the authority of the elders was undermined.

At Independence (Uhuru) in 1963 the Kenya government incorporated much of the rural administrative structure instituted by the British. In Embu District today, chiefs and subchiefs, who work closely with the Commissioners representing the district and province, are the most important administrative officials for individual homesteads within locations and sublocations. The clan structure continues to exert some influence in social proceedings, especially in the case of land transfers, although increasingly land is held by individual title rather than communal arrangement. The opinion of the elders is still important, although their power base is restricted due to the government administrative structure headed by the chief.

It should be emphasized that the chief does not have unmitigated power. The chief's power base depends on the support of local residents. The chief works with elders through formal meetings called barazas, which aim to evoke public consensus on important issues. In addition to barazas, locations and sublocations use a communal self-help strategy called harambee.

Availability of Social Services

Similar to other locations in the fertile Mt. Kenya area, Kyeni South Location contains more government and private social services than other less fertile and scarcely populated rural areas of Kenya. These social services include technical extension assistance, primary and secondary schools, health centers, a water project and a network of feeder and rural access roads.

Both the Ministry of Agriculture and the Ministry of Culture and Social Services provide extension staff in the Kyeni South Location. The Ministry of Agriculture supports five extension agents in the study area who work with local farmers and officers of the coffee cooperative, cotton and lint marketing board and representatives of the British American Tobacco Co. These agents assist farmers in acquiring new technologies and information through either farm visits or training seminars offered at the Embu Agricultural Institute or the District Development Centre.

The Ministry of Culture and Social Services assigns to each location a Community Development Assistant charged with the task of engaging government support for projects originating from community initiative. These projects are of two types: Social Activation Projects and Income Generation Projects. Projects of the Social Activation type are designed to benefit the entire community through, for example, the building of a school, health center, church, etc. Income Generation Projects represent the priorities of a particular group within the community seeking to generate earnings from some activity, such as craft training, building of maize mill, reinforcement of women's group activities, etc.

A social service of equal if not greater importance than extension services is government sponsored education. In Kyeni South Location there are twelve schools of which three are secondary schools (Kyeni Girls High School, Kegonge Boys Secondary School and S.A. Kyeni Secondary School), and the remaining nine are primary schools. The primary schools have an average enrollment of 440 students and a staff of 14 teachers. The local communities provide substantial material and financial support for these schools and, not surprisingly, are quite active in the school programs through parental groups and elected School Committees consisting of parents, sponsors and representative of the District Educational Board.

In addition to formal schooling, there are two Village Polytechnics in the study area. These two training centers instruct young people who have completed their formal schooling in a number of technical areas. Examples of such technical training are shoe making, carpentry, tailoring, mechanics, etc. Admission is based on a general examination and is independent of previous school performance. The centers are open to all Kenyans but local residents are especially encouraged to apply.

Government and private health care services are available to Kyeni South residents. The location is fortunate to have a Catholic mission hospital in Kyeni and a rural health training center at Karurumo. Although not large by urban standards, the Catholic hospital does have a full complement of medical professionals (physicians, nurses, technicians, support staff), 117 beds and 33 cots, and offers a wide range of medical care. A minimal fee is charged for services rendered. The hospital is at the upper periphery of the study area.

The Karurumo Rural Health Training Centre, established in 1978, has a staff of 68, including 13 nurses, five clinical officers, one pharmacist, two laboratory technicians, four family planning officials and two nutrition extension staff. It is estimated that the Centre sees 5,000 outpatients per month, in addition to inpatient care in a small maternity and children's ward. The Karurumo Centre is within the lower periphery of the study area and about ten kilometers from the Kyeni hospital.

Also located in the study area is a small dispensary at the Kathanjure market place. The dispensary, staffed by two nurses, provides basic curative care for nearby residents. It is estimated that the dispensary sees 2,000 outpatients per month.

Serious illnesses are referred to Kyeni Hospital or to the Provincial Hospital in Embu town (approximately 25 kilometers away).

Other social services available in Kyeni South Location relate to water supply and communication/transportation. In 1972 a harambee-funded Water Project designed to provide water for domestic use for 15,000 households was completed. Originally the water was to be provided without charge, although abuse and wastage prompted local leaders to institute a charge (15 ksh/month; in 1985, 16 ksh = $1.00) for the service. The water is not treated but is sufficiently clean for most domestic use. Due to demand and the limited supply of water, households are severely fined if found irrigating field crops with the piped water.

Although the community has no electricity, telephone service or postal service, there does exist a good system of well-maintained feeder and access roads. Maintained by the Ministry of Transportation, the feeder roads run the length of the study area, while the rural access roads intersect the feeder roads and serve as avenues for transportation and communication to individual household settlements. The feeder roads are passable during the rainy season, although the access roads often wash out during heavy rains. These access roads are maintained by local committees who quickly repair them when damaged.

Summary of Case Studies

The Nutrition CRSP Kenya Project undertook an ethnographic study just prior to and during the first six months of the main study. The goal of the case studies was to complement the main study's reliance on questionnaires and direct observation. This ethnographic undertaking, which consisted of case studies of individual households, was designed to fulfill many functions. First, it was conceptualized as a research effort that would provide investigators with culturally rich descriptions of Kyeni South Location households that would assist in the interpretation of quantitative data. Second, within the general anthropological description generated by the case study protocol, information on the project's main study variables would be collected. This second priority was instrumental in clarifying the hypothesized relationships between food intake and a number of dependent variables. A third objective was to use the case study information to "fine tune" the core-study questionnaires. The following briefly summarizes the main foci of the case studies and a few of the findings, particularly those of significance to the core hypotheses and functional areas.

The case studies began in November 1983 and concluded in March 1984 (9). Twenty households were selected from those remaining after the main study households had been identified following the Rapid Pregnancy Survey (see Chapter 5). While these households resembled main study households, they were not necessarily representative of the area. Their selection was based on composition, cooperation and location. Selected teams of enumerators visited these households on a regular basis, employing open-ended questions, unstructured conversation and observation to record information in the following general categories: household composition, physical setting, social characteristics, income and expenditure, decision-making, general activities, typical daily tasks, agriculture, eating and food sharing, and sanitation and hygiene.

In a preliminary manner, enumerators sought to elicit possible relationships between socioeconomic characteristics and attitudes and behavior regarding diet, health, pregnancy and eduction. For example, household socioeconomic position was found to be closely related to access to education and information, which often leads to significant "off-farm" income. This "off-farm" income is critical, since households unanimously reported experiencing money problems after paying school fees and during and after periods of depleted crop supplies, pregnancy, and unexpected illness.

The case study questions regarding decision-making in and response to common and atypical households situations proved particularly insightful. Respondents answered questions on "what would happen if", for example, "your wife was sick?" The answers to these open-ended questions revealed many subtle interactions relevant to the core hypotheses. For example, respondents reported that during prolonged adult convalescence due to illness or pregnancy, household members' roles adjust to the absence of this key individual; children accept more responsibilities, the husband may undertake traditionally female tasks (the opposite is also true), school attendance may be affected, the level of sanitation and hygiene may decline, and closely-related kin may provide prolonged assistance. All these responses are clearly relevant to many of the hypothesized relationships investigated during the project's main study.

Finally, much of the case study research focused on food production and food intake. As in the example above, informants reported many possible interactions between the type of agricultural production and the availability of food for the households. Respondents described problems of land shortage, irregular rains, lack of technical assistance and how households adapted to such deficiencies through, for example, temporary wage labor, the growing of cash crops, the marketing and exchanging of food, and strategies for preparing "satisfying meals" with few ingredients.

The above short description illustrates the type of ethnographic information collected during the case studies. This qualitative information complements and will help interpret the quantitative data collected through the use of questionnaires during the main study. Additionally, the case study material continually raises new research questions for the main study to address.

REFERENCES

1. Republic of Kenya. Kenya Population Census, 1979, Volume I. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, 1981.

2. Odhiambo Atieno, E. S. A History of East Africa. London: J.M.F. Williams, 1977, pp. 64-65.

3. Haugerud, A. Household Dynamics and Rural Political Economy Among Embu Farmers in the Kenya Highlands. PhD Dissertation, Northwestern University, Evanston Illinois, 1984.

4. Mwaniki, H. S. K. A Political History of the Embu: C.A.D. 1500-1906. M.A. Thesis, University of Nairobi, 1973.

5. Middleton, J. and G. Kershaw. The Central Tribes of the Northeastern Bantu. In: Ethnographic Survey of Africa, Part V, edited by D. Forde, London: International African Institute, 1965.

6. Republic of Kenya. Situation Analysis of Children and Women in Kenya, Section 4, The Wellbeing of Children. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, 1984.

7. UNICEF. The State of the World's Children. Oxford: Oxford Press, 1986, pp. 132-133.

8. World Health Organization. World Health Statistics. Geneva: WHO, 1982.

9. Cattle, D., and B. Nyaga. Case Studies: Preliminary Report. Nutrition CRSP Kenya Project, March 1984.

Chapter 3

PROJECT DEVELOPMENT AND FIELD OPERATIONS

This chapter describes briefly the administrative, financial and staffing arrangements that were developed to manage the Kenyan Nutrition CRSP Project.

CONTRACTUAL ARRANGEMENTS

Following a feasibility visit by Dr. Christina Wood of the University of California, Berkeley, Dr. Charlotte Neumann visited Kenya in 1979 to further investigate its suitability for the CRSP Project. This visit began a two year period of planning and discussions in order to determine the feasibility of Kenya for the project and secure the concurrence of the USAID Kenya mission. In November of 1981 Dr. Irwin Hornstein, representing the USAID office of Nutrition in Washington D.C., and Dr. Charlotte Neumann, the Principal Investigator from UCLA, traveled to Kenya to expedite USAID clearance. Meetings were held with the USAID Kenya Mission, the Ministry of Health, the University of Nairobi Medical School, the Nutrition Unit and Central Bureau of Statistics of the Ministry of Finance and Planning, and the Kenyan Medical Research Institute. These meetings were designed to explain the nature of the project as well as establish contact with the various potential collaborators in Kenya in order to delineate areas of mutual interest and the proposed content of the research. Discussions were also held around budgetary, administrative and logistical arrangements. This trip concluded with a very positive reaction from all interested parties and the official concurrence from USAID, allowing the project to proceed, was received that same month.

The USAID clearance allowed the project to begin discussions with the University of Nairobi concerning a formal subcontract and other collaborative arrangements. A delay was experienced in signing this subcontract due to student unrest at the University which necessitated its closing in 1982. In spite of this temporary setback, a subcontract between the University of Nairobi and the University of California (UCLA) was signed on February 28, 1983 by the Vice Chancellor, Professor Mungai, and the Registrar, Mr. Gicuhi, for the University of Nairobi, and by Mr. Robert Pierce on behalf of the Regents of the University of California for UCLA. This subcontract allowed for the flow of funds to the University of Nairobi so that field work could proceed.

INSTITUTIONAL AFFILIATIONS

In order for the project to be successful it was essential that it establish close institutional arrangements with various government and non-government organizations which were involved in nutrition issues and which could facilitate the work of the Nutrition CRSP Project. Among these were the following:

University of Nairobi, School of Medicine - The Dean of the School of Medicine, and Chairman of Obstetrics, Dr. Mati, was extremely supportive and helpful. Additionally, the Departments of Community Health, Pediatrics, Immunology, Physiology, and Computer Science provided invaluable assistance to the project.

Ministry of Health, Government of Kenya - The central contact was Dr. S. Kanani, the Deputy Director of Medical Services. The Provincial Medical Officer for Eastern Province, Dr. Oyoo, provided the project with essential logistical support through the Karurumo Rural Health Training Center and the Provincial Hospital in Embu.

Ministry of Finance and Planning - The Central Bureau of Statistics (CBS) was very cooperative. They shared training materials, census data, and maps with the project as well as the loan of three fieldworkers and a senior field supervisor from the Embu District Office who had worked on the recent census and nutrition surveys to help with the training of the Kenya project staff. The senior supervisor was seconded to the Nutrition CRSP for its duration. Of special mention at CBS are Mr. Omoro and Dr. Agunda, the director. The Nutrition Coordinating Unit, headed by Mr. Wasonga, also provided significant assistance in the planning of the project.

Ministry of Education - The office of Educational Research participated in the discussions about the studies on school performance in relation to food intake and nutritional status.

Kenya Medical Research Institute (KEMRI) - Dr. Stephen Kinoti, a physician, nutritionist and director of the Medical Research Institute of KEMRI shared his technical staff and laboratories for food composition analysis. Also, one of his staff was hired as a field nutritionist with field staff training responsibilities.

Institute of Development Studies - The Institute, located at the University of Nairobi, was helpful in consulting on some of the socio-economic surveys and household productivity studies.

Comprite - Comprite Data Entry, a private sector company, provided invaluable assistance in entering the large amounts of data onto computer tapes so that they could be transferred to UCLA for analysis. They provided rapid and accurate data entry with full verification.

United States Agency for International Development, Kenya Mission - The Kenyan Mission provided advice, relevant information and moral support to the Nutrition CRSP Program. They were particularly helpful with advice in administrative and protocol matters. They also expedited clearance of all USA CRSP project personnel and consultants coming to Kenya. Of special mention are Dr. Rose Britanek, Mr. Charles Mantione and Mrs. Linda Lankenau, all of whom visited the project site and had an excellent understanding of the project.

In addition to these supporting organizations, special acknowledgements are made to the Member of Parliament from Embu, Mr. Jeremiah P. Nyaga, for his public support; to the Management Entity consultants and staff; to the former Chief of Embu District, Mr. Fred Nthambiri and the Subchiefs for their constant support and assistance; to the Danfa Project under Dr. Alfred Neumann and Ms. Ramona Wassenberg for their help in the preparation of the original project proposal; to Mr. Philip Costic of Contracts and Management, UCLA, for his personal interest and workload on behalf of the project; to Ms. Lanita Hetland from UCLA for her administrative support with regard to the fiscal management of the project and to Dean A.A. Afifi and Assistant Dean Peggy Convey for their support of the project; and to the UCLA School of Public Health for its assistance throughout the life of the project.

The project was also supplemented by additional financial support. Approximately $15672 was received from a Biomedical Research Support Grant through the UCLA School of Medicine and the School of Public Health; Professor Allen W. Johnson of the UCLA Department of Anthropology arranged for $6000 to be transferred from his National Science Foundation grant to supplement some project activities; University of California Berkeley funds were used to support the work of Suzanne Murphy; the project was assisted by approximately $5500 in computer funds through Albert A. Barber, Vice Chancellor of Research at UCLA; and UNICEF allowed the project to purchase vehicles at cost through it's reimbursable procurement plan.

PHYSICAL FACILITIES

One of the first actions that needed to be taken was the establishment of offices for the Nutrition CRSP Project. With the approval of the Provincial Medical Officer, it was decided that the project could construct an office building on the grounds of the Embu Provincial Hospital. It was agreed that at the conclusion of the project, this building would become the property of the hospital. This building provided office space for the Field Director, Administrator, accountant, secretaries, and main laboratory, and had additional space for storage. It also served as the base station for a 2-way VHF radio communication system. An additional office was rented in Embu for the data management staff, storage of most of the field records, and the Apple microcomputer used in field operations. A field laboratory was set up at the Karurumo Health Training Center for the RMR determinations and a small building was used for physical examinations, taking of blood and other samples and for selected anthropometry. This space was loaned to the project by the Provincial Medical Office of the Ministry of Health.

Given the size of the area to be covered by the project, it was decided that one field office should be set up in each of the four clusters to manage the day-to-day data collection activities. Four small houses were rented so that each cluster had one centrally located office. All fieldworkers reported to their respective cluster office every morning and afternoon. Each cluster office was staffed by a "field office supervisor" who, along with the functional supervisors, ensured that assignments were made and carried out daily, that households were visited as scheduled, that completed data forms were forwarded promptly to Data Management, and that all necessary supplies and materials were available for the fieldworkers.

TRANSPORTATION AND COMMUNICATIONS

At the peak of operations the project maintained ten vehicles for the purpose of transporting various groups of fieldworkers and supplies to the work sites. In addition, the project had a 2-way VHF radio system which allowed for communications between the various work sites, vehicles and the main office. This system consisted of a base radio in the main office in Embu, five mobile radios in vehicles, and two hand-held radios. In an area lacking telephones, the system saved a great deal of driving by allowing for the coordination of multiple and simultaneous project activities. A vehicle shuttle, operating on a fixed schedule serving all clusters and the Embu office, transported supervisors to different areas, data forms from the field to the data office in Embu, and supplies to the field. It was also used in emergency situations.

STAFFING

The Nutrition CRSP Project staff was made up of a large and diverse group of researchers, field staff, administrative and support staff. The following section outlines those who contributed to the successful completion of this project.

Principal Investigators

Final responsibility for all project matters rested with the Principal Investigators. They were drawn from the two universities responsible for the Kenya CRSP Project and are listed in Table 3.1. In addition to these Principal Investigators, there were two Co-Principal Investigators and one Co-Investigator drawn from the University of California at Berkeley; these are listed in Table 3.2.

Faculty Investigators

Faculty investigators based at UCLA and the University of Nairobi assisted in the development of the study research design and implementation. Table 3.3 lists these individuals by the functional area in which they were involved.

TABLE 3.1
The Nutrition CRSP Kenya Project's principal investigators.

University	Name	Date
UCLA	Charlotte Neumann, M.D., M.P.H.	1982-1987
U. of Nairobi	James Kagia, MBChB, M.P.H.	1982-1984
	Nimrod Bwibo, MBChB, M.P.H	1984-1987

TABLE 3.2
The Nutrition CRSP Kenya Project's UCB participants.

Name	Dates
Janet King, Ph.D.	1982-1983
Robin Gorsky, Ph.D.	1983-1984
Suzanne Murphy, Ph.D.	1985-1987

TABLE 3.3
The Nutrition CRSP Kenya Project's faculty investigators.

InstitutionalArea	Name	Affiliation
Cognition/ Psychology	Emmy Werner, Ph.D. (1982-1983)	UCLA
	Julius Meme, MBChB (1982-1986)	U of Nairobi
	Marian D. Sigman, Ph.D. (1983-1987)	UCLA
Data Management/ Epidemiology	Anne H. Coulson (1982-1987)	UCLA
Food Intake	Stephen Kinoti, MBChB, M.S. (1982-1987)	KEMRI
Immunology	T. Bowry, MBChB (1982-1987)	U of Nairobi
	David Koech, Ph.D. (1982-1987)	KEMRI
	E. Richard Stiehm, M.D. (1982-1987)	UCLA
Infectious Diseases	Peter Tukei, Ph.D. (1982-1987)	KEMRI
	James Cherry, Ph.D. (1982-1987)	UCLA
Reproduction/ Anthropometry	A.A.J. Jansen, M.D., Ph.D. (1982-1987)	U of Nairobi
Statistics	Abdelmonem A. Afifi, Ph.D. (1982-1987)	UCLA
	Potter Chang, Ph.D. (1987)	UCLA
Work Physiology/ RMR	Kihumbu Thairu, Ph.D., MBChB (1982-1984)	U of Nairobi
	M'Tama Mugambi, MBChB, Ph.D. (1985)	U of Nairobi
	Kimani Kung'u, MBChB, Ph.D. (1986-1987)	U of Nairobi
	Gerald Gardner, Ph.D. (1982-1987)	UCLA

Field Staff

Project staff working in Embu and Kyeni South Location consisted of about 170 individuals at the peak of the project. Field staff were engaged in either data collection, laboratory analysis, data management, or administration support. The staff were divided into "senior-level" and "junior-level" personnel.

The Field Director was ultimately responsible for all project operations. He was complemented by the Administrator who oversaw most financial, logistical, personnel and support details. The balance of the senior staff was made up of field investigators assigned to the various areas of data collection. In most cases the senior UCLA field investigators worked with counterpart Kenyan staff. Table 3.4 lists all senior staff members.

The junior field staff was comprised primarily of data collection and data management personnel. The distribution of the junior field staff is provided in Table 3.5. Junior staff fieldworkers were responsible for data collection in a particular function, and were supervised by the senior staff member responsible for that function. Between four and 24 fieldworkers worked in each functional area depending on the function. These fieldworkers were distributed evenly over the four clusters. All fieldworkers were from the general vicinity and lived in or near the study area. They were employed prior to the commencement of data collection and all underwent a long orientation and training period. Junior-level supervisors were, in general, selected from the enumerator pool.

To facilitate the work of the field staff and data management staff, a support staff was hired. Table 3.6 provides a breakdown of this group.

Consultants

In addition to the field and faculty investigators, the project called on outside consultants to address special needs. Table 3.7 lists individuals who were consulted and the area of their assistance.

Research and Administrative Staff

Finally, the project was supported by staff at UCLA who assisted with data management, data analysis, day-to-day administrative tasks, and the writing of reports and findings. Table 3.8 lists these individuals.

FISCAL PROCEDURES

The flow of funds to the Kenya Project was complicated and designed to protect the project against fiscal disruptions. Basically, there were two main flows into the project: first, funds which were required for the fulfillment of the subcontract with the University of Nairobi and, second, funds which were required to meet University of California related expenses that were outside of the control of the University of Nairobi.

Subcontract Funding Flow

Funds were transferred quarterly from the University of California (UCLA) to the University of Nairobi (U of N) upon receipt of expenditure reports and expense projections prepared by the Nutrition CRSP Administrator and Field Director and approved by the U of N. These funds came as an advance, based on a submitted budget and proper documentation of previously received funds. UCLA maintained an external project account in Nairobi at the Commercial Bank of Africa (CBA) which was later moved to Barclay's Bank (under the name "U of C. Board of Regents") to facilitate more timely transfers. This external account was put into place because this made it easier to trace transfers if they were lost. Both subcontract-related and UC-related funds were transferred into this account. The quarterly advances from UCLA were deposited into this account; the project Administrator then transferred the subcontract-related funds to the Nutrition CRSP Research Account through the Finance Department of the U of N.

TABLE 3.4
The Nutrition CRSP Kenya Project's senior field staff.

	Name	Title	Dates
UCLA Staff:	Eric Carter, Ph.D.	Field Director	1982-1985
	Michael Baksh, Ph.D.*	Field Director	1985-1986
	William Martin, M.P.H., M.B.A.	Administrator	1983-1986
	Dorothy Cattle, Ph.D.	Anthropologist	1982-1985
	Michael Paolisso, Ph.D.*	Anthropologist	1985-1986
	Amrullah Khelghati, M.D., M.P.H.	Field Physician	1983-1985
	Mark Marquardt, M.D., M.S.P.H.	Field Physician	1985-1986
	Sue Roberts, Ph.D.	Nutritionist	1982
	Susan Weinberg, M.A.	Nutritionist	1983-1986
Kenyan Staff:	Duncan Ngare, B.A.†	Social Scientist	1983-1986
	Erastus K. Njeru, B.Sc.†	Data Manager	1982-1986
	Susan D'Souza, M.A.	Psychologist	1984-1985
	Charity Njiru, B.Ed.	Nutritionist	1984-1985
	Wilson Mugisha, HND	Lab. Technician	1983-1985
	Sam Kabengera, HND	Lab. Technician	1983-1985
	James Waswa, MBChB	Field Physician	1984-1985
	Tom Nguli, B.Com.	Accountant	1983-1986
	David Cheboi, B.Com.	Asst. Administrator	1984-1985
	Charles Kinyungu	RMR Technician	1983-1985
	Ephantus Kimotho	Clinical Officer	1985-1986
	Ben Muriria Sr.	Field Supervisor	1982-1986
	Mekesh Meke, B.Sc.	RMR/Physiology	1983-1984
	Julius Kinuthia, HND	RMR Technician	1983-1985
	Benjamin Nyaga, B.A.	Social Scientist	1983-1984
	Millicent Omuhambe	Senior Nurse	1983-1985
	Ann Pertet, B.Ed., M.A.	Nutritionist	1983-1984
	Dennison Maina	Asst. Administrator	1983-1984
Part-Time Staff:	Dumisile Nxumalo Martin	Asst. Data Manager	1983-1986
	Francis Carter	Admin. Assistant	1982-1985
	Susan Pinder Baksh	Admin. Assistant	1985-1986
	Anita Menna	Admin. Assistant	1985-1986
	Dr. Nyakundi	Physician	1984

* Continued at UCLA from 1986-1987.
† Enrolled in M.P.H. program at UCLA School of Public Health, 1986-1987.

TABLE 3.5
The distribution of Nutrition CRSP Kenya Project junior field staff.

Position		Number
Data Collection Staff:	Enrolled Community Nurses	5
	Supervisors	28
	Enumerators	64
Data Management Staff:	Data Processors	6
	Calculators	15

TABLE 3.6
The distribution of Nutrition CRSP Kenya Project support staff.

Position	Number
Secretaries	2
Drivers/Mechanics	8
Radio/Xerox Operator	1
Office Helpers/Cleaners	8
Night Watchmen	10

TABLE 3.7
Consultants for the Nutrition CRSP Kenya Project.

Name	Area
Alfred K. Neumann, M.D., M.P.H., M.A., F.A.B.P.M	Management/Field Logistics
Alfred Zerfas, M.D., Ph.D.	Anthropometry/Site Selection
Kay Wotton, M.D., M.P.H	Morbidity Staff Training
Derrick B. Jelliffe, M.D., D.T.M.&H., D.C.H.F.R.C.P.	Nutritional Status/Lactation
Patrice Jelliffe, R.N., M.P.H.	Food Intake/Lactation

TABLE 3.8
Research and administrative staff for the Nutrition CRSP Kenya Project, at UCLA.

	Name	Date
Computer Sciences:	Ben Browdy, Ph.D.	1984-1987
	Warren Choi	1986-1987
Staff Research Associate:	Terry Silberman, M.P.H.	1986-1987
	James Thomas, Ph.D. (doctoral research)	1986
	Richard M. Trostle, M.P.H.	1986-1987
Administrative Staff:	Lilly Knutson	1981
	Gloria Ku-Taylor*	1982-1984
	Martha Brady*	1984-1985
	Bonnie Glass-Coffin	1986-1987
	Glenn Wong, M.P.H.	1983-1984, 1987

* Full time

The project Administrator made monthly requests for operating funds from the University of Nairobi. Based on budget projections and actual expenses, the Field Director and Administrator submitted an advance requisition form to Professor Kagia or Professor Bwibo for approval. Professors Kagia and Bwibo reviewed these requests alternately, gave their approval, and forwarded them to the Finance Department. Checks were then issued by the Finance Department for deposit into the Nutrition CRSP Project field account in Barclay's Bank, Embu. This account was exclusively for subcontract expenditure funds. These advances had to be fully accounted for to the University of Nairobi signatory (either Professor Kagia or Bwibo) and to the Finance Department, with every disbursement substantiated by proper documentation before a subsequent advance could be issued. The University of Nairobi also had to account for disbursement of its quarterly advances to the University of California. The Nutrition CRSP Field Director and Administrator worked with the U of N finance officials to prepare these accountings. A simplified view of how funds and requests for funds flowed through the project is provided in Fig. 3.1 Two audits were conducted on the project by the private firm of Deloitte Haskins and Sills. The first audit was done in November of 1984, and the second in February of 1986.

UC Related Funding Flow

In addition to the flow of funds needed to support the subcontract, some funds were also needed to cover University of California related expenses not covered by the subcontract. The Nutrition CRSP Field Director submitted quarterly requests for UC related funding and those funds were sent to the external account. The Field Director and Administrator could then write checks on the UC related funds in the external account. These funds were not deposited into the Nutrition CRSP Project field account in Embu, so that the accounting of these funds could be kept separate from that of the subcontract funds. The accounting of all University of California expenses was carried out according to the Field Accounting Guide (FAG) of the University of California, with the Field Director designated as the "Chief of Party." These funds were also covered by the two audits mentioned above.

Informed Consent

There were two major aspects to obtaining the informed consent of those subjects to be studied in the Kenyan Nutrition CRSP Project. First was the approval of the UCLA Human Subject Protection Committee, and second was the approval of the Kenyan government and community officials.

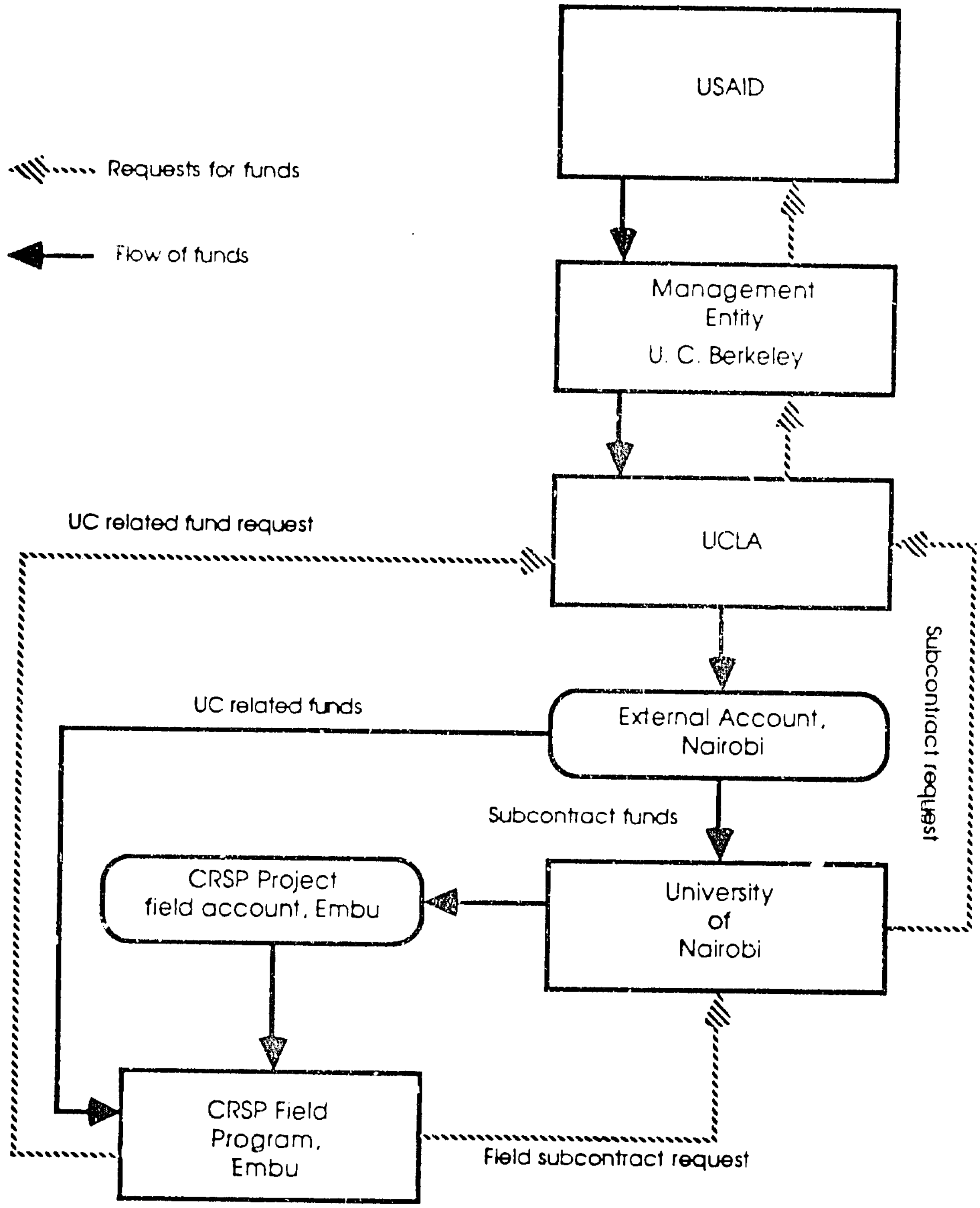


FIG. 3.1. Flow of funds within the Kenyan Nutrition CRSP Project.

UCLA Human Subject Protection Committee Approval

All procedures and protocols for each functional area were submitted for review to the UCLA Human Subject Protection Committees for the general campus and the School of Medicine. The first approval of the committee was obtained in May of 1982. Approval was valid for a period of one year. New applications were submitted each year and have been consistently approved since the start of the project.

A waiver for written consent was requested and approved by the committee. Given that the study was carried out in a rural area of Kenya where many people read little or not at all, it was decided that oral consent would be more appropriate. This procedure was in accordance with the University of Nairobi, School of Medicine practice and was approved prior to the start of data collection.

Activities in Kenya with Regard to Informed Consent

The Nutrition CRSP Project was approved by the Office of the President under research permit number OP/13/001/12C78/(9), University of Nairobi, Faculty of Medicine. Permission was also sought from and granted by the Provincial Commissioner, the Provincial Medical Officer, the District Commissioner, the District Officer, location chiefs and sublocation subchiefs. Permission from these individuals was granted after a series of meetings with members of the field research team.

The next step was to inform the community of the plan and to seek their approval. Local leaders arranged for community meetings (barazas) to be held in several key locations within the study area so the project staff and local leaders could explain the purpose of the project and answer any questions that arose. After a complete discussion of the project the chief asked the community to approve the project by a voice vote. About 800-1000 individuals attended each baraza, and the vote to accept the project was unanimous. The chief also mentioned that individual households were free to decide not to paricipate if they so chose, that no one would coerce them to participate and that there would be no repercussions if they chose not to be involved.

As the research progressed and new studies were introduced, more barazas were held to update the community. The chiefs and subchiefs provided the community with the names of the research team and where they could be reached if there were any more questions or grievances. In addition to this, the field staff lived within or adjacent to the study community and were easily accessible for further discussions, questions or complaints. While many people speak English, all of the discussions were translated into the local languages (Kiembu and Kikuyu) so that everyone was fully informed.

In addition to these barazas the Field Director and his Senior Field Supervisor personally called on each potential study household to answer any questions they had and give them the opportunity to express feelings which they may have been hesitant to raise at the community meetings. A sample of what was said to the household is given below.

> As you may recall from the barazas, the government of Kenya is interested in your health problems, the types and amounts of food that you eat, and how these affect your health. As you recall, the groups you met from the University of Nairobi and the University of California and the field workers of this area will be the people carrying out the study and visiting your homes. We invite you to be a part of this research study.
>
> Your household has been selected among 300 others as it has the people of the right age group that we would like to study, as these are the age groups that have the most problems with lack of food and illness, or whose work may be the most affected. These are mothers and fathers, school age children between the ages of 7 and 9, the young children between the age of 18 and 30 months, the mother who is in early pregnancy or will become pregnant shortly, and her infant up to six months of age. Each of those people that we have mentioned, except the infant, would stay in the study for 12 to 18 months, but followed at least for one year, and for two years at the most.

The study will help us understand how decreased food intake affects the health of the people. We wish to study what and how much people eat, how this is related to how they grow and their body size, how women who are pregnant gain weight, and the size and health of the newborn baby. We wish to know what diseases people get and how their bodies defend themselves against infection. We wish to learn the effect of food intake on the way people work and how activities change. How the children and adults learn and how children do in school will be studied. We also need to know something about a family's economic position. From all of this we hope to find clues as to where improvements can be made in terms of improved intake.

The young men and women of this district to whom you were introduced at the barazas will be visiting your homes several times a month, sometimes more often, as much as once per week. They will usually be the same group of people although there may be some changes now and then. They are from your district and speak your language and some of you will know them already. Some will ask questions about your illnesses and the food you eat, some will actually get a height and weight and measure your arm size and fatfolds. Some will ask about your work and activities and about your water supply, latrines, and other household activities. Some will give tests which will tell us how well you can learn.

An enrolled qualified community nurse, whom you know, will stop to see you and your family members being studied when there is illness, and the doctor will examine you twice a year to see if there are any health problems. If you or other family members are seriously ill the physician will come to see you at that time, and if there is any emergency he will treat you. He will refer you to the hospital if necessary. A doctor or nurse will be getting blood samples from you from an arm vein and will also do some skin testing. One will be for tuberculosis and the other will be to see how your body reacts to other infections. This is a way to tell how the body's resistance to infection is working. Stools will be checked for parasites.

The main inconvenience we see is that you may mind people coming to your house so often and asking questions. You may feel that this is taking your time away from your more important work and that you also might not wish to have people who are not part of your family in your household asking questions and making observations. The project field workers all have name badges with their pictures on them so you will know who they are.

Many of you have had your blood test taken at one time or another and know that it causes slight pain when the needle goes through the skin. Only enough blood will be taken so that we can tell if the blood is normal or if there is anemia or "weak" blood, or trouble with resistance to infection or malaria. The skin tests may hurt at the moment they are given but the pain does not last long. The test is injected into the skin to see how your body reacts. You may have a big red area that may itch and feel strange but this will fade within three or four days.

The breathing test, called the RMR Test, is taken while you are lying down and resting, and you blow and breathe in and out of a tube which is connected to the machine. The machine tells us how much oxygen you use while you are resting. It gives us an idea of how much energy you have to carry out your activities that you have to do. This test will be done on adults and school children only.

Your children may cry during examination, during blood drawing, or skin testing. During skin testing and blood drawing they may have momentary pain and the young babies may cry as much from being held by strangers as from the actual test. If the lab tests tell us that you may have malaria, intestinal parasites or anemia, then you will receive treatment.

Any of the staff, particularly Ben Muriria (the senior field supervisor), the senior supervisors, the field director, or the project physicians will be very happy to answer any or all of your questions about the project. They can be reached through the project office in Embu on the grounds of Embu Hospital (under the water tower) P.O. Box 1002, or telephone 20376. Also, Professor Nimrod Bwibo and Professor Charlotte Neumann are available from time to time. Dr. Bwibo is the Kenyan principal investigator and he comes to the field once per week. Dr. Neumann, who is in California, comes to Embu for about 4-6 weeks three times per year and can be reached through the School of Public Health, University of California, Los Angeles.

You and your family members are free to withdraw from the study at any time without any bad actions or feelings on part of the chiefs or project staff.

If we find that it is difficult for family members to be present for interviews or tests, or there are other difficulties, the household may be dropped from the study.

The information collected will be kept confidential. No one will know to whom the information refers other than by study number, once the information is sent for analysis. Your records will be kept in a locked office.

If any of the procedures or study design change, you will be informed about the changes.

Oral consent for an activity such as the Nutrition CRSP Project is the standard approach in Kenya. The staff was informed that a written informed consent could cause confusion and suspicion among community members. Furthermore, data collection staff were instructed to explain the research procedures when they visited a household and ask permission from the head of the household or a responsible adult before proceeding with the study routines. They were told not to persist if there was resistance or if permission was not granted.

The Project also had full insurance coverage so that individuals being transported by vehicle for physical examinations or RMR tests were covered All questionnaires were translated into local languages so that subjects could fully understood what was being asked, and verbal approval from a parent was required for involvement of a minor.

Chapter 4

SUMMARY OF TOPICS INVESTIGATED BY THE NUTRITION CRSP KENYA PROJECT

This chapter serves to both introduce the subsequent chapters of Part II, and to summarize the major variables investigated by the Kenya Project.

The objectives of sampling, the process of selecting households for the "main study," and the biases between the study sample and the universe are summarized in Chapter 5. Chapters 6 through 20 constitute the bulk of Part II; each is devoted to a specific research topic. Nine of these data topics are "core investigations," and the remaining six are "country-specific." Chapter 21 describes the 1983-84 drought and the project's investigations of the consequences of this on the study population and on the project itself. Finally, Chapter 22 describes the project's data management system; all procedures ranging from initial data capture to final archiving are reviewed.

The data topic chapters (6-20) are presented in a standardized format. Each commences with the objectives for investigating the topic and proceeds to describe the households (and, when applicable, the types of target individuals) sampled, as well as the time frame of the research and the schedule used for data collection. Each chapter then discusses how the data collection techniques were developed, the training of the staff members responsible for carrying out the fieldwork, and the pilot testing activities performed. The actual techniques of data collection are then summarized and followed by a description of the quality control measures employed. The procedures for preparation of raw data for analysis (data reduction, transformation, calculation, etc.) are presented next. Finally, summary statistics are provided for most research topics, and the descriptive findings generated to date are discussed.

THE CORE INVESTIGATIONS

The first nine data topic chapters (i.e., Chapters 6 through 14) comprise the Nutrition CRSP "core investigations." They are labelled "core" because all three Nutrition CRSP country projects were required to investigate them in order to address the project's original "core hypotheses" (see pp. 2-3). The major variables investigated and for which data are available are summarized in Table 4.1.

It should be noted that the "findings" sections of the Food Intake, Anthropometry, and Disease chapters go beyond basic, summary description; several detailed analyses of each topic are provided. It is also noteworthy that Chapter 12, Resting Metabolic Rate, is complemented by Chapter 17, Energy Expenditure of Activity. Finally, the chapters on Socioeconomic Status and Sanitation and Hygiene include discussions of important "non-core" research activities that were conducted to complement the available "core data."

THE COUNTRY-SPECIFIC INVESTIGATIONS

Six major "non-core" research topics were investigated by the Kenya Project. The overall objective for collecting data on these subjects was to assist the interpretation and explanation of findings of the "core" variables. Actually, each of the "non-core" investigations represents an important methodological and substantive contribution by the Nutrition CRSP Kenya Project. The major variables studied by these topics are summarized in Table 4.2.

TABLE 4.1
Summary of the major "core" variables measured by the Nutrition CRSP Kenya Project.

No.	Form Name	Summary of Variables Measured
FOOD INTAKE		
111	Meal preparation	Time (start to finish); Dish; Ingredients; Net weight; kcal/gm; Total kcal (ingredient and dish)
112	Target individual/guest kcal consumed	Dish/food (name and description); Portion taken (net weight); Leftovers (net weight); Net consumed
113	Non target individual (non meal foods and food taken outside the HH)	Subject name; Dish/food; Portion taken (net weight); Leftovers (net weight); Net consumed; kcal consumed
114	Meal preparation - summary	Cooked dish (net weight); Ingredients (net weight)
115	Consumer unit	Dish code; Net consumed; Consumer type
116	Target individual/nontarget individual - summary	Dish/food code; Net consumed
119	kcal intake summary	kcal consumed by dish number; Total kcal consumed by guest; Snack/non HH foods consumed; For target individual - total HH meal; kcals; total non-meal kcals; total non-HH meal kcals
ANTHROPOMETRY		
211	Anthropometry	Length; Height; Weight; Mid upper arm circumference; Head circumference; Skinfold triceps; Skinfold biceps; Skinfold subscapular; Skinfold suprailiac; Skinfold abdomen; Skinfold thigh
MORBIDITY		
301	Disability and chronic disease quarterly update	Illness complaints; Condition; Admission to Hospital
314*	Individual four weekly report	Diagnostic category; Illness duration; Severity; Diagnostic level; Type of treatment; Outcome; Change in activity (appetite or food intake); Task reassignment
315	Household four weekly report-target and non-target individuals	Positive probe responses
323	Clinical exam - summary	Blood pressure; Body temperature; Vision; Height; Tonsil size; Liver size; Weight; Thyroid size; Spleen size; Immunizations; Clinical nutritional diagnoses; Clinical non-nutritional diagnoses

IMMUNOLOGY AND HEMATOLOGY

341	Laboratory - Physiological samples, Embu	Urinalysis (glucose, ketones, protein, haematuria); Haematology (haemoglobin, haematocrit, malaria, R.B.C. stain, R.B.C. morphology, white cell count, PMN, lymphocytes, Eos, Baso, Monocytes, Nuc RBC, Hyper seg PMN, Ferritin); Stool (Ascaris, hookworm, giardia, amoeba, strongyloides, trichuris, taenia, hymendepis, enterobius, schitosomae, Liver Flukes); Breast milk (Creamatocrit, E. Rossette, small Rossette)
342	Immunology and Household water contamination	Skin tests (PPD-Tuberculin. Candida, Tetanus); Immunology (immunoglobin-G, immunoglobin-A, immunoglobin-M, transferrin, reactive protein, complement-C3, prealbumin, albumin); Household water contamination (source, bacterial count)

REPRODUCTION AND LACTATION

411	Reproductive history	Age at first marriage; Number of marriages; Age at first pregnancy; Number of pregnancies; Number of live births; Number of stillbirths; Number of abortion/miscarriages; Number of abnormal deliveries; Menses; Present family planning measures; Past pregnancy history
412	Pregnancy survey	Date of last menstrual period; Current pregnancy status; Expected date of delivery; Symptoms; Prenatal care; Place of delivery; Medication; Lactation
413	Pregnancy outcome	Birth date; Outcome of delivery; Type of delivery; Plurality; Apgar; Where delivered; Who delivered; Weight; Gestational age; Dubowitz; Infant physical condition; Abnormal findings; Maternal condition
421	Lactation questionnaire	How baby is fed; Breast-feeding practices; Supplementary foods; Water; Use of formula; Condition of baby

COGNITION AND PSYCHOLOGY

511	Cognitive infant - summary	Visual attention test; Bayley motor items; Bayley behavior record
512	Infant interaction	Types of interaction
513	Infant behavioral and neurological assessment scale (Brazelton)	State; Elicited responses; Descriptive paragraph; Quieting activity; Behavior score scale
521	Cognitive toddler - summary	Uzgiris Hunt; Bayley items; Bayley behavior record
522	Toddler interaction	Interaction; Play
523	Cognitive toddler - summary - 30 months	Uzgiris Hunt; Bayley items; Bayley motors items; Bayley behavior record; Play
531	Cognitive schooler - summary	Picture drawing; Digit span; Raven's Matrices; Verbal meaning; Block design; Test behavior
532	Schooler classroom observations	How time spent

533	Schooler playground observations	Interaction with other children; Level of activity; Emotion
534	School attendance/performance	Times absent/term; Times present/term; Total number of sessions/term; Grades and score/term
541	Cognitive adult - summary	Digit span; Raven's matrices; Similarities; Block design; Test behavior; Arithmetic; Verbal meaning
641	Care-giving activities	Duration; Activation; Interaction; Location

RESTING METABOLIC RATE

711	Resting metabolic rate	Minute ventilation; Breathing frequency; Tidal volume; Oxygen uptake; Oxygen consumption; Carbon dioxide production; Respiratory quotient; Resting energy expenditure; REE/body weight; REE/body surface

SOCIO-ECONOMIC STATUS

631	Socioeconomic status (SES)	Land (owned & cultivated); Livestock; Income/cash; Employment; Business; Possessions; Materials used in house construction; Labor; Does HH feel better off than 3 months ago?; School expenses; Education of HH head; Church attendance; Mail, telephone, bank; Social participation; Organizational membership; Employment of self or relation; Skills; Visit by extension service; Improved Ag. methods; Improved compound
662	Household economic questionnaire	Land available; Coffee under cultivation?; Size of coffee crop and income; Marketing of coffee; Tobacco under cultivation?; Income from tobacco; Cotton under cultivation?; Income from cotton; Marketing of cotton; Other cash crops; Income from other cash crops; School fees; Household labor
	Subchief household ranking study	Household social status; Household economic status

SANITATION AND HYGIENE

621	Sanitation and hygiene (SAHY)	Washing; Sleeping; Toilet; Shoes; Clothing care; Kitchen; Household cleaned; Food storage; Rodents; Source of water; Compound cleaned; Animals; Observations on animals and compound; House construction; Latrine, Comments
622	Sanitation and hygiene observations	Times LF washes hands; Times infant washed; Times toddler washed; Times schooler washes; Cloth items washed; Times dishes washed

• Form 314 replaced form 313.

TABLE 4.2
Summary of major "non-core" variables measured by the Nutrition CRSP Kenya Project.

No.	Form Name	Summary of Variables Measured
TIME ALLOCATION		
661	Time allocation	Time; Activity; Body position
AGRICULTURE PRODUCTION		
671	Agriculture crop household questionnaire	Food crop; Rains; Amount harvested; Amount sold; Amount planted/local market/other uses; Amount in home storage; Purchased in last month
672	Seed planting questionnaire	Seeds planted; Amount planted; Planting date
681	Market survey - summary	Total number of traders per crop; Price per piece of each crop
ENERGY EXPENDITURE OF ACTIVITY		
NA	Energy expenditure	Energy expended by activity
ADULT LITERACY		
542	Adult literacy test	Reading test; Writing test; Assessment of reading ability; Assessment of writing ability
ANXIETY AND DEPRESSION		
951	Anxiety and depression self report questionnaire (951 part 1)	Headaches; Poor appetite; Sleep; Frightened; Nervous; Digestion; Happy; Thinking; Cry; Decisions; Daily work; Tired
ALCOHOL CONSUMPTION		
951	Alcohol consumption questionnaire (915 part 2)	Amount of traditional beer consumed; Amount of commercial beer consumed; When beer consumed
DROUGHT EXPERIENCES AND RESPONSES		
663	Drought questionnaire	Behavior during drought; What was eaten during drought; Eating patterns; Selling of animals; Employment; Food aid; Future practices; Drops planted now; Food storage; Land cultivated; Animals kept

OTHER SUPPLEMENTARY FORMS

611	Entry/change/exit	Entry, exit or change in status for TIs
612	Census update	Member of household; Sex; Age; Relation to head; Marital status; Year of marriage of head; Religion; Languages; Tribe; Clan; Highest class attained in school; Current school attendance; Time spent out of sub-location last year; Reason for absence; Month of death; Cause of death; Total number of persons living in household; Length of time in sub-location
651	Weather data	Daily temperature (min. and max.); Rainfall; Humidity

Chapter 5

SAMPLING

This chapter reviews the sampling process that was employed during the Nutrition CRSP Project. The criteria for sample selection are discussed along with the composition of the sample. This chapter also reviews the degree of bias that is contained within the sample and how this bias could affect generalizations and other uses of this sample.

THE SAMPLING UNIVERSE

The sampling universe for the project was comprised of the three sublocations of Kathanjure, Kathunguri and Karurumo in Kyeni South Location, Embu District in Eastern Province. According to the 1979 Kenyan National Census of Population, these sublocations included 2,059 households and 11,810 individuals (1).

SAMPLING OBJECTIVES

The research questions which the Nutrition CRSP was to explore can be divided into two main levels of examination. First, there were questions which could only be examined within the context of the micro-community of the household. For example, if the mother's intake were to affect the child's behavior, it would be necessary to collect information for both mother and child within the same household. Second, there were questions such as social and economic performance or household sanitation which required the household to be studied as an entity or as the sum of individual functions.

The research design also required samples of individuals designated by their specific roles in the household or by age groups. These individuals were called target individuals (TIs). Therefore, information needed to be collected on individuals within households, on households as units, and on individuals. The primary task of the entire sampling process was to secure adequate numbers of both target individuals and households to allow for testing of study hypotheses.

A preliminary examination of household composition and age distribution in the Embu population indicated that an overall sample of between 200 and 300 households would be adequate to provide the appropriate numbers of TIs. The target individuals were lead males, lead females, infants (0-6 months), toddlers (18-30 months) and school age children (7-9 years). It is important to note that households were selected for inclusion in the sample based on their ability to supply adequate numbers of the target individuals and not for their representativeness of households in the area. The presence or potential presence of target individuals within the household formed the core of all selection criteria.

CRITERIA FOR THE SELECTION OF THE MAIN STUDY SAMPLE

The specific criteria that were used for sample selection were the following:

1. The household had to be monogamous;

2. The lead female had to be 40 years of age or younger;

3. The lead female should have had a high likelihood of becoming pregnant during the study;

4. The lead male could not be away from the household for longer than three months out of the year;

5. The household should contain one or more children in the toddler or schooler category; and

6. The household must demonstrate a willingness to cooperate with the study for a minimum of one year.

The criteria of monogamy and lead male presence in the household were strictly applied to all households selected. The other criteria were prioritized so as to allow for the formation of adequate sub-samples of TIs. A critical sub-sample was composed of women who would give birth during the main study. This group was the most difficult to identify and so the selection process had to try to maximize the potential of getting adequate sample of mother-infant pairs. It was necessary to collect observations on a minimum of 100 mother-infant pairs with pregnancy mothers observed for at least five months before birth and six months post partum. Thus, at the beginning of the study, all those women in their first three or four months of pregnancy, plus those who were likely to become pregnant during the following nine months, were candidates for satisfying this criterion. The first births eligible for the main study would be those occurring during the fifth or sixth month of the first year; the last births to be accepted into the study would be those occurring during the eighteenth month (July, 1985). The problem of identifying candidates for this group was overcome by excluding all households in which the lead female met any of the following criteria:

1. Was older than 40 years;

2. Had her last pregnancy over five years ago (the surrogate measure for last pregnancy was the last child);

3. Was over 25 years of age with no pregnancies (children were the surrogate measure for pregnancy);

4. Was past the first trimester of pregnancy at the start of the main study; and

5. Had a child born after March 1, 1983 (given the average birth interval for the area (25 months) this did not allow for a high probability that the woman would become pregnant again in time for inclusion in the main study).

In addition to these selection criteria, there were specific definitions for the other target individuals and minimum sample sizes for each group that had to be taken into account. The sampling process not only had to identify prospective candidates for each group but also had to judge their suitability based on their age at the starting date of the main study. Their age at the time of the preliminary survey was irrelevant since the starting date for the main study was delayed. Study design required that each TI enter the designated age period during the study and complete the required period of observation before the end of the main study. The specific requirements for toddlers and schoolers were as follows:

Toddlers (18-30 months)

One year of observation from age 18 to 30 months inclusive was required for at least 100 toddlers. Thus, at the first month of the study, all children between 6 and 18 months of age were eligible candidates for inclusion in the toddler cohort. Children were included in the study when they reached 18 months of age but none were added after the beginning of the second year.

Schoolers (7-9 years)

Observations were required for at least 100 children between the ages of 7 and 9 years for a period of one year. Therefore, to be eligible for the study, a child had to be at least 6 years old but not older than 8 years at the beginning of the study.

While eligible candidates for the toddler and schooler cohorts were readily identifiable, the mother-infant pair presented some problems. The selection criteria allowed for selection of women who were in their first trimester of pregnancy at the beginning of the study or likely to conceive within the first nine months of the study. Therefore, the last acceptable birth could be no later than the eighteenth month of the study.

There were two major problems involved in establishing the mother-infant sample:

1. Determination of who was pregnant and the gestational age; and
2. Determination of who was most likely to become pregnant during the first nine months of the main study.

The factors examined in making these determinations were as follows:

- Prevalence of contraception
- Determination of birth intervals
- Determination of pregnancy
- Dating time of conception
- Probability of fetal deaths
- Infant survival rate (up to 6 months)
- Rate of attrition from the study

The field staff had to continually update their information and reassess the composition of their samples. This was further complicated by a delay in the starting date for the main study.

THE SAMPLE SELECTION PROCESS

The field activities that were necessary to secure the main study sample took place between mid 1982 and the beginning of the main study in January of 1984. Given the complexity of the sample, a number of steps were required to assure that all selection criteria had been satisfied and that the sub-samples were of sufficient number for the testing of study hypotheses.

There were three major stages involved in the development of the main study sample.

Stage I (June 1982 - February 1983)

This stage was characterized by the reduction of the universe from 2059 households to a preliminary sample of 823 households.

Aerial Photography and Mapping

One of the first activities was to map the entire study area. The Central Bureau of Statistics (CBS) and the Bureau of Land and Survey furnished topographical and outline maps of Embu District. These maps had a scale of 1:10,000 which made it difficult to identify dwellings and they lacked the necessary detail that was needed for the study.

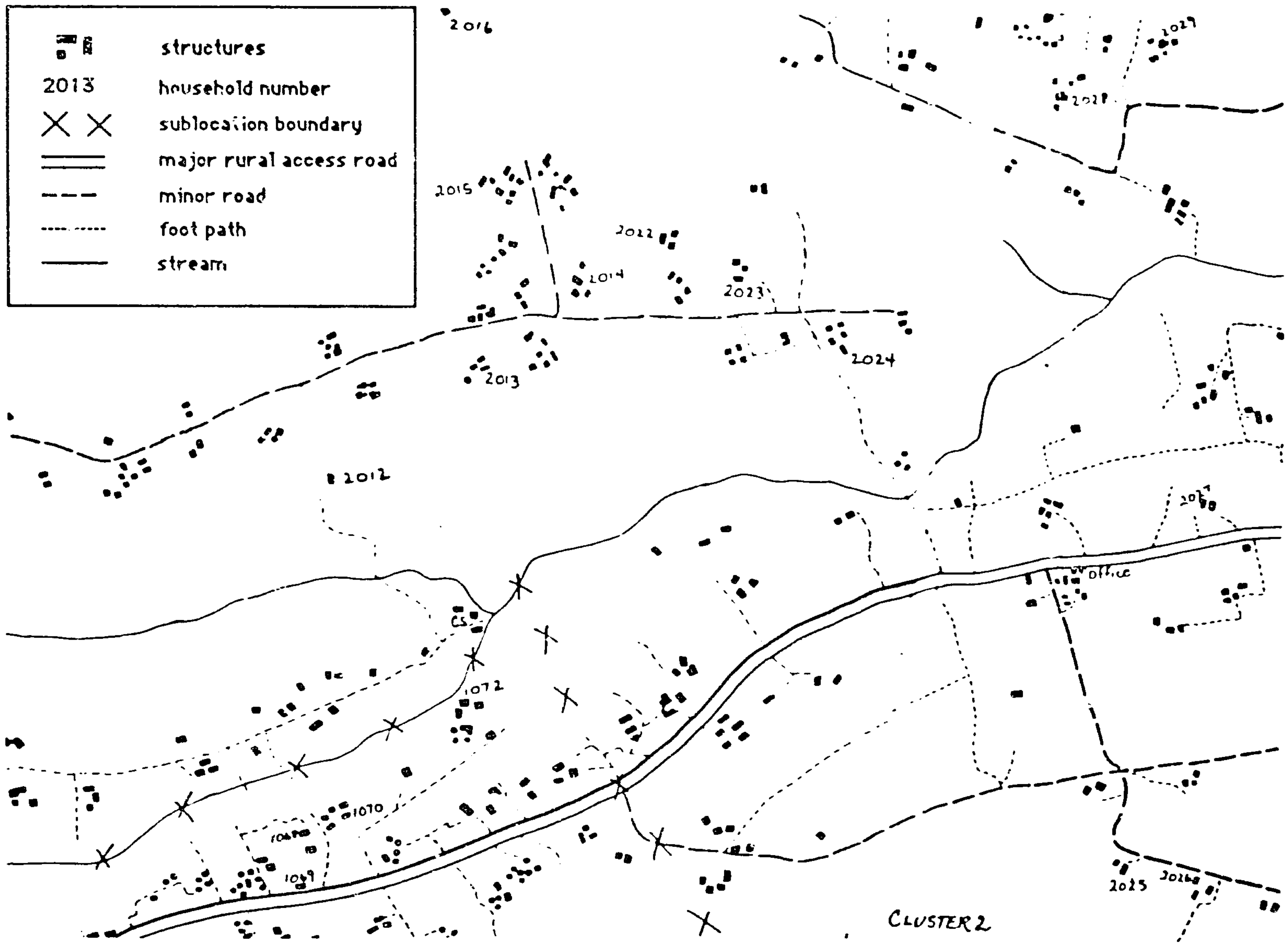
Due to the inadequacies of these maps the project arranged for the Landsat Sensing Agency to perform aerial photography on the study area in September of 1982. The aerial photographs were on a scale of 1:5000 which allowed for adequate detail. The topographic maps were then enlarged to the scale of 1:5000 and the necessary details were transferred from the photographs to the maps. This resulted in a map size for each sublocation of 120cm X 90cm which permitted a maximum household density of two households per cm^2. These maps were large enough and detailed enough to allow numbering of all households and they served as the basis for the household registration. Map 5.1 shows a sample of a working map that was drawn from an aerial photograph.

Field Surveillance

The mapping process allowed for identification of buildings but it did not indicate how many households were in each building or compound nor which buildings were inhabited. This information had to be obtained from a phy ical inspection of each unit. Trained field staff were sent to each area to identify households and gather preliminary information on their suitability for inclusion in the main study sample.

For the purposes of this study, a household was defined as a nuclear or extended family who shared cooking, eating, and sleeping facilities; were economically interdependent; and recognized the same head. The registration and mapping process had assigned four digit numbers to all compounds; it was the responsibility of the field staff to confirm the existence of these households. Once they had confirmed a household they wrote the appropriate four digit number on the door with a magic marker. In cases where there was more than one household in a compound, the household number was expanded to a five digit number with a decimal point to indicate the various households in that one compound. For example, the map number for a compound may have been 3120 but the field staff identified three separate households living in that compound. Those households were then given the number 3120.0, 3120.1 and 3120.2.

Some households had been previously designated as sites for more intensive study by the Central Bureau of Statistics. These households were excluded from consideration in the CRSP study as it was felt that their participation in both studies would be an excessive burden that would precipitate high levels of attrition. The field staff were required to identify these households so that they could be excluded from further consideration. Th[illegible] study was based on a national probability sample and did not include any bias in it.



MAP 5.1. Excerpt from field map used to identify target households.

Household Registration

The registration process was in some ways an extension of the field surveillance activities. Trained enumerators were sent to each household to collect information that would be used to eliminate households which did not meet the basic selection criteria.

Household registration was conducted at the same time as the Preliminary Survey. Enumerators asked basic questions that were designed to form a decision tree. Depending on the responses from the head of household, the enumerator decided if the household met the basic criteria and warranted further examination (Preliminary Survey Census) or whether the household should be rejected from consideration from the main study sample. Table 5.1 outlines the decision tree process and the criteria that were employed at this stage of the sample selection.

The process required that all households considered eligible for further consideration be composed of a monogamous pair living together. Once that basic condition had been met, a positive answer to any one of questions 3, 4, or 5 resulted in inclusion in the preliminary sample. Therefore, at this time in the sampling process it was possible, for example, to include a woman over the age of 35 who was not pregnant if she had a child in the age group of 0-12 years. In addition, the registration process was used to assess the household's willingness to cooperate with the study. The conditions of the study were explained in person and at community meetings by local officials and the project team. Households were free to reject the study. A total of 823 households qualified for further examination and also expressed interest in going on with the survey during this process.

Stage II (February 1983 - August 1983)

The sample was reduced from 823 to 447 households during this stage. The tool used to reduce the sample was the Preliminary Survey. The Preliminary Survey consisted of a household census which recorded information on household composition, ages, reproduction, morbidity, anthropometry, mortality, and household construction. A preliminary food intake study was also done at this time.

TABLE 5.1
Decision tree used during initial household registration.

Question	Response and action
1. Is there a husband/wife pair living in the household?	No --- Reject Yes -- Ask question 2
2. Is the wife the only living wife?	No --- Reject Yes -- Ask question 3
3. Is there a child 0 - 12 years of age?	No --- Ask question 4 Yes -- Do census
4. Is the wife pregnant?	No --- Ask question 5 Yes --- Do census
How old is the wife?	> 40 years --- Reject < 40 years --- Do census

The objective of this survey was to gather more detailed information on the household's ability to provide target individuals given the further refinement of the selection criteria. Families which had had a birth since March of 1983 were eliminated if there were no other target children of interest, as they were considered less likely to have another birth in time for entry into the main study sample. There was also a concern that ages be as accurate as possible. The preliminary survey allowed for inspection of birth records (where available) so that ages could be accurately established. This survey also eliminated all lead females over the age of 35 years. The reasoning was that they were less likely to give birth within the study period than younger women and this could adversely affect the sample's ability to meet the sub-sample requirement of at least 100 infants.

Finally, the Preliminary Survey gave families a better feeling for the manner in which information would be collected during the main study and allowed them to make a more informed judgement as to whether they wished to participate in a process that required considerable cooperation over a long period of time. Thus cooperation could be better assessed as a result of this survey than previous determinations. When all of these factors were taken into consideration, the sample was reduced to 477 households.

Stage III (August 1983 - December 1983)

Original plans had been for the main study to start in the Fall of 1983. The Kenyan program was, therefore, prepared to begin the main study with 447 households that were identified during Stage II. However, due to overall delays in the part of the Nutrition CRSP, the main study did not begin until January of 1984. There was concern in Kenya that this change in the starting date might adversely affect the nature of the sub-samples of target individuals; therefore, it was decided that it would be necessary to resurvey the sample of 447 households. In September and October of 1983, the field team conducted a Rapid Pregnancy Survey to detect changes which could adversely affect the sample composition.

The Rapid Pregnancy Survey addressed the issues of target individual's ages and the pregnancy status and potential of lead females. While this survey sought to reconfirm the major criteria (head and wife still living together in the house, dates of birth of household members and their relationship to the head), the major issue was the pregnancy status of the wife. Given that the starting date for the main study had been delayed by several months, it was important to reestablish the eligibility of women who were pregnant. As was noted earlier, pregnant women had to be in the first trimester of pregnancy at the time of the start of the study. With the change in starting date, the accuracy of previous determinations on this criterion were called into question. The groups of toddlers and schoolers also had to be re-examined to insure that adequate numbers would be available for each of these sub-samples and to identify which individuals would be TIs.

Given that the 447 household sample was considerably larger than the targeted 200 to 300 households needed for the study, it was felt that the project should reduce the sample size. This would reduce the data collection burden during the main study and allow for a more manageable work load without jeopardizing the study results. As a result of this process, the sample was reduced to 292 households.

Once the sample was reduced to 292 households and the starting date for the main study confirmed, the households were divided into four clusters. The division into clusters was for operational convenience only and allowed for the data collection to be managed from four field offices. Although the boundaries of the clusters approximated sublocation boundaries, they were only intended to facilitate the management of the main study. After a household had been allocated to a cluster, it was given a new identification number. The new number was a four-digit number with the 1000's representing Cluster 1, the 2000's representing Cluster 2, and so on. These new numbers were painted on a metal plate which was permanently affixed to the front door of the household. Additionally, each target individual was assigned a specific code number (lead male = 01, lead female = 02, male infant = 51, female infant = 52, male toddler = 41, female toddler = 42, male schooler = 27, and female schooler = 37). Non-target individuals were also given code numbers to indicate their position in the household.

Due to attrition, the number of household that finished the entire study was 247, which represented 12% of all households in the three sublocations. Forty-five households dropped out or were excluded from the study because they became ineligible with respect to the selection criteria. Table 5.2 lists the reasons for which households either dropped out or were excluded from further participation in the main study.

DEGREE OF BIAS IN THE STUDY SAMPLE

Because the study required specific numbers of target individuals, the selection process was biased in favor of those households which could supply the target individuals. The sample was, therefore, intentionally biased. Since age was the key factor in defining target individuals, age was also the primary factor in sample bias.

Figures 5.1 and 5.2 show the population pyramids for the total population of Embu and the study sample respectively. In Embu, 36.25% of the total population is below the age of 9 years (1) while 44.56% of the study population was in this age group. The CRSP sample also had a slightly higher percentage of women in the age groups of 20-40 years (CRSP = 14.8%, Embu = 12.1%). These groups were expected to be higher than the general population given that they constituted the main target individuals which the sampling process was designed to maximize. Since women over the age of 40 were not accepted as lead females, the sample included very few females above this age (CRSP = 0.9%, Embu = 8.2%).

Figures 5.3 and 5.4 further demonstrate the bias distribution of the sample with regard to age. The sample over-represents the population in the younger school age categories and at certain ages of lead adults (30-45 for males and 30-40 for females), and it under-represents the population in the teenager, young adult, and older adult categories (males over 50 and females over 40).

TABLE 5.2
Reasons for household attrition during the main study (source: CRSP field notes).

Reason	Number of Households
Did not qualify (no reason given)	16
No children in target groups	11
Refusal to cooperate	6
Lead female left the household	3
Household moved out of area	2
Lead female aborted	2
Household became polygynous	1
Lead male died	1
Lead male and female too old	1
Lead male remarried, new female did not qualify	1
Economic hardship	1
Total	45

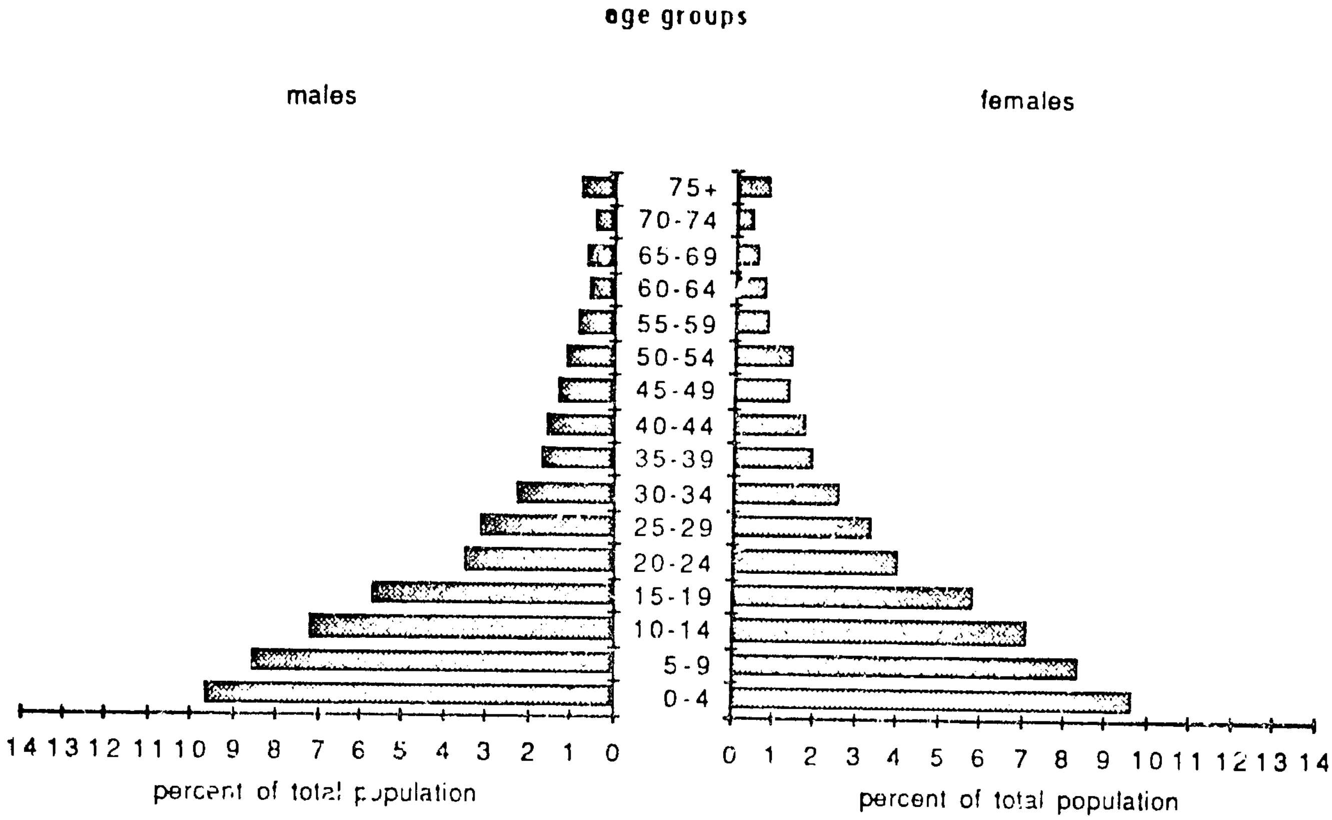


FIG. 5.1. Population pyramid for Embu District; N = 262,793 (1).

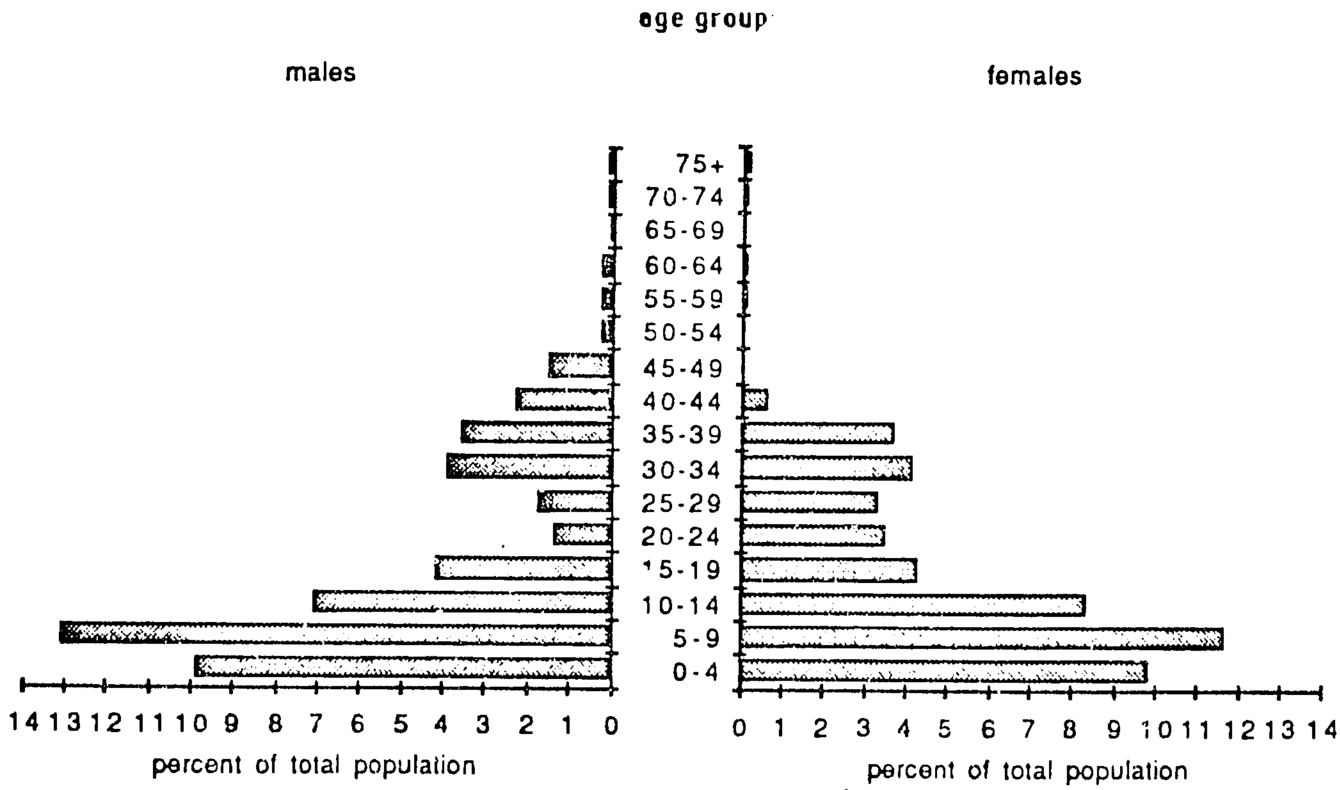


FIG. 5.2. Population pyramid for the CRSP main study sample as of January 1984; N = 1800.

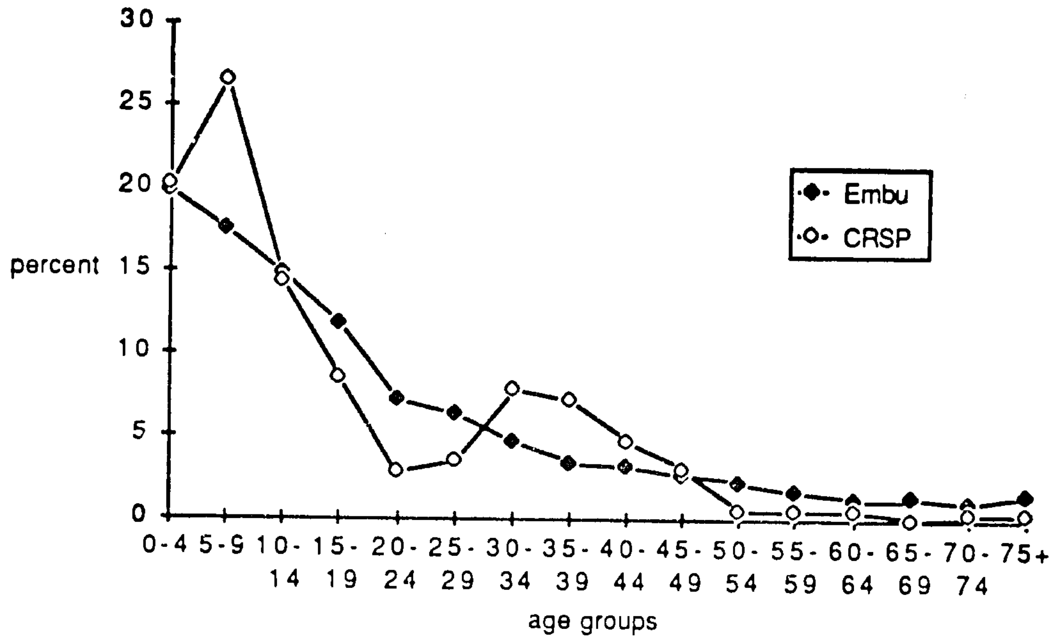


FIG. 5.3. Age distribution of males for Embu District (1) and the CRSP main study sample as of January 1984.

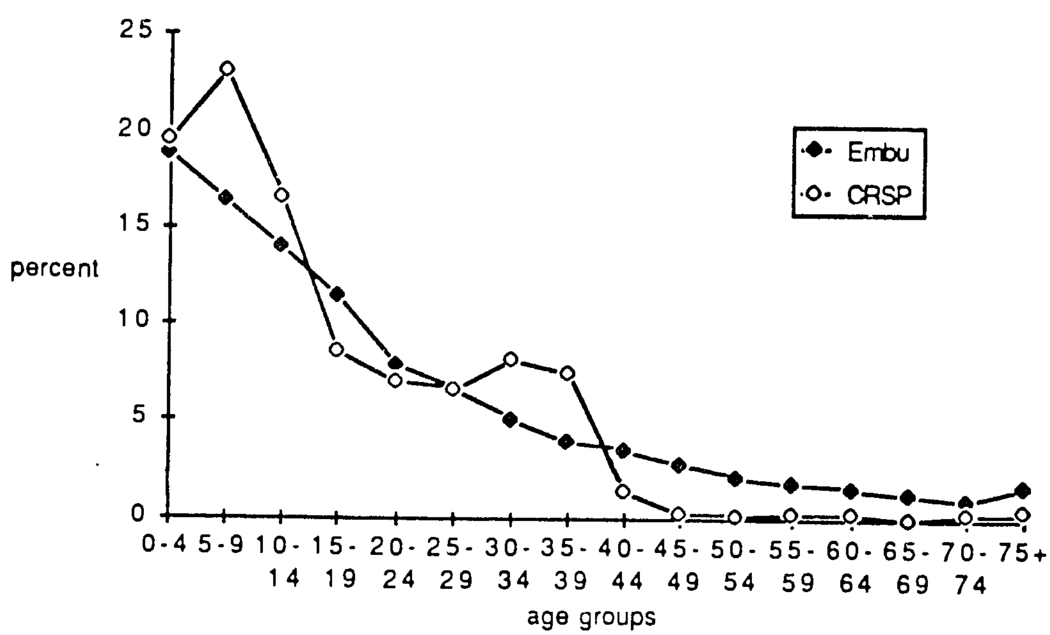


FIG. 5.4. Age distribution of females for Embu District (1) and the CRSP main study sample as of January 1984.

The size of the average household was also an indicator of sample bias. Table 5.3 indicates how household size varied from the overall population to the CRSP sample. Given that the study was only concerned with households which had children, it was expected that the average size of CRSP households would be larger than that of the total population.

Sample bias was also detected in the level of education attained by CRSP lead adults. It must be noted, however, that data on education for the three sublocations is not available and so the sample must be compared with the entire population of Embu. Because of this, it cannot be determined if the sample was biased with respect to its universe (Kathanjure, Kathunguri and Karurumo) or if these three sublocations were biased with respect to the district of Embu. It is the impression of the field staff that schools were well distributed and attended throughout the three sublocations and that educational levels are high in this area. At present, however, CRSP has no data to support this observation.

When the educational rates of highest class attained are standardized for age distribution, they show that 21.5% of CRSP males above the age of 20 had no schooling. For Embu District, the figure is 34.8% (1). The data for females shows that 32.2% of CRSP females between the ages of 20 and 55 had no schooling, while 56.4% of Embu females had no schooling (1). Figures 5.5 and 5.6 show the complete comparison for all educational levels.

Table 5.4 gives the rates for individuals currently attending school. There is no reason to believe that the CRSP sampling process discriminated on education, however, the difference remains even after being corrected for the age distribution.

Other comparisons of the CRSP sample to the universe are hindered by the fact that comparable data on the universe is not available. In general, however, the CRSP sample was younger than the universe and the households were larger. The sample appears to be better educated than the Kenyan population as a whole but this may also be true for the entire universe of Kathanjure, Kathunguri and Karurumo.

COMPARISON OF ATTRITED HOUSEHOLDS WITH MAIN STUDY HOUSEHOLDS

Besides comparisons with the universe, there are a number of descriptive statistics that provide a comparison of attrited households with main study households (Table 5.5). It should be noted that the CRSP sample was never fixed in size. The sample fluctuated in composition as children were born and others completed their period of observation or dropped out of the study for other reasons. The information presented here is taken from the census conducted in January of 1984. At that time, there were 292 households registered for the study. Forty-five of those households later dropped out of the study and are not included in the project results. The descriptive data presented here represents two separate groups as they appeared in the census of January 1984. One is the 247 households that completed the entire study and the other is the 45 households that did not complete the study.

No significant differences were detected between those who completed the study and those who dropped out of the study except for the possibility of education. Table 5.5 shows that 26.8 percent of lead males in families that dropped out of the study completed a grade higher than Form 1; the figure for those remaining in the study was 18.4%. For females, the difference was more dramatic and probably more of a contributing factor to attrition (21.6% for those who dropped out compared to 7.6% for those who remained). Project field staff indicated that one reason for households dropping out was that the lead male and lead female spent too little time at home. Several families who cited this problem were composed of a lead male and lead female who had completed secondary school and were both school teachers. This could account for the higher levels of education among drop-out families. Families in which the lead female was a teacher had difficulty finding the time to cooperate with the study and, therefore, were most likely to drop out; thus the importance of the higher education level among lead females in the drop-out group. No other differences between the two groups were found to be significant.

TABLE 5.3
Comparison of the mean household size for the study sample with Kenya, Embu and the three sublocations of Kathanjure, Kathunguri, and Karurumo.

Area	Mean houschold size
Kenya (1)	5.18
Embu (1)	5.24
3 CRSP Sublocations (1) (Kathanjure, Kathunguri, Karurumo)	5.74
Study Sample (N=247)*	7.28

* Source: CRSP Census Update, January 1984

TABLE 5.4
Percent of individuals between the ages of 5 and 30 years currently attending school.

Population	Males	Females
Kenya (1)	50.8	43.3
Embu (1)	55.5	51.3
CRSP sample*	69.1	63.1

* Source: CRSP Census Update, January 1984

TABLE 5.5
Comparison of the CRSP main study sample with those who dropped out or were excluded from the study (source: CRSP Census Update, January 1984).

Descriptive Characteristic	Main Study Sample	Exclusions/Drop-outs
1. Sample size		
Households	247	45
Individuals	1800	331
2. Mean age (years)		
Lead males	37.03	37.53
Lead females	31.49	32.36
Total sample	16.18	17.21
3. Age ranges (years)		
Lead males	24-74	26-70
Lead females	20-54	22-48
Total sample	0-83	0-70
4. Household size(mean/range)	7.28/3-17	7.38/3-14

TABLE 5.5 continued

Descriptive Characteristic	Main Study Sample	Exclusions/Drop-outs
5. Tribe (% of total)		
Embu	98.3	100.0
Kikuyu	0.7	0.0
Kamba	0.4	0.0
Meru	0.2	0.0
Other	0.4	0.0
6. Religion (% of total)		
Protestant	49.4	53.3
Catholic	50.6	46.7
7. First language (% of heads of household)		
Kiembu	98.8	100.0
Kikuyu	0.8	0.0
Kikamba	0.4	0.0
8. Mean length of marriage (years)	12.5	12.6
9. Highest class attained (% of lead males and females)		
Lead Males		
No school	13.6	2.4
Standard 1-4	19.7	29.3
Standard 5-7	48.3	41.5
Form 1-4	17.12	4.4
Form 5 +	1.3	2.4
Lead Females		
No school	25.5	16.2
Standard 1-4	21.9	32.4
Standard 5-7	45.1	29.7
Form 1-4	7.1	21.6
From 5 +	0.5	0.0
10. Length of time household has been in sublocation		
(years, mean/range)	11.12/1-28	11.04/1-31
11. Time spent out ofsublocation by lead male (% of total)		
Less than 3 months	95.9	93.3
more than 3 months	4.1	6.7

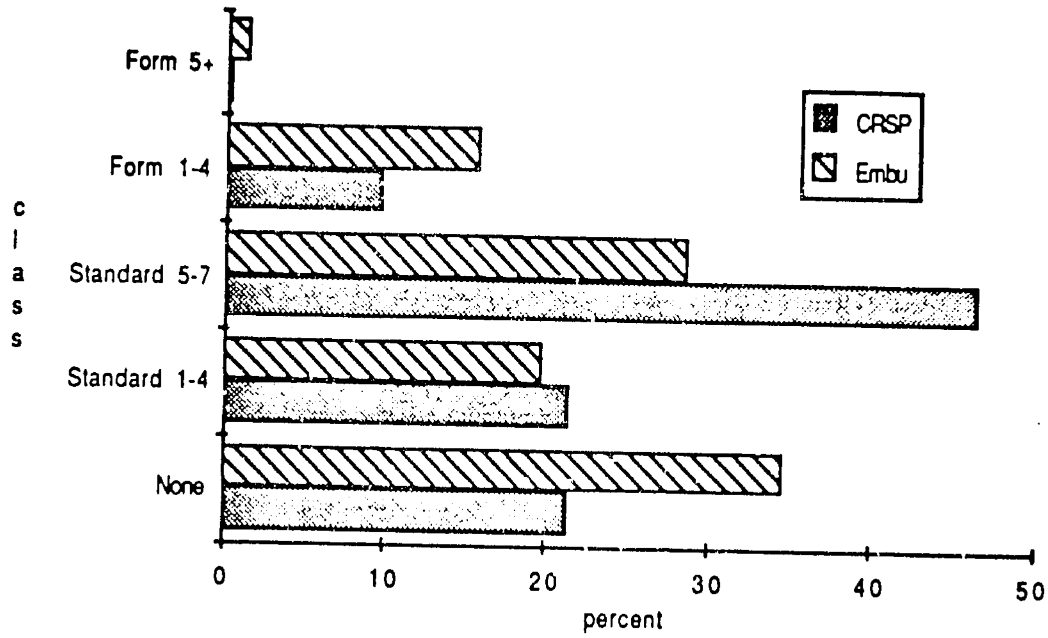


FIG. 5.5. Highest class attained for males over 20 years of age.

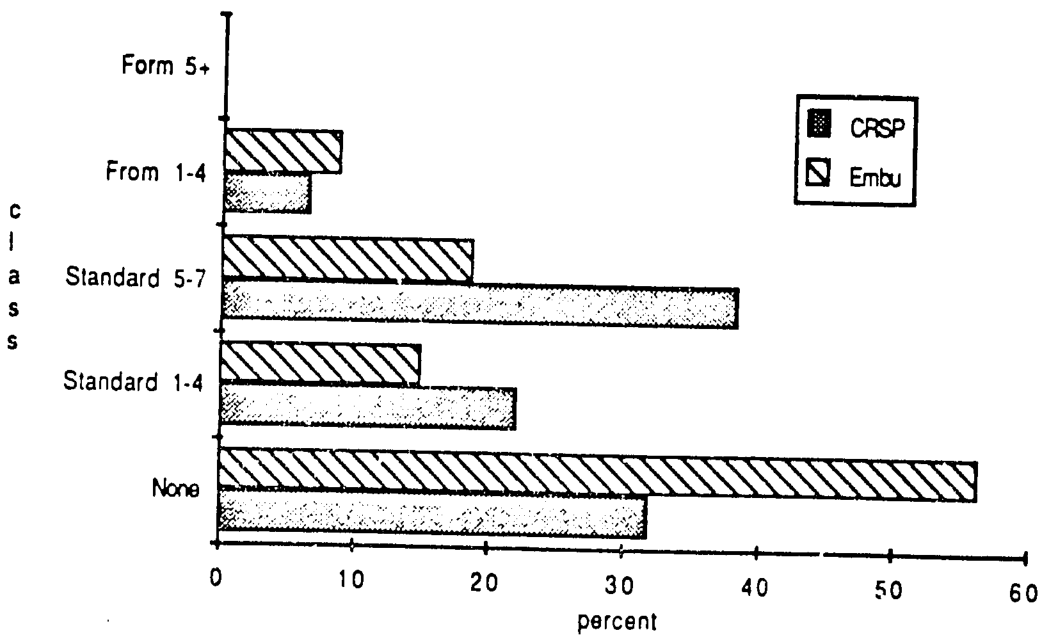


FIG. 5.6. Highest class attained for females between 20 and 55 years of age.

The study area was divided into four clusters as described above. When the statistics used to describe the entire sample were examined for each cluster, no substantial variations were detected. With respect to religion, however, there is an unexplained inconsistency. While the overall sample showed 49.4% Protestant and 50.6% Catholic, Clusters 2 and 3 presented marked variations (see Table 5.6).

The difference in religion for Clusters 2 and 3 does not seem to be associated with any other differences in data. Household size in Cluster 2 was the largest among all four clusters but the difference was not significant.

It should also be noted that Cluster 4, which was almost entirely composed of the sublocation of Karurumo, showed some variation with regard to the length of time the household had been in the sublocation. This area is relatively newly settled as it has been a site of recent migration. The average duration for a household living in this sublocation was 9.67 years compared with 12.26 years in Cluster 1 and an overall duration of 11.12 years for all clusters. Households were also smaller in this area (6.92 compared to 7.28 for the entire area, significant at $P < .05$). There was no significant difference with regard to age of individuals, however, in Cluster 4.

TABLE 5.6
Comparison of religion among the four clusters (source: CRSP Census Update, January 1984)

Cluster	% Protestant	% Catholic
1	50.9	49.1
2	29.2	70.8
3	72.9	27.1
4	46.3	52.2

GENERALIZABILITY OF THE FINDINGS

As was mentioned above, the biased nature of the CRSP sample is centered around age distribution and household size. Beyond these factors there is no evidence to indicate that the CRSP sample was not representative of the universe from which it was selected. This does not, however, intend to imply that the sample was representative of the universe of Kenya as a whole. A major problem in determining the degree of bias is the unavailability of comparable information on the universe. Also, it must be kept in mind that the comparisons made here are based on information taken from the CRSP census form. Other comparisons such as socioeconomic variables were not included in this analysis. Descriptive information on these variables appear in this report under the relevant chapters. Age and family size may very well be related to other factors which could adversely affect the generalizability of conclusions (other than those presented in this report) that are drawn from this data base. It is important to give appropriate recognition to the degree of bias in this sample with regards to uses such as policy development. The CRSP sample was selected to optimize the testing of study hypotheses and the degree of bias was concomitant of this. To the extent that the CRSP data base can be applied to non-CRSP research questions, an awareness of the degree and nature of sample bias is critical.

REFERENCE

1. Republic of Kenya. Kenya Population Census, 1979, Volume I. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya, 1981.

Chapter 6

FOOD INTAKE

The Nutrition CRSP Kenya Project developed a quantitative method to collect data on food prepared and consumed by study household members. The method of measuring food intake included both direct weighing of recipe ingredients and foods and recall of foods and dishes consumed. Energy intake is considered the principal independent variable of the study.

RESEARCH OBJECTIVES

The objective of Food Intake data collection was to measure the consumption of food by study household members. A nutrient data base for Kenyan food items (Embu District) was developed in order to calculate the energy value and the content of protein, fat, carbohydrates, iron and other selected nutrients of foods in the diet. The relationship between energy intake (the independent variable) and the dependent or outcome variables comprise the core CRSP analyses.

The major technique utilized to collect food intake data was the direct weighing and volume measurement of ingredients and foods, with recall of consumed foods and dishes used when direct weighing and measurement were not possible. "Child following" was utilized for the toddlers whenever possible to observe and record self-fed snacks.

THE SAMPLE

Food preparation/consumption information was recorded for two consecutive days per month in each of 247 study households for a period of one to two years. This yielded 24 days of food intake information per household per year. As described in detail below, an enumerator actually spent two consecutive days in a household collecting data, and returned early on the third day to collect recall data on foods prepared and consumed following the enumerator's departure on the evening of the second day. The fieldworkers (women) were in the household from 7:00 am to 6:00 pm, and the data collection schedule was staggered throughout the week in order to collect food intake information that represented all week days. Only one Sunday per month was covered for each household as respondents felt it would be too intrusive beyond this, and many were away on Sundays attending church or visiting.

Food intake information was collected on all target and non-target individuals, as well as on guests who consumed food prepared by the household. Each enumerator was assigned a list of TI's for each household on whom to collect data on all meal foods, non-meal foods (snacks), foods consumed away from the house, and those received elsewhere and brought home. Food intake data collected for non-target individuals were collected on non-meal foods (snacks), foods taken outside of the household, and those received from elsewhere. Data collected on household guests were limited to meal foods only.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Food intake data collection techniques were developed after a preliminary survey and a series of pilot studies and extensive field trials. The preliminary survey provided information on the varieties, approximate quantities and frequency of foods eaten. The pilot studies were used to test various methodologies prior to use in the main study, as well as to provide intensive training of both food intake enumerators and supervisors.

After a preliminary three-week training session, a one-week field trial was conducted in an adjoining sublocation in preparation for the preliminary survey.

Preliminary Survey

A variety of background information on about 150 households was collected by the preliminary survey. Food intake data collection excercises performed in each household included:

1. A one-day recall of food prepared and eaten.

2. A one-day semi-quantitative recall of food eaten by lead females and by their children under five years of age.

3. A seven-day recall of food types consumed.

The objective of the one-day recall was to record foods prepared and consumed by household members on the previous day. Problems encountered included difficulties in measuring the wet and dry capacities of the various cooking and eating utensils, and the common habit of preparing foods in advance and eating them later as leftovers (sometimes in an altered form or as a new dish).

The semi-quantitative recall study aimed to obtain estimates of food consumed by mothers and their children under five years of age. To indicate levels that had been consumed, fieldworkers requested mothers to fill the eating dishes used with water for consumed beverages, flour or dirt for ugali, or maize or beans for githeri. These were then transferred to a measuring jug/cylinder and the volumes were estimated. Tables were later used to convert these volumes into weights of raw foods and ingredients. The main difficulty with this method was attempting to estimate the intake of small children who frequently served themselves from the cooking pot.

Seven-day recalls of food types consumed by households were conducted to obtain an idea of the types of food that were being eaten at that time of year. A food frequency recall as to the type of food and number of times eaten per week was attempted but dropped because respondents had considerable trouble remembering what foods they had eaten during the previous seven days.

Market Use Questionnaire

In August 1983, teams of two enumerators were sent to the three sub-locations of the main study -- Kathanjure, Kathanguri and Karurumo. The enumerators asked the heads of 500 randomly selected households from which markets and shops they purchased their food. The survey showed that the markets most often used in the three sublocations were at Runyenjes (81% of the households used this market), Karurumo (70%), Kathangure (68%), Ishiara (54%), Embu (25%), and Kathanjure (22%). All but the Ishiara (20 km away) and Embu markets (25 km away) were within or very close to the study area. Further market surveys were then carried out in these markets.

Market Surveys

Market surveys were carried out in September 1983 at Ishiara, a large market 20 km northeast of the study site, and at Runyenjes, a smaller market five km. southwest of the site. The objective of the surveys was to collect information that would enable conversion of household measures of recalled foods into weights. Researchers attempted to weigh and measure replicates of all available foodstuffs in the market in the form that they were sold i.e., the weight of a 2 kg tin of maize, the weight of a medium sized English potato and the average weight per length of sugarcane.

Weight measurements were made in the following manner. The empty tin used by the trader was weighed using a 5 kg. digital readout scale. The trader was asked to fill the container as she would for selling. The tin plus food was then weighed in replicates. Enumerators attempted to obtain ten readings per measure, where sufficient quantities of the item were available in the market. The data were converted by hand into grams of raw ingredients. These were further described as to their nutrient content using tentative food composition tables that had been compiled from the market surveys, the preliminary surveys, and the available literature (1). Conversion tables are found in the Food Intake Manual.

Additional surveys were carried out in local markets to determine food availability, prices and purchase units. The number of traders selling specific food items was surveyed to indicate overall food availability. These surveys were conducted during the Main Study every three months until mid-1985.

Preliminary Survey-Food Intake Estimates

During the preliminary survey, an effort was made to determine the range of food intake among households of the study area. Initially all household food intake data were obtained from the one-day household food preparation form. A household "eating score" was derived from the type and number of persons partaking of a meal. Conversions used to calculate household eating scores were based on figures for individual energy requirements according to FAO (2). Thus, the energy requirement for each household member was multiplied by the following factors:

Adult Male	multiplied by	1.0	(2700 kcals)
Adult Female	"	0.75	(2000)
Youth Male	"	1.1	(2900)
Youth Female	"	0.8	(2100)
Schooler	"	0.9	(2400)
Pre-schooler	"	0.5	(1400)
Infant	"	0.3	(800)

The resulting figures were then summed and the overall household kcal food intake was divided by the household requirement score. The data collected by the Kenya CRSP on household intake included only dishes prepared or eaten in the household and did not include snacks.

Food Weighment Pilot Study

A food weighment pilot study was conducted in 30 households over a two-week period in 1982 in a sublocation adjacent to the study area. All food prepared and eaten by the mother, school child, and toddler from 7:00 am to 7:00 pm was weighed. This pilot study was used to develop methodology as well as to serve as a training exercise for the enumerators.

A series of additional pilot studies was carried out between June and August 1983 to further develop food intake methodology and provide intensive training of both enumerators and supervisors. These included:

Pilot I --	June/July 1983	--Comparison of food weighment versus 24-hour recall.
Pilot II --	July 1983	--Testing of methods for use in the Main Study.
Pilot III --	August 1983	--Testing of refined method for use in the Main Study.
Pilot IV --	August/September 1983	--Field Testing of Computerized Data Forms.

Factors identified in the pilot studies as relevant to the development of the study methodology included the following:

Pilot I

Data analysis revealed that there was high inter-household and inter-meal variation in the density of various cooked meals. It was considered important, therefore, that measurement methods for the Main Study be capable of estimating the composition of each batch of cooked food, including the amounts of water used. Comparison of weighing vs. recall of the composition of cooked foods revealed that recall overestimated density, indicating that weighing should be used as much as possible. Also, while comparison of weighing vs. recall for TI food intake showed that recall was a suitable method on a population basis, weighing should be used as much as possible in that collection of individual data.

Other findings showed the unwillingness of enumerators (all women) to start work at dawn and to work until after dusk; they felt it to be dangerous to walk long distances in the dark. Thus, enumerators were scheduled to work only in daylight hours, which limited measurement of evening meal portions and ingredients. These were to be obtained by recall the next morning.

As the three, different-sized scales used for weighing were far too heavy for enumerators to carry, a single 25 kg Salter infant weighing scale was used as an alternative. Cooked food, usually prepared in a large aluminum pot (sufuria), was placed on a locally constructed cradle and hooked onto the scale which, in turn, was suspended from a house or door beam.

The 24-hour recall (by mothers) of snacks was found to be inaccurate, particularly for pre-school children. It was therefore decided that snack food consumption would be assessed at frequent intervals and that toddlers would be directly observed and followed to the extent possible on the day of food intake measurement. It was also found that traditional weaning foods, such as porridge, were not always considered foods by mothers; additional probing of this topic was therefore necessary.

Pilot II

Methods for measuring food intake were tested in Pilot II. Improved procedures for recall were determined to be necessary since enumerators could only work and travel during daylight hours, making it impossible to weigh all meals prepared and consumed. Other necessary improvements included the development of 1) an improved recall procedure for foods which could not be measured by volume (ugali, cassava), 2) techniques to measure portions that could not be levelled off and marked in small serving plates, and 3) techniques to collect recall information from the lead female about TI's who left the house prior to the morning arrival of the enumerator.

Pilot III

Refined methods for use in the main study were tested in Pilot III. One enumerator per household was determined to be adequate for Food Intake coverage. A time sequence design for household visits was developed to minimize the travel distance between households.

Plastic bowls of different colors for use by each TI were introduced. The mothers were given grease pencils to mark the food levels, this proved to be extremely successful. Hanging Salter scales for weighing a household's cooked food was found to be both well accepted and practical.

Pilot IV

Pilot IV was designed to field test computerized data forms and to give field practice to Food Intake enumerators and supervisors. While the forms were understood by the enumerators and supervisors, continued field experience was recommended for increased familiarization with procedures. An examination was administered to test the understanding of forms used and overall knowledge of the food intake method by supervisors/enumerators. The mean test score was 82% ± 7% with a range of 69% - 91%. Immediate feedback was provided to the staff.

Household Food Intake was defined as:

(HH meals prepared - leftovers) + snacks + non-HH foods consumed by HH members - HH food consumed by non-HH members.

Three types of forms were developed for the collection of these data. The Meal Preparation Form (No. 111; Fig. 6.1) was used to record weight and/or recall of raw ingredients, cooked dishes and leftovers prepared in the household. The Target Individual/Guest Form (No. 112; Fig. 6.2) was used to record portions consumed and the time of consumption by the five possible Target Individuals and to enable accounting of household foods consumed by non-household members. The Non-Target Individual Form (No. 113; Fig. 6.3) was used to record non-meal foods consumed by non-TI's and to account for foods consumed outside the household by these individuals. The Meal Preparation Summary Form (No. 114, Fig. 6.4) was utilized to summarize necessary conversions and calculations.

The Meal Preparation Form (No. 111) was later updated to account for the number and identification of people consuming meal foods in the households visited, and a tally sheet was kept for each person consuming food in the household. Dishes were to be tallied only if a portion of the food was consumed "as is". If a certain dish was to be used later as a ingredient (leftover), it did not need to be tallied.

Equipment used included the 2 kg. Chatillon Platform scale, the 25 kg. Salter Hanging scale, rulers, and a variety of sizes of graduated cylinders for measurements of liquids.

<u>Food Conversion Tables</u>

Conversion tables were developed to express recalled data by weight. Foods were weighed in the field from November 1983 to July 1984, with additions made as necessary. Single ingredients were measured as well as cooked dishes. At least ten measurements per food type were made to arrive at the figures in the tables. Conversion factors accounted for:

1) Percent of waste of food items.
2) Gram equivalents for volumes or household measures used.

The percent waste values presented were derived from Platt (3).

The conversion tables were used by the food intake calculators to determine gram amounts of foods prepared and/or consumed from recalled food intake information. A calculator used the table by finding, first, the food item requiring conversion, and second, the type of measure used for recall (graduated cylinder volume or HH measure). The gram equivalent for that measure was then recorded on the calculation section of the Food Intake form.

<u>Temporary Food Nutrient Composition Data Base Used In The Main Study</u>

A preliminary data base was compiled from available publications so that the field investigators could have rapid feedback about food intake. This was particularly important during the famine. Food composition tables representing average values for food items were compiled from several sources. A description of the final food to nutrient conversion system is presented in Appendix B.

<u>Staff Training</u>

A total of eight Food Intake teams (two per cluster), each consisting of one supervisor and four or five enumerators, were required to cover all households. Several additional staff members, with A-level educations (equivalent to U.S. Junior College) were hired to do the necessary calculations and conversions and record results on the Food Intake form. Extensive staff training was conducted by the Field Nutritionists. Staff training was initiated prior to the field trials, and continued through the preliminary survey. Four pilot studies served to train enumerators and supervisors in techniques of observation, interview and measurement, as well as to familiarize the staff with the data collection forms and use and care of the weighing equipment. Scale reading examinations were frequently conducted.

TECHNIQUES OF DATA COLLECTION

The methods employed to determine household food preparation and consumption combined both actual weighing and recall of ingredients and foods prepared and consumed. Weighing was preferable to recall and comprised the majority of the observations in all households.

Weighment was defined as the actual weighing of raw ingredients, cooked foods, portions consumed and leftovers for meals and non-meal foods. Measurements were made using a 2 kg Chatillon scale (accuracy level of 5 gms) and a 25 kg Salter scale (accuracy level of 100 gms).

An enumerator instructed a respondent to give her all raw ingredients for weighing before adding them to a cooking pot. Once the food (dish) was prepared, the cooking pot and cooked food were weighed. After consumption was completed, the remaining food was weighed. All non-cooked foods were also weighed.

The "recall" method was used when an enumerator could not be present in the household during food preparation or consumption. In these instances, an enumerator asked the respondent to recall or estimate the amounts of ingredients/foods used in recipes and portions taken by household members. This also included foods eaten outside of the household.

For recalled foods, the enumerator instructed the respondent to indicate how much of each ingredient was used to prepare a given dish and how much was consumed. The following measures were used:

a. HH measures (handful, teaspoon).

b. Volume measures (transferring food from household cookpots to volume beakers and recording milliliters).

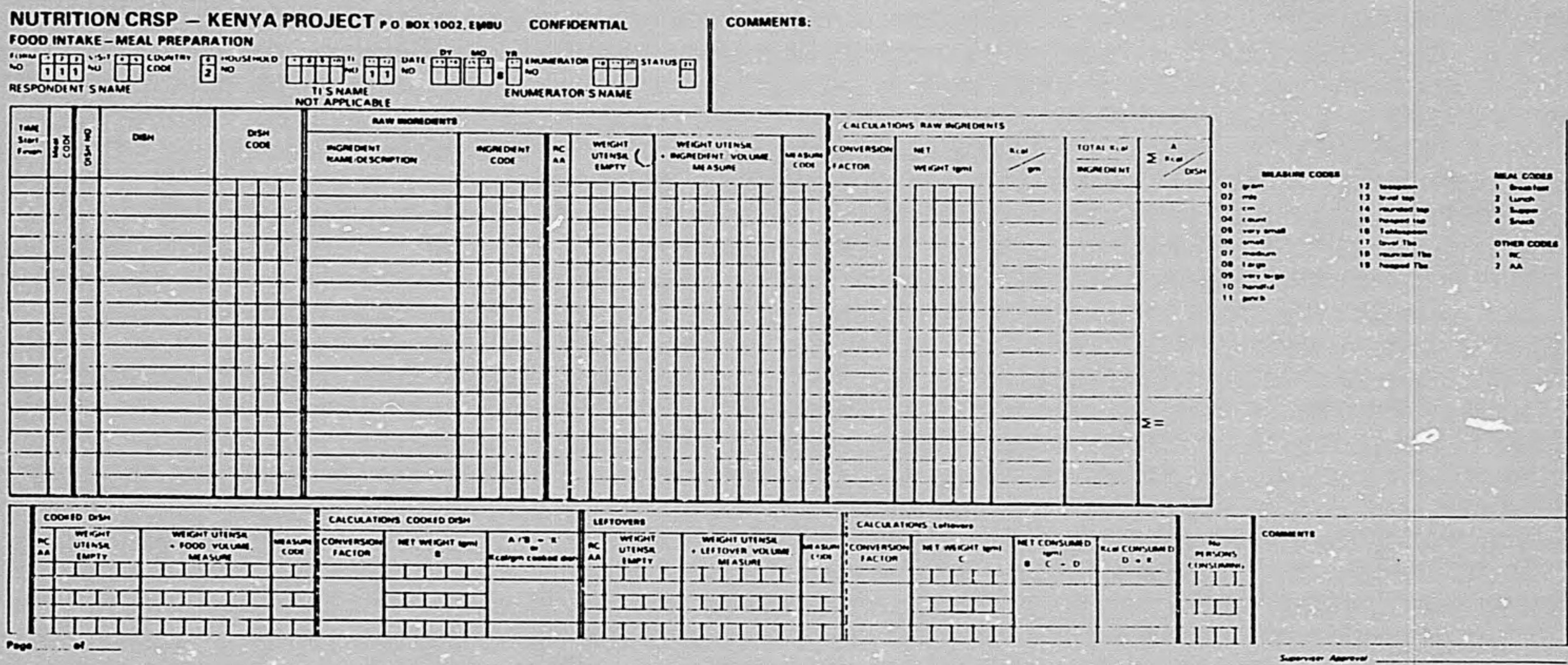
c. Length, thickness, diameter measures (sugarcane, bread, chapati).

d. "Recall aids" such as plastic bowls were provided to the TI's to serve meals when the enumerator was not present. The level of the portion served was marked on the side of the plastic bowl with a grease pencil.

Actual samples of the ingredients/foods recalled were used to determine the recalled measures. When the same or similar ingredients were not available, substitutes (as described in the table of substitute items) were used. The aim of the recall procedures was to obtain the best possible estimate of Food Intake when actual weighment was not possible.

The meal preparation form (No. 111) was developed during the preliminary field studies. Each dish prepared in the household (either observed or recalled) was given a number and recorded on a meal preparation form. Numbering proceeded consecutively over the two-day period. On the TI/Guest form (No. 112), both the dish number and the dish name were recorded.

Terms used on the food intake form were defined as follows: An "ingredient" was any food item used in the preparation of a dish (a single food or a combination of foods). A "recipe" was a list of ingredients used to prepare a specific dish. A "dish" was the local name given to the food that was prepared. All ingredients were weighed using the Chatillon 2 kg scale. If the weight of the utensil and ingredient was greater than 2,000 gms, the ingredient was weighed in parts; the parts were then summed and the weight of the utensil was subtracted.


NUTRITION CRSP – KENYA PROJECT P.O. BOX 1002, EMBU CONFIDENTIAL

FOOD INTAKE – MEAL PREPARATION

COMMENTS:

RESPONDENT'S NAME

TI'S NAME
NOT APPLICABLE

ENUMERATOR'S NAME

FIG. 6.1. Food intake meal preparation form 111.

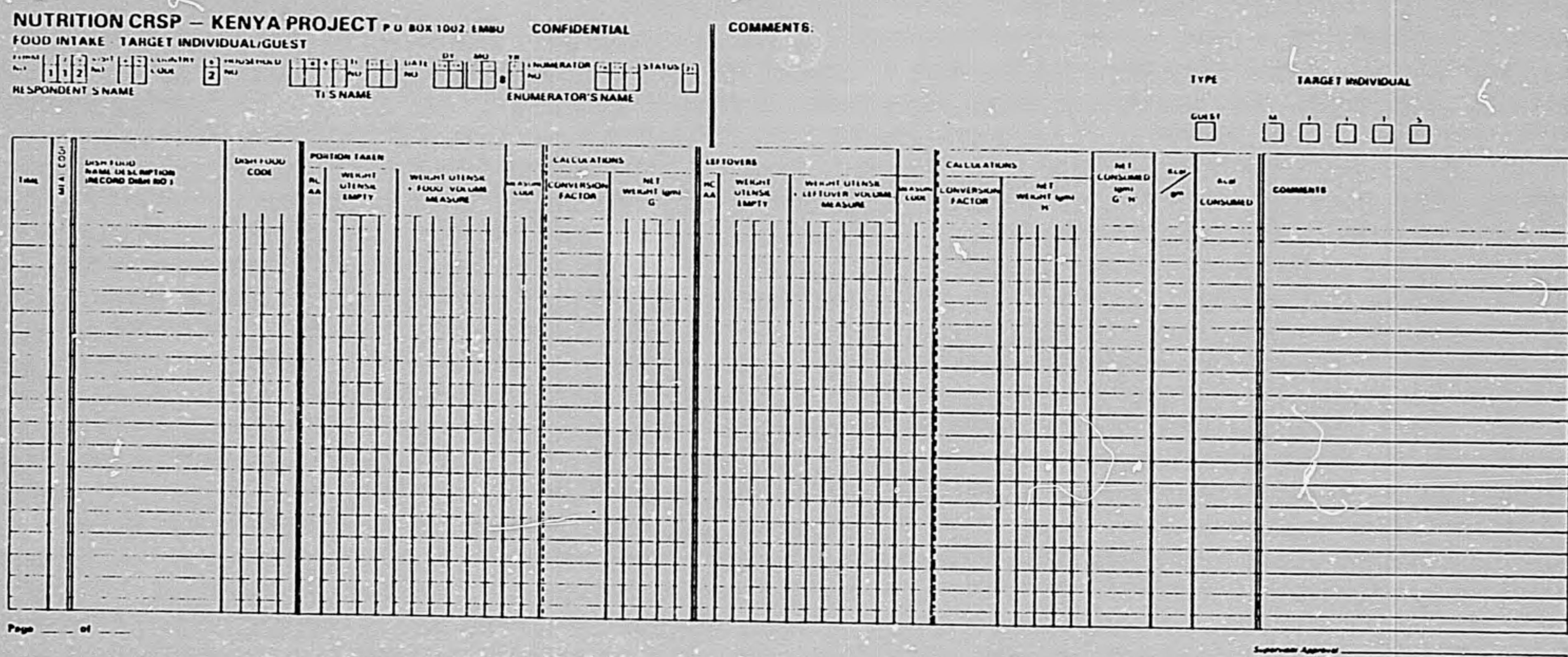

NUTRITION CRSP — KENYA PROJECT P O BOX 1002 EMBU
CONFIDENTIAL
COMMENTS:
FOOD INTAKE TARGET INDIVIDUAL/GUEST
RESPONDENT'S NAME
T I'S NAME
ENUMERATOR'S NAME
STATUS
TYPE
TARGET INDIVIDUAL
GUEST
TIME
DISH FOOD CODE
PORTION TAKEN
CALCULATIONS
LEFTOVERS
CONVERSION FACTOR
NET CONSUMED
COMMENTS
Page ___ of ___
Supervisor Approval

FIG. 6.2. Food intake form 112 for target individual/guest.

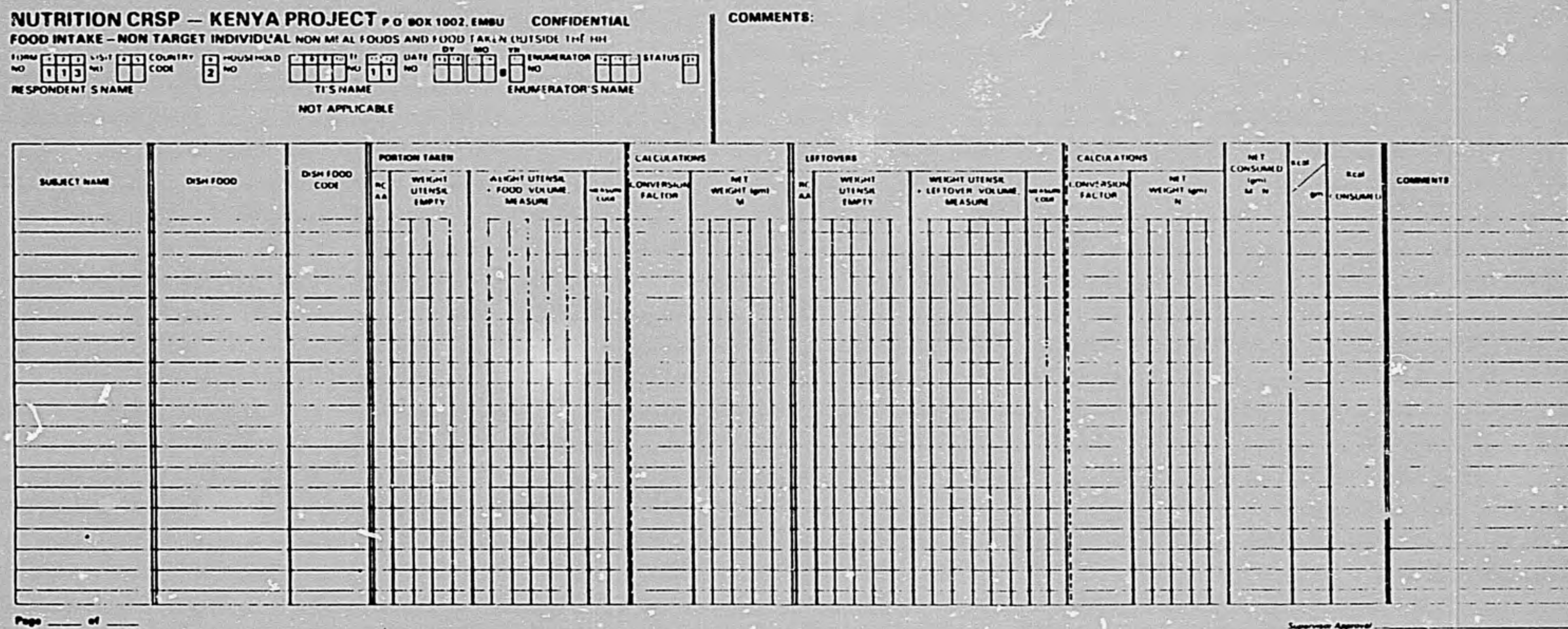
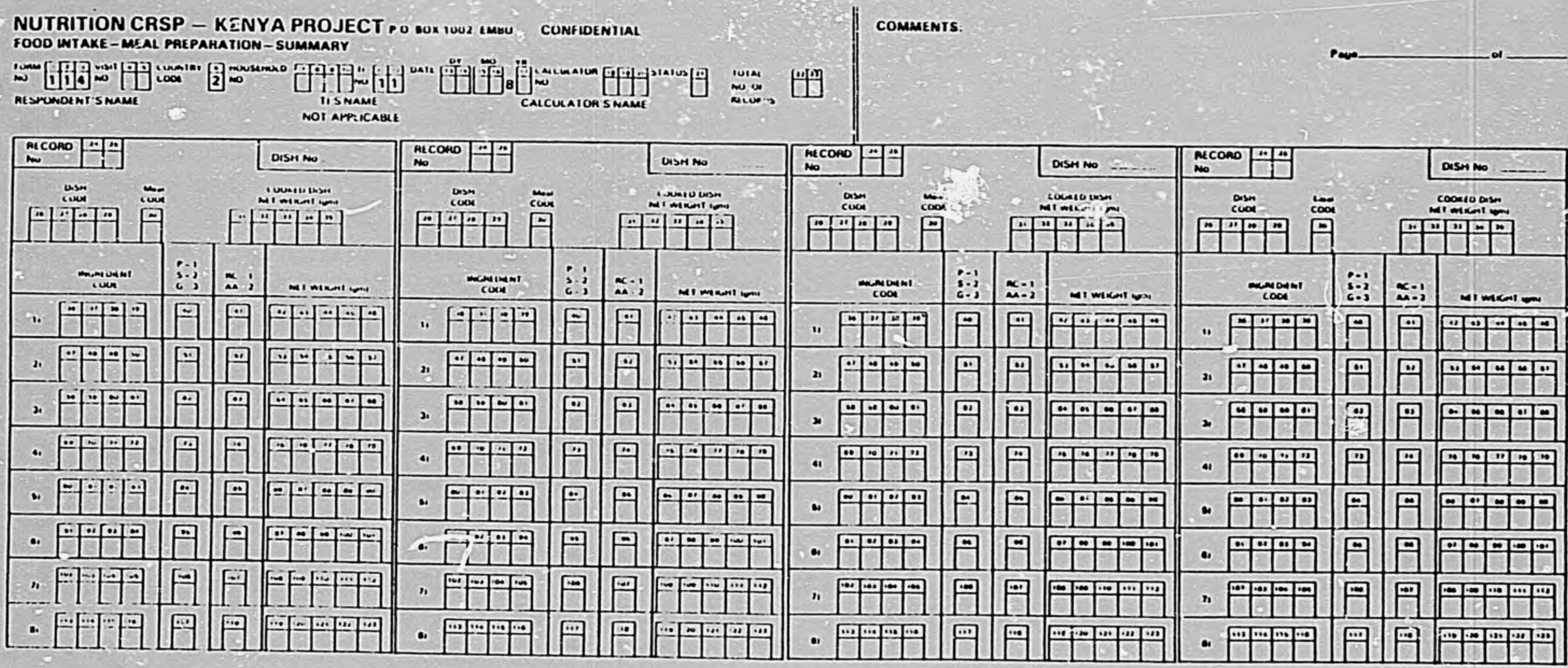


FIG. 6.3. Food intake form 113 for non-target individuals.


NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002 EMBU CONFIDENTIAL

FOOD INTAKE — MEAL PREPARATION — SUMMARY

FORM NO 114 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TI NO 11 DATE DY MO YR 8 CALCULATOR NO STATUS TOTAL NO OF RECORDS

RESPONDENT'S NAME

TI'S NAME

NOT APPLICABLE

CALCULATOR'S NAME

COMMENTS:

Page ____ of ____

RECORD No | DISH No

DISH CODE | MEAL CODE | COOKED DISH NET WEIGHT (gms)

INGREDIENT CODE | P = 1 S = 2 G = 3 | RC = 1 AA = 2 | NET WEIGHT (gms)

FIG. 6.4. Food intake form 114 for meal preparation summary.

All cooked foods were weighed on a 25 kg Salter scale, usually in a big aluminum cook pot (sufuria). If the scale showed a weight of less than 2 kg, the cooked food was weighed on a 2 kg Chatillon scale. When weighing leafy vegetables or vegetables with peels, it was noted whether they were weighed with or without waste.

Recipes of previously prepared ingredients were also recorded on separate meal preparation forms. The recipe used in preparation was recalled along with the cooked volume and leftovers. It was then noted in the "Comments" section that this recipe was an "ingredient" to be used in dish #__. The amount of each ingredient to be used in the new dish was weighed and recorded in the meal preparation form along with the other ingredients used in preparation. If the previously prepared ingredient had been prepared elsewhere, the respondent recalled all ingredients which she thought the dish contained. Colored plastic bowls were used to aid in the recall of amounts of food. When a previously prepared ingredient (leftover) was from a study day, the new recipe ingredients used were recorded and the "previously prepared" ingredient was labelled as to which dish it had come from.

As noted above, in the absence of an actual ingredient or food, substitution tables were used to determine which food should be used to measure each type of ingredient or dish. The food item used to measure the recall of ingredients was noted on the meal preparation form. When no substitution foods were available, non-food items, available in the field offices, were used.

Data collection visits were conducted in the following manner:

Day 1

Upon arrival at a household an enumerator weighed all ingredients used in breakfast preparation (utensils alone, and utensils plus ingredients). When possible, the cooked dish was weighed before portions were distributed. If food preparation was already in progress, the enumerator weighed as many foods or ingredients as possible and recorded the weights as recall data.

TI portions were weighed by first weighing the utensils (e.g., bowls) alone, and then with the food placed in them. Utensils were weighed again after the subject finished eating to determine the weight of any leftovers. After all members had finished eating, the cooking pot was also weighed again to determine the weight of any leftovers. Meal portions given to guests were also weighed and recorded.

All ingredients to be used for lunch preparation were weighed, with recall data collected for those missed. Additions of water were itemized separately on the meal preparation form. Once the meal was ready, the cooking pot was weighed before food was served. TI portions and leftovers were weighed as they were for breakfast.

All snack foods consumed by household members throughout the day were observed, weighed, and recorded. At 2:00 pm the enumerator questioned household members regarding all foods and snacks eaten that day. Household members were also asked about meals eaten away from the house and these were recorded.

Ingredients used for supper preparation were weighed by the enumerator before she left the household at 5:00 - 6:00 pm. Enumerators instructed respondents in the use of plastic bowls for measuring TI portions. Clean bowls and grease pencils were left at the house for this purpose.

Day 2

The enumerator returned to the household on the second day at 7:30 am. Recall data were collected on supper ingredients, preparation, and portions consumed by TI's and guests (the marked plastic bowls were used to determine volumes consumed). Foods eaten outside the household by household members were also recorded.

If breakfast preparation was in progress, the first priority was to weigh these ingredients. Observations continued as in Day 1 until 5:00 - 6:00 pm. Before leaving the household an enumerator informed the respondent that she would return to carry out food intake recall the following morning.

Day 3

The enumerator returned to the household on the third morning to collect recall data on any food prepared or consumed during the evening of Day 2.

QUALITY CONTROL MEASURES

Numerous safeguards were built into data collection and handling procedures to ensure that high quality data were collected and recorded. Quality control measures undertaken for Food Intake data collection included: direct field supervision of data collection; daily data form checks; scale calibration; staff meetings; validation studies; and simultaneous measurements by enumerator and supervisor. It was not possible to conduct revisits to check the data collected by virtue of the method used.

Direct and frequent field supervision of data collection by the senior and junior field nutritionists were the mainstay of ensuring that quality data were being collected. One supervisor was assigned to four or five enumerators to observe data collection and check data forms for correctness and accuracy of calculations. The supervisors and nutritionists visited enumerators daily in the field to check the accuracy of their work. Supervisors were rotated periodically among the clusters. Enumerators were rotated within their clusters, but not between clusters due to the distances and logistical difficulties.

Checks of data forms were implemented at four levels. Supervisors reviewed the forms first, while still in the field. The calculators received the forms from the field, calculated net weights and conversion factors, and then recalculated and converted one another's forms. The forms were then coded by the enumerators, and the completed, calculated, and coded forms were rechecked by the calculators' supervisor. The field supervisors reviewed the data calculations, the coding, and the data transfer forms. All rechecks were signed by the person checking the form.

The data clerks in the Embu field office also coded Food Intake data. These workers coded the forms assigned to them, and then checked the forms of their co-workers. The supervisors checked the coding, and the data were then transferred to the computer forms. This transfer was also reviewed by a supervisor.

At the end of every two weeks the food intake enumerators calibrated their weighing scales in the field offices, and filled out a scale calibration form. The forms were reviewed by a supervisor and scales which did not fall within the acceptable range (5% error) were replaced. All other equipment was checked for possible replacement need at that time.

The Field Nutritionists held monthly meetings with the field supervisors to discuss data collection procedures and any issues of fieldworkers' performance, as well as to review any questionable data forms.

Validation Study

To validate the Food Intake method used in the Main Study, a comparison study using a total weighment method was carried out simultaneously with the usual method. The primary aim was to determine the effects of utilizing recall for the early mornings and late evenings when enumerators were not in the households.

The validation study was conducted on ten households for three days each. Additional enumerators were present in the validation study households from early morning, before any food was eaten by household members, until late in the evening, after all food consumption was completed. These special enumerators weighed all ingredients for prepared foods and all foods consumed throughout the day. Only foods consumed away from home were not weighed and these were not included in the validation study.

The regularly scheduled food intake enumerators also conducted their standard method of data collection during the same three days. Recall proceeded as in the overall study; ingredients and foods, usually weighed by the regular enumerators, were weighed by either enumerator and the measurements were recorded by both.

Analyses were done by dishes and by individual foods consumed. Ingredients were summed for each dish and grams and kcals consumed were calculated. Both calculations were done for 219 dishes. Calculations were also made for three specific types of dishes: githeri, ugali and porridge. Kcals and gram intakes were calculated for the three day period for each type of target individual (lead male, lead female, schooler, and toddler).

The preliminary results indicate that there is good agreement between the special study methodology and usual study methodology. The median differences are always zero, and the ranges are surprisingly small. These results must be confirmed by further analysis at UCLA. Further analyses planned for these data include food by food and total daily intake analysis for households and target individuals.

PREPARATION OF DATA FOR ANALYSIS

Preparation of data for analysis is covered under conversion and coding of food stuffs above and also in the Nutrient Data Base (Appendix B).

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Description of Diet

In order to present an overview of the typical diet consumed in the study area, 7-day recall data from the preliminary survey in 1984 of dishes and ingredients consumed are presented, as well as a summary of the most commonly consumed dishes and ingredients derived from the quantitative food intake data. The distribution of food type consumed by households in the three sublocations based on a 7-day recall by food groups is presented in Table 6.1.

Among the cereals, maize, sorghum, and wheat are most commonly consumed. Millet and rice are used less often. Only minimal cluster differences were noted.

Kidney beans are consumed by twice as many households as the other legumes. The frequency of kidney bean consumption was highest in Kathanjure, the higher, wetter cluster, while cowpeas and pigeon peas are used more often in the drier, lower zones.

English potatoes, sweet potatoes, green banana, and taro are the main starchy roots, tubers, and fruit eaten. No significant cluster differences were found.

A wide variety of vegetables particularly onions, tomatoes, cabbage, and kale are eaten, and dark green leafy vegetables are often used in stews. Bean leaves are used mainly in the upper zone and cowpea leaves are more commonly used in the lower drier zones, both excellent sources of carotene and some protein.

A wide variety of fruits are available, including papaya, sweet banana, and avocado, all excellent sources of carotene and vitamin C. Bananas and papaya are the most commonly consumed fruits. Avocados are more commonly eaten in the upper zone, and bananas in the lower zone. Citrus, passion, and guava fruits are consumed less frequently.

Among the nuts, macadamia nuts, (an excellent source of calories and fat) are the most frequently consumed, particularly in the middle zone. Groundnuts are also often eaten and are more commonly consumed and grown in the lower drier areas.

Animal products represented by cow's milk, meat, eggs, and occasionally goat's milk were consumed in all three clusters. In each cluster, milk is most commonly consumed, followed by meat and eggs. The quantitative food intake measurements indicate that meat and eggs constitute a very small portion of the diet.

Of the sugars, refined sugars are the most commonly consumed followed by sugar cane, with honey occasionally reported. Honey was produced by some of the households and is often used as an ingredient in beer production.

The most frequently used dish ingredients, based on preliminary analysis of the main study nutrient database derived from the quantitative food intake data collected from Jan. 1984 to Dec. 1985 are presented in Table 6.2. The most frequently occurring ingredients included water, milk, maize (flour, raw, boiled), kidney beans, salt, sugar, tea leaves and cooking fat.

TABLE 6.1
Distribution of food types consumed by household by food groups, expressed as the percentage of times each food item was named for each specified food group, based on 7-day recall.*

	Kathanjure n=37 (%)	Kathunguri n=43 (%)	Karurumo n=44 (%)
<u>A. Cereals</u>			
Maize (Mbembe)	28	25	28
Maize Flour (Mutu wa Mbembe)	23	24	23
Sorghum (Muvia)	26	19	23
Millet, Bullrush (Mwere)	5	16	9
Millet, Finger (Mugimbi)	0	0	1
Rice (Mucere)	8	5	6
Wheat Flour (Mutu wa Ngano)	10	11	11
Total	100	100	101
<u>B. Green Legumes</u>			
Bean, Kidney (Mboco, Nduru)	64	43	42
Bean, Lima (Noe)	0	1	1
Bean, Mung (Ndergu, Ngira)	2	6	6
Pea (Minji)	0	2	4
Pea, Cow (Nthoroko)	23	36	27
Pea, Pigeon (Mjugu)	11	13	24
Total	100	101	104

Continued.

TABLE 6.1 continued.

	Kathanjure n=37 %	Kathunguri n=43 %	Karurumo n=44 %
<u>C. Starchy Roots and Tubers</u>			
Potato, English (Waru)	27	31	23
Potato, Sweet (Ngwaci)	16	9	23
Cassava (Mwanga)	9	13	14
Yam (Gikwa)	3	5	2
Green Banana (Ndigu Mbithi)	29	32	25
Taro/Arrowroot (Nduma)	17	11	14
Total	101	101	101
<u>D. Vegetables</u>			
Leaf, Bean (Nyeni cia Maboco)	11	2	2
Leaf, Potato (Nyeni cia Waru)	1	3	1
Leaf, Cassava (Nyeni cia Mianga)	0	0	0
Leaf, Cowpea (Mathoroko)	8	6	14
Cabbage (Mboga)	15	18	12
Tomato (Nyanya)	23	20	22
Kale (Gukuma)	12	17	9
Tree Tomato (Matunda ma Nthakame)	4	3	2
Pumpkin (Irenge)	2	1	1
Onion (Gitunguru)	32	31	29
Carrot (Karati)	3	5	6
Total	111	106	98
<u>E. Fruits</u>			
Mango (Igembe)	4	9	3
Sweet Banana (Ndigu ndune)	14	19	31
Papaya (Evavai)	23	16	21
Pineapple (Inanaci)	3	3	4
Avocado (Icondovia)	12	4	3
Guava (Mbera)	3	5	3
Lemon (Itimu)	6	17	8
Orange (Icungwa)	16	16	12
Passion Fruit (Matunda ma Kithaka)	9	4	10
English Passion Fruit (Matunda ma Kithungu)	7	4	4
Roseberry (Ndare)	0	4	0
Gooseberries (Macuca)	10	1	3
Total	98	102	102

Continued.

TABLE 6.1 continued.

	Kathanjure n=37 %	Kathunguri n=43 %	Karurumo n=44 %
E. Nuts			
Cashewnuts (Nguroco)	0	0	0
Queennut (Nguta)	8	0	13
Macadamia nut (Ngandamia)	69	89	50
Groundnut (Njugu Karanga)	23	11	38
Total	100	100	101
G. Animal Products			
Milk (Iria)	48	42	43
Meat (Nyama)	27	30	29
Eggs (Matumbi)	25	29	381
Total	100	101	100
H. Sugars			
Sugar (Cukari)	56	62	56
Honey (Uuki)	7	5	3
Sugarcane (Igwa)	37	33	41
Total	100	100	100

* These data are drawn from the 1984 preliminary survey. Each food group does not total to 100% due to rounding error.

TABLE 6.2
Frequency of most commonly used ingredients in recipes (based on preliminary analysis).

Ingredient	Frequency	%
Water	54,609	31.3
Salt, non-iodized	13,360	7.7
Sugar	9,417	5.4
Githeri	8,487	4.9
Milk, cow, whole	8,033	4.6
Tea leaves	7,819	4.5
Maize, dried flour	6,536	3.8
Onion	6,513	3.7
Kimbo, (cooking fat)	6,352	3.6
Maize, dry, raw	5,510	3.2
Kidney beans, dry, raw	5,127	2.9
All other ingredients	42,622	24.4
Total	174,385	100.0

Description of Local Dishes

Household members in the study area usually ate three meals a day, with most household members present at each meal. Portions were usually served into individual dishes. The composition and preparation of commonly used dishes are described below.

Githeri: Maize and beans are boiled in water with beans added. Potatoes and bananas may be added as well. The ratio of maize to beans varies from 0.5:1 to 5:1 depending on seasonal and regional availability. Tomatoes and green vegetables may be added. Githeri is often refried with onions and lard.

Gikwero: A mixture of kidney beans, cowpeas, pigeon peas, potato, and banana boiled together. Onion is fried in lard, the above boiled ingredients are added, and the mixture is then mashed. This is frequently given to small children, often without beans and peas. The usual ratio of beans/peas to potatoes to bananas is 0-1:1:2.

Mataha This dish is similar to githeri but often contains bananas.

Ugali: Made from purchased white maize flour, added to boiling water and stirred until stiff. Ugali is most often eaten with stew.

Stew: Stews consist of onions fried with lard with vegetables, beans, and peas. Meat may be added in amounts as available. This dish is boiled and served with ugali or rice.

Chapati: A flat pan fried bread usually made from wheat flour and water, fried in vegetable oil or lard.

Uji: A porridge, made with water or milk, maize or sorghum flour, and a little sugar or salt. The consistency ranges from thin to thick.

Tea Tea leaves, water, milk, and sugar are boiled together with approximately 20% whole milk and 5-10% sugar.

The most frequently consumed dishes in Embu are presented in Table 6.3. These data are based on preliminary analysis of the nutrient data base derived from the quantitative food intake data, which were collected from Jan. 1984 to Dec. 1985. The most commonly consumed dishes were tea, githeri, porridge, ugali, and stew.

The frequency of the type of dishes served at each meal, and the occurrence of dishes served as leftovers (obtained from preliminary survey data) are presented in Table 6.4.

Household Intake

Average household daily intake by month is presented in Table 6.5. Household intakes for kcal, protein, fat and carbohydrate were calculated by summing the total meal nutrients consumed within the household plus snack nutrients and meals consumed by target and nontarget individuals outside of the household regardless of the source of the food (guest intakes are subtracted). Total household kcal, protein, fat, and carbohydrate were averaged for the two days in which data were collected each month so that an average household nutrient intake per day for each month and each household was obtained.

TABLE 6.3
The frequently consumed dishes in Embu expressed as a percentage of the total number of dishes reported.

Dish	% Occurrence
Tea (milk, sugar)	18.1
Githeri (maize, beans, vegetables)	14.6
Ugi (porridge)	10.4
Ugali	7.7
Stew	6.9
Mataha (maize, beans, vegetables)	5.4
Gitwero	4.1
Coffee	1.8
Rice	1.4
Other dishes	29.6
Total	100.0

Although the household kcal consumption has not been adjusted for household demography, there is a consistent fall in total kcal intake starting as early as July 1984, but most marked from Sept. through Nov./Dec. 1984, the time of the famine, when the intake in some households in the subsample fell by over 50%. The number of households included in the sample remained relatively constant from May 1984 through January 1985. There was very little missing food intake data and the changes of the households represented each month were mainly due to enrollment of additional households for the first 4 months of the study and dropping of households in 1985 as they finished the study. A commonly observed pattern was a "picket fence" of higher than usual household intake alternating with months of very low intake, the former representing relief food aid with variations up to 5000 kcal. The kcal intake on the two consecutive days of measurement also frequently were very low one day and high the second day depending on donated food. In contrast, other times of the year showed fairly consistent intake from month to month. Another striking feature during the famine months was that the use of snack foods dropped to nearly zero, almost pathognomonic of the food shortage.

A second period of relative food shortage occurred in April and May 1985, with a shortfall in the long rains and a failure of the maize crop in the drier lower cluster (Karurumo).

TABLE 6.4
Occurrence of dishes served at breakfast, lunch & supper as well as leftovers from previous days (each dish served is expressed as a percentage of the total number of dishes served).*

	Sublocation		
	Kathanjure	Kathunguri	Karurumo
Breakfast	n=33	n=40	n=43
Mean no. of dishes served per breakfast	1.1	1.2	1
% Occurrence of			
Tea	42	39	41
Uji	53	52	57
Bread	3	2	2
Gitwero	3	0	0
Others	0	7	0
Total	101	100	100
Lunch	n=31	n=40	n=45
Mean no. of dishes served per lunch	1.1	1.1	1
% Occurrence of			
Githeri	56	57	76
Gitwero	15	9	11
Mataha	12	9	0
Ugali & Stew	12	9	13
Rice & Stew	0	2	0
Uji	3	0	0
Chappati & Stew	0	9	0
Others	0	7	0
Total	101	100	105

Continued.

TABLE 6.4 continued.

	Sublocation Kathanjure	Kathunguri	Karurumo
Supper	n=35	n=41	n=47
Mean no. of dishes served per supper	1	1	1.1
% occurrence of:			
Githeri	51	51	73
Ugali & stew	26	15	6
Chappati & Stew	0	5	0
Rice & Stew	3	2	2
Mataha	3	10	2
Gitwero	6	10	6
Uji Porridge	6	8	0
Others	5	0	10
Total	100	101	99
Leftovers	n=16	n=20	n=14
Mean no. of dishes served as leftovers	1	1	1
% occurrence of:			
Githeri	63	65	93
Gitwero	25	5	0
Mataha	12	5	0
Tea	0	0	6
Porridge	0	10	0
Gruel	0	10	0
Chapati & Stew	0	5	0
Total	100	100	99

* Percentages do not add to 100% due to rounding error.

Mean Daily Energy Intake By Target Individual and Sex

Mean kcal intake by target individual based on the mean of two days observation per month is presented in Table 6.6 and Figure 6.5. The most striking finding is the uniform decrease in kcal intake in all target groups, except toddlers, becoming apparent in July 1984, declining further in August through November, and persisting into the first few months of 1985. The target group showing the relatively largest decrease in food intake was the lead female (see Table 6.7). The slight increase in toddler intake over time may be due to a cohort phenomenon, which exaggerates the increase in the group as a whole. As an individual toddler gets older it is expected to increase its intake. The toddlers who are at a stage of expected rapid growth, however, may not be increasing their intake as much as they should. Also the toddlers may have received relatively more famine relief food than other target individuals.

TABLE 6.5
Household mean monthly food intake.

Month	Mean		
	kcal/day	SD	N
1984			
1	10,973	4,914	90
2	11,333	4,954	212
3	11,936	4,557	190
4	12,125	5,388	216
5	11,206	4,818	223
6	11,197	5,044	226
7	11,019	4,534	235
8	10,770	5,090	239
9	9,325	4,219	239
10	9,728	4,671	238
11	9,818	4,721	231
12	10,863	5,299	225
1985			
1	11,259	4,713	222
2	9,969	3,762	179
3	11,395	4,145	169
4	11,929	4,994	145
5	11,460	5,015	144
6	11,924	4,790	143
7	11,689	4,907	142
8	11,632	5,145	143
9	12,143	4,914	141
10	11,796	5,168	140
11	11,338	4,302	91
12	9,246	2,944	8

TABLE 6.6
Kenya mean monthly energy intake by target type and sex expressed as mean kcals/day.

Date	LM	N	LF	N	MS	N	FS	N	MT	N	FT	N
Jan 84	1880	130	1934	139	1560	63	1520	45	738	18	586	22
Feb 84	2122	367	1833	381	1640	140	1274	122	646	49	729	68
Mar 84	2338	352	2015	376	1762	120	1504	89	776	86	763	94
Apr 84	2204	389	1793	408	1659	115	1601	95	854	86	755	88
May 84	2019	431	1710	455	1535	135	1309	114	822	90	852	105
Jun 84	2020	425	1689	445	1563	129	1482	108	786	92	773	100
Jul 84	2094	443	1815	459	1548	136	1440	116	910	98	858	100
Aug 84	1937	451	1624	465	1483	137	1408	119	888	99	834	100
Sep 84	1684	435	1406	457	1269	145	1138	121	794	94	767	104
Oct 84	1693	431	1382	458	1273	150	1184	124	926	97	779	104
Nov 84	1681	437	1388	454	1287	151	1258	122	814	91	830	105
Dec 84	1815	420	1566	441	1332	146	1284	119	860	109	845	102
Jan 85	2037	410	1781	433	1640	147	1369	124	864	90	862	97
Feb 85	1980	332	1716	354	1574	81	1210	77	863	81	900	92
Mar 85	2227	314	1891	328	1609	69	1430	67	1031	77	868	73
Apr 85	2070	271	1790	286	1553	59	1468	49	926	54	931	49
May 85	1978	266	1758	283	1577	55	1454	44	775	35	1035	32
Jun 85	2188	254	1875	279	1787	49	1500	42	1081	24	879	20
Jul 85	2011	261	1621	277	1481	36	1435	34	1031	14	810	9
Aug 85	1993	260	1756	283	1415	26	1341	22	747	10	780	6
Sep 85	2128	251	1837	268	1787	28	1501	14	846	8	855	4
Oct 85	2076	254	1789	276	1644	16	1333	12	920	6	1055	2
Nov 85	2018	160	1853	181	1374	14	1130	10				
Dec 85	1849	14	1767	16	1676	4	1127	2				

N = number of observations (days), LM = lead males, LF = lead females
MS =male schoolers, FS = female schoolers

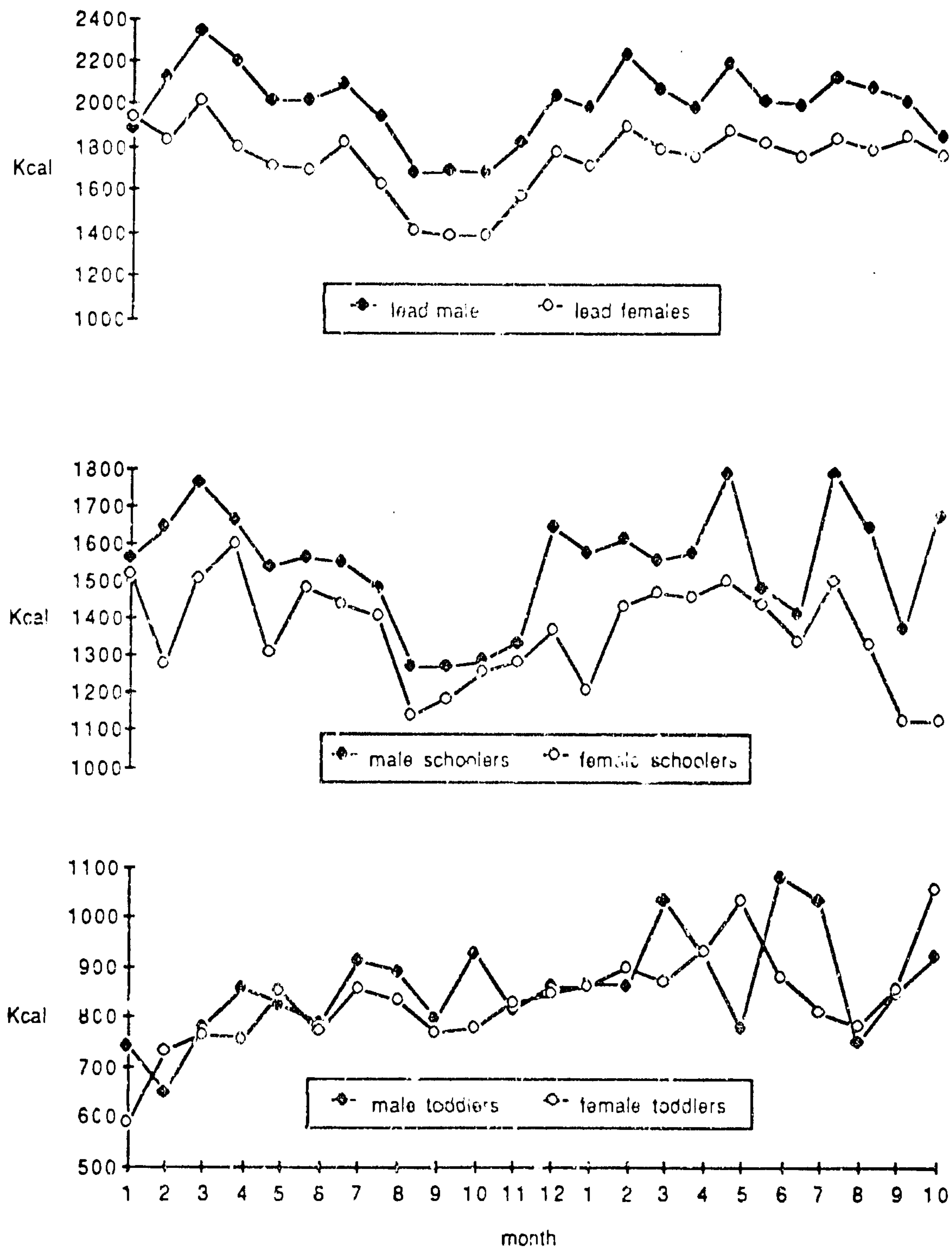


FIG. 6.5 Mean daily food intake by target individual by month for 1984-1985.

TABLE 6.7
Mean absolute and percentage kcal decrease during severe drought by target individuals ([July kcal minus Oct. kcal] divided by July kcal).

TI	kcal Decrease	% Decrease
Lead Male	401	19
Lead Female	433	23
Male Schooler	275	18
Female Schooler	256	18
Male Toddler	(+14)	(+2)
Female Toddler	52	6

The mean daily intake of energy (kcal) animal and total protein, fat, carbohydrate and iron are presented in Table 6.8 by target individual and by sex. The diet is generally very low in animal protein, with toddlers consuming 3.1 to 3.9 grams/day, schoolers consuming 2.5 to 2.7 grams/day, and adults consuming 3.9 to 5.0 grams of animal protein a day, comprised mainly of cow's milk. Iron intake is lowest and least adequate in the toddlers, 6.0 to 6.4 mg/day. The total protein intake appears adequate.

The percent of kcal derived from fat is 13 to 14% in adults, about 13% for schoolers and 13 to 15% in toddlers. This is about one-third of the kcals derived from fat in the USA. About 12% of energy is derived from protein, except for toddlers, who received less, about 10.5%. The percent of protein-kcals derived from animal sources is very low, ranging from 6 in the male schooler to 19% in the female toddler.

Examination of correlation coefficients between toddler fat intake and SES, and animal protein and SES, show r's to be .32 to .34 and .22 to .32 respectively. Also fat intake and animal protein are highly correlated ($r = .33$ to $.89$, $p < .05$). Fat and animal protein in the diet may be possible markers for SES.

Estimation of Household Requirement

An attempt was made by the staff at Management Entity, Berkeley to arrive at some measure of the ratio of household nutrient intake to requirement. Household requirement is defined as the sum of individual basal metabolic rates (expressed in kcal), where individual age, sex, and weight data are used in standard FAO/WHO/UNU BMR equations (6). Weights were an average of all measures for an individual (and thus do not vary with time). Since non-target individuals were not weighed more than twice a year, if at all, missing data with respect to the weight is considerable. Birthdate and sex data for this group were taken from the quarterly household census. Protocols were developed so that estimated or actual values for all variables used in the BMR equations were obtained for every household member, and underestimation of household "requirement" due to missing data did not occur. Mean values for age by target type were used as the default values for those individuals with missing age data.

TABLE 6.8
Kenya nutrient intake by target type and sex for 1984 - 1985.

	LM	LF	MS	FS	MT	FT
No.of observations	7758	8202	2151	1791	1495	1607
Energy (mean kcal/d)	1995 ± 1001	1713 ± 832	1513 ± 644	1357 ± 592	841 ± 452	805 ± 432
Protein (g/d)	60 ± 34	51 ± 28	45 ± 22	40 ±19	23 ± 15	21 ± 14
Animal protein(g/d)	5.0 ± 11.4	3.9 ± 8.1	2.7 ± 5.8	2.5 ± 4.6	3.1 ± 5.6	3.9 ± 6.5
Fat (g/d)	31 ± 20	26 ± 17	22 ± 12	20 ± 11	13 ± 11	14 ± 11
Carbohydrate (g/d)	388 ± 199	338 ±166	300 ± 131	269 ± 121	166 ± 98	156 ± 88
Iron (mg/d)	17.9 ± 10.9	15.4 ± 9.3	13.5 ± 7.0	12.5 ± 7.2	6.6 ± 4.9	6.0 ± 4.4
% kcal from fat*	14.0	13.7	13.1	13.3	13.9	15.7
% kcal from carbohydrate*	77.8	79.0	79.3	79.3	79.0	77.5
% kcal from protein*	12.0	11.9	11.9	11.8	10.9	10.4
% Protein-kcal from animal sources	8.3	7.6	6.0	6.3	13.5	18.6

* Kcal calculated roughly as fat : g x 9; carbohydrate, g x 4; and protein, g x 4. Energy intakes have been calculated from the nutrient data base, which uses specific energy values appropriate to the food, i.e. taking account of composition and digestibility.

LM = lead males, LF = lead females
MS = male schoolers FS = female schoolers
MT = Male toddlers, FT = female toddlers

Fourteen distinct target types were defined, each with a unique variable "ID" number. Six types include wide variations in age, non-target offspring, other relatives, and non-relatives. Mean weights and ages are defined for both males and females in each category (see Table 6.9). For target types that are overly aggregated with respect to sex or age, such as "other relatives" mean values for weight for 12 distinct sex/age groups were used (see Table 6.10). Once all default values were assigned, standard equations were used to calculate basal metabolic rates for each individual. The equations, one for each of 12 sex/age categories, appear in Table 6.11.

TABLE 6.9
Mean weight and age by person type and sex.*

Person Type	Mean Weight (kilograms)	N_{wt}	Mean Age (years)	N_{age}
Lead Male	55.06	280	37.7	291
Lead Female (NPNL)	50.00	290	32.2	291
Male Schooler	20.33	122	8.2	114
Female Schooler	20.06	105	8.3	94
Male Toddler	10.30	57	2.1	46
Female Toddler	9.83	70	2.2	55
Male Infant	5.47	79	0.3	73
Female Infant	5.06	64	0.2	61
NT† Male Offspring	--	--	9.7	563
NT Fem Offspring	--	--	10.3	597
Other Relative (M)	--	--	22.0	42
Other Relative (F)	--	--	25.7	76
Non-relative (M)	--	--	20.7	45
Non-relative (F)	--	--	19.7	34

* These means are for the complete Kenya project sample.

† NT = Non Target

TABLE 6.10
Mean weight by sex and age group.*

Sex	Age Group (y)	Mean Weight (kg)	n
Male	0 - 3	8.68	129
Male	3 - 10	17.79	310
Male	10 - 18	32.84	141
Male	18 - 30	55.12	68
Male	30 - 60	55.06	239
Male	60	44.41	6
Female	0 - 3	8.61	130
Female	3 - 10	17.35	282
Female	10 - 18	33.77	157
Female	18 - 30	52.19	127
Female	30 - 60	51.68	189
Female	60	46.07	8

* These means are based on the entire Kenya project sample.

TABLE 6.11
Equations for predicting basal metabolic rate (BMR) from body weight (wt)*

Sex	Age Group	Equation
M	3 - 10	BMR = 22.7(wt) + 495
M	10 - 18	BMR = 17.5(wt) + 651
M	18 - 30	BMR = 15.3(wt) + 679
M	30 - 60	BMR = 11.6(wt) + 879
M	60	BMR = 13.5(wt) + 487
F	0 - 3	BMR = 61.0(wt) - 51
F	3 - 10	BMR = 22.5(wt) + 499
F	10 - 18	BMR = 12.2(wt) + 746
F	18 - 30	BMR = 14.7(wt) + 496
F	30 - 60	BMR = 8.7(wt) + 829
F	60	BMR = 10.5(wt) + 596

* Taken from FAO Protein and Energy Requirements, 1985.

In order to arrive at a household requirement, individual basal metabolic rates were summed for each household in an 8% subsample for each month. This subsample is a convenience sample chosen to be used for developing a computer program for the larger data set. The households in the subsample are all from a single cluster in the upper study zone, the most fertile part of the study area with the highest annual rainfall. For months in which the exact household composition was unknown, (census surveys were administered every third month) the most recent prior household composition was used for the calculations. Finally, household intakes and requirements were averaged over all the households in this subsample for each of the 23 months of the study. The mean household intake, requirement, and the ratio of intake to requirement are presented in Table 6.12. The apparent drop in caloric intake and the Int/BMR ratio for the three-month period beginning in September of 1984 parallels the results found in the analysis of individual intake data, and is a reflection of the famine at that time.

<u>Apparent Nutritional Adequacy of Reported Diets</u>

Many studies have demonstrated that as energy intake increases, the intake of most nutrients tends to increase. That is, subjects tend to consume differing amounts of similar foods with similar nutrient/energy concentrations. An implication of this covariance between nutrients and energy is that energy intake serves as a proxy for nutrient intake, as well as a measure of a discrete variable. An original concern of the CRSP design was that relationships seen between energy intake and outcome functions might really be a relationship between a nutrient and that function. Such is a distinct possibility if the diet is quite low in one or more nutrients in comparison to estimated needs for those nutrients. In this section we try to address this question for the intakes of the two nutrients that have been estimated to date - protein and iron.

TABLE 6.12
Food intake summary statistics*: household intake, requirement for basal metabolic energy expenditure and intake/BMR requirement.

Date	kcal Intake	±SD	N	HH BMR†	±SD	N	Int/BMR	±SD	N
Jan 84	9866	4161	18	7766	3046	49	1.32	0.54	18
Feb 84	11722	5853	33	7712	2905	34	1.62	0.82	33
Mar 84	9928	3512	32	7856	3090	32	1.40	0.56	32
Apr 84	11059	5259	34	7449	2946	35	1.50	0.48	34
May 84	10686	3683	36	7668	2941	47	1.53	0.69	36
Jun 84	10711	3393	35	7937	2944	35	1.42	0.40	35
Jul 84	10291	3942	39	7818	3002	39	1.40	0.48	39
Aug 84	10538	4391	39	7876	2802	45	1.37	0.36	39
Sep 84	8147	3272	38	7792	2940	38	1.14	0.48	38
Oct 84	8813	3172	39	7840	2917	39	1.19	0.41	39
Nov 84	8697	4038	38	7810	2845	44	1.18	0.47	38
Dec 84	10664	4226	37	7871	3015	37	1.41	0.49	37
Jan 85	11282	5173	37	7932	2963	37	1.46	0.49	37
Feb 85	9754	3759	29	7620	2944	29	1.35	0.47	29
Mar 85	11066	3693	26	7668	2840	26	1.51	0.41	26
Apr 85	13227	11694	22	7796	2936	22	1.66	0.83	22
May 85	10338	3594	22	7859	2758	22	1.36	0.43	22
Jun 85	11646	3932	22	7859	2758	22	1.54	0.42	22
Jul 85	11817	3980	22	7840	2825	21	1.59	0.50	21
Aug 85	11209	7267	22	7820	2827	21	1.45	0.57	21
Sep 85	10444	3613	22	7820	2827	21	1.38	0.47	21
Oct 85	10056	3228	22	7527	3296	4	1.56	0.34	4
Nov 85	9125	2791	10	5384		1	1.29	.	1

* Sample means, standard deviations, and sample sizes for the variables, mentioned are presented in this table. Sample is about 8% of the households studied.

† HH BMR is calculated from equations using mean weight for an individual. Thus, weight loss during the famine is not reflected in HHBMR (or in the intake/BMR ratio).

The approach taken is based on the "probability assessment" of dietary nutrient adequacy developed in a recent National Academy of Sciences report (6). In essence, that approach places the estimated intake of an individual within the distribution of requirements for that type of individual and assigns a probability that the intake is or is not adequate for such an individual. By repeating this across all of the individuals and then summing the probabilities, a statement can be offered about the expected proportion ("prevalence") of individuals who would have inadequate intakes - a probability assessment of the nutrient adequacy of the reported dietary intakes of the population. If the computed prevalence is high it is quite possible that energy intake is serving as a proxy for the covarying nutrient intake and that it is the latter that exerts the effects seen. If the estimated prevalence of inadequate intakes is low, then there is much greater confidence in assuming that energy intake, rather than nutrient intake, is the variable of interest.

Dietary Intake Estimates

For these analyses, all dietary data available for each individual (except days with missing nutrient data for one or more foods) were pooled to provide a mean intake estimate for the individual across the whole period for which he or she was in the study. No adjustment was made for periods of reduced intake (as in the drought period or in illness), nor was any separate examination of such periods undertaken. For protein, the observed mean intakes were divided by the average of all weight data collected for the individual to give an estimate of intake/kg/day. In the case of women, data were pooled across time without regard to physiologic state (pregnancy, lactation). These approaches have important implications for interpretation of the findings but seemed appropriate to the primary purpose - assessment of the diets.

Dietary protein intake was estimated as "utilizable protein". That is, estimated digestibility and amino acid score were applied to the observed protein intakes of each individual. An FAO/WHO/UNU committee (7) provided guidelines for the estimation of digestibility of dietary proteins. Animal source foods were considered to have digestibilities equivalent to milk or egg (100%). From empiric evidence reported for diets based on maize, beans, and rice, as well as mixed diets said to be typical of the Philippines and India (7), it was accepted that the vegetable source foods consumed in Embu had protein digestibilities approximately 82% that of milk or egg protein. These factors were applied to the components of observed protein intake. Direct estimates of the amino acid composition of Embu diets were not available. Again based on estimates of amino acid composition of mixed diets in other parts of the world in relation to the estimated pattern of amino acid requirements of toddlers, schoolers, and adults (7), it was accepted that the amino acid scores for the diets consumed in Embu were about 70% for toddlers, 90% for schoolers, and 100% for adults. These estimates were applied to the total digestible protein without further adjustment for the potential impact of animal source foods to the amino acid score. These calculations led to an estimate of the utilizable protein intake with utilization considered in terms of equivalence to milk or egg protein.

Protein Requirement Estimates

The estimates of distributions of protein requirements developed by an FAO/WHO/UNU committee (7) were adopted. That committee estimated the amount of egg or milk protein required to establish and maintain nitrogen balance in adults and to sustain normative levels of protein accretion in growing children (adults, 0.60 +/- 0.075; schoolers, 0.81 +/- 0.10; toddlers, 0.92 +/-0.11 g/kg/d). Since the protein intakes were adjusted to an equivalence to milk or egg protein, the intake and requirement figures may be compared directly. Separate estimates were not developed for pregnant and lactating women.

Iron Requirement Estimates

The estimates of the distributions of iron requirement were based on the unpublished report of an FAO/WHO committee (8). That committee estimated the distributions of iron losses (and depositions during normative levels of growth). The distributions for toddlers (0.49 +/- 0.07 mg/d), schoolers (0.94 +/- 0.14 mg/d), and adult men (0.91 +/- 0.14 mg/d) were assumed to be Gaussian. In contrast, the distribution of menstrual iron losses is known to be very skewed, approximating a log-normal distribution. For the present calculations it was accepted that women had a basal iron loss of 0.77 mg/d plus a menstrual loss, described in log units, of -0.7339 +/- 0.7312. In the present report, separate estimates for pregnant and lactating women were not developed.

The committee provided guidelines for the estimation of the proportion of dietary iron that might be expected to be absorbed. This was seen as a function of both the nature of the diet and the state of body iron stores. An iron-replete individual would be expected to absorb a lower proportion of dietary iron than would an iron depleted individual. Requirement estimates were developed for two levels of body iron status. The Basal Requirement was estimated as the amount of dietary iron needed to maintain all recognized functions of iron, including hematopoiesis, with provision for only very low levels of storage iron. The amounts of dietary iron needed to stabilize a mild degree of anemia equivalent to the international markers of the beginning of anemia (stores completely depleted), were also estimated. Table 6.13 presents the estimates of dietary iron availability applied in the present calculations. The diets consumed in Embu are believed to have varying levels of ascorbic acid depending on season (quantitative estimates not available). Without ascorbic acid the diets would be classified as "low bioavailability"; with ascorbic they might fall in the "intermediate bioavailability" category. To obtain an estimate of dietary iron need, the amount of absorbed iron needed to balance iron losses (and iron accretion during growth) is divided by the bioavailability estimate (see Tables 6.14 to 6.17). The present estimates of the absorption of dietary iron, or the manner in which the committee applied them to the estimate of distribution of iron losses (8), lead to appreciably higher estimates of dietary iron needs than previously proposed (9); dietary iron needs may be overestimated in the present examination.

TABLE 6.13
Estimates of Bioavailability of Dietary Iron Based on the Nature of the Diet and the Iron Status (Level of Requirement) of the Subjects

Characteristics of the Diet	Requirement Definition* Stabilize Mild Anemia	 Satiate all Recognized Functions (Low Storage)
Low Bioavailability cereals, roots, tubers little meat, fish, Vit C	7.5%	5.0%
Intermediate Bioavailability cereals, roots, tubers modest meat, fish or Vit C	15.0%	10.0%

* Based on FAO/WHO (8)

Dietary Assessment

Applying the above estimates of protein and iron requirement distributions to reported mean intakes, the predicted prevalences of inadequate dietary intakes shown in Tables 6.14 to 6.17 were obtained.

The requirement estimates applied in these analyses are for presumed normal and healthy individuals. Pregnancy and lactation were not taken into account as factors affecting requirement; adequacy of the diet for non-pregnant, non-lactating women was assessed. Judged against requirement estimates for healthy individuals, it appears unlikely that inadequate protein intake per se is a sufficiently limiting factor in the Embu diets to seriously confound the interpretation of energy intakes. No requirement estimates are available for subjects with current or recent infections. Protein needs are believed to be higher in such circumstances as are also energy needs (7). If recurrent infection and other factors limit growth, then protein (and energy) needs to support a compromised growth rate would be reduced. These considerations do not provide a clear basis for altering the primary judgment.

In the case of iron, the opposite may be true. That is, unless the higher estimate of dietary iron availability is used, the analyses suggest that covarying iron intake may well confound the interpretation of energy intake, at least for those functional outcomes that have a suggested relationship to iron status. Aspects of cognitive development have been tentatively linked to iron status. In this situation it will be desirable to include independent measures of iron status (hemoglobin, transferrin, and ferritin levels) in analyses of the relationship between energy intake an outcome measures even though interpretation of those status measures is complicated by the effects of infection.

TABLE 6.14
Assessment of Probable Adequacy of Diets Consumed by Lead Males (285 subjects; 286 with weight data)

Nutrient	Level of Requirement	Requirement Estimate (Mean +/- SD)	Estimated Intake (Mean +/- SD)	Expected Prevalence of Individuals with Inadequate Intakes
Protein (g/kg/d)	Maintain Nitrogen Balance	0.60 +/- 0.075*	0.92 +/- 0.24†	7.6%
Iron Low Avail. (mg/d)	Stabilize Anemia	12.1 +/- 1.9	17.8 +/- 4.8	12.7%
	Basal Needs	18.2 +/- 2.8	17.8 +/- 4.8	52.8%
Iron Intermed. Avail.	Stabilize Anemia	6.1 +/- 0.9	17.8 +/- 4.8	1.1%
	Basal Needs	9.1 +/- 1.4	17.8 +/- 4.8	3.8%

* Expressed as milk or egg protein

† Expressed as the utilizable protein equivalent to milk or egg

TABLE 6.15
Assessment of Probable Adequacy of Diets Consumed by Lead Females.* (285 subjects)

	Level of Requirement	Requirement Estimate (Mean ± SD)	Estimated Intake (Mean ± SD)	Expected Prevalence of Individuals with Inadequate Intakes
Protein (g/kg/d)	Maintain Nitrogen Balance	1.60 +/- 0.075†	0.85 +/- 0.22‡	12.4%
Iron Low Avail. (mg/d)	Stabilize Anemia§	----	15.7 +/- 4.0	62.5%
	Basal Needs§	----	15.7 +/- 4.0	94.6%
Iron Intermed. Avail.	Stabilize Anemia §	----	15.7 +/- 4.0	9.8%
Basal Needs§		----	15.7 +/- 4.0	32.8%

* Assessed adequacy for nonpregnant, nonlactating women; dietary data from women in all physiologic states included

† Expressed as milk or egg protein

‡ Expressed as the utilizable protein equivalent to milk or egg

§ See text for derivation of requirement estimate

TABLE 6.16
Assessment of Probable Adequacy of Diets Consumed by Schoolers, Both Sexes (285 subjects, 167 with weight data)

Nutrient	Level of Requirement	Requirement Estimated (Mean ± SD)	Estimated Intake (Mean ± SD)	Expected Prevalence of Individuals with Inadequate Intakes
Protein (g/kg/d)	Maintain Normative Growth	0.81 +/- 0.010*	1.67 +/- 0.38†	.7%
Iron Low Avail. (mg/d)	Stabilize Anemia	12.5 +/- 1.9	13.4 +/- 4.1	43.5%
	Basal Needs	18.8 +/- 2.8	13.4 +/- 4.1	87.5%
Iron Intermed. Avail. (mg/d)	Stabilize Anemia	6.3 +/- 0.9	13.4 +/- 4.1	3.0%
	Basal Needs	9.4 +/- 1.4	13.4 +/- 4.1	13.9%

* Expressed as milk or egg protein
† Expressed as the utilizable protein equivalent to milk or egg

TABLE 6.17
Assessment of Probable Adequacy of Diets Consumed by Toddlers, Both Sexes, Excluding Breast-fed (133 subjects)

Nutrient	Level of Requirement	Requirement Estimate (Mean ± SD)	Estimated Intake (Mean ± SD)	Expected Prevalence of Individuals with Inadequate Intakes
Protein (g/kg/d)	Maintain Normative Growth	0.92 +/- 0.11*	1.36 +/- 0.36†	9.2%
Iron Low Avail. (mg/d)	Stabilize Anemia	6.5 +/- 0.9	6.3 +/- 1.7	55.0%
	Basal Needs	9.8 +/- 1.4	6.3 +/- 1.7	93.8%
Iron Intermed Avail. (mg/d)	Stabilize Anemia	3.3 +/- 0.5	6.3 +/- 1.7	3.7%
	Basal Needs	4.9 +/- 0.7	6.3 +/- 1.7	13.9%

* Expressed as milk or egg protein
† Expressed as the utilizable protein equivalent to milk or egg

Energy Intakes

The probability assessment approach used above is not applicable to energy intake (6). All that can be done is to compare observed group mean intakes to estimated mean requirements without specific assessment. The FAO/WHO/UNU report (7) can be used as a basis for such comparisons. That committee estimated mean energy needs per kg body weight for children assuming normative rates of growth and normative levels of physical activity. In the case of adults, it estimated needs based on predicted BMR multiplied by a factor representing the increased energy needs for a predetermined level of physical activity. 1.75 X BMR was suggested for moderate activity levels. In the absence of more specific information about activity levels in Embu, this factor was used. Table 6.18 compares observed mean intakes with mean energy needs estimated as above, using group mean weights seen in Embu. In addition, for adults and schoolers, mean observed RMR X 1.75 has been used to generate a "local" estimate. RMR is normally up to about 10% higher than BMR (due to the thermogenic effect of ingestion of food). Conversely, the Beckman Metabolic Measurement Cart used in the Kenya project yields estimates that are about 10% lower than with Max Plank equipment (by a validation study conducted by Project staff). The Max Plank values were close to FAO/WHO/UNU regression estimates of BMR. In view of uncertainty about adjustment factors (measured RMR to theoretical BMR) that should be used, the estimates are presented without adjustment.

TABLE 6.18
Comparison of Mean Energy Intake With Two Estimates of Mean Energy Needs for Normative Growth Rates and Activity Levels (kcal/d)

Requirement Derivation	Adults Male	Adults Female	Schoolers Male	Schoolers Female	Toddlers Male	Toddlers Female
FAO/WHO/UNU	2656	2242	1626	1464	1071	1032
Embu Estimate	2340	2095	1295	1295	----	----
Observed Intakes	1995	1713	1513	1357	841	805
% FAO Recommended Intake	75	76	93	93	79	78

REFERENCES

1. Latham M.C. Human Nutrition in Tropical Africa. Rome: Food and Agriculture Organization of the United Nations. 1979.

2. United States Department of Health, Education, and Welfare, Public Health Service, Health Services Administration, National Center for Chronic Disease Control Nutrition Program; and Food and Agriculture Organization of the United Nations, Food Consumption and Planning Branch, Nutrition Division. Food composition table for use in Africa. Bethesda, MD, and Rome, Italy. 1968.

3. Platt B.S. Tables of representative values of foods commonly used in tropical countries. Privy Council, Medical Research Council Special Report Series No. 302. London: Her Majesty's Stationery Office. 1962.

4. Paul A.A., Southgate D.A.T. McCance and Widdowson's the composition of foods. Fourth revised edition. New York: Elsevier/North-Holland Biomedical Press.

5. Watt B.K., Merrill A.L. Composition of Foods. Agricultural Handbook No. 8. United States Department of Agriculture. Washington D.C. 1975.

6. National Academy of Sciences. Nutrient Adequacy: Assessment Using Food Consumption Surveys. Washington D.C.: National Academy of Sciences Press. 1986.

7. FAO/WHO/UNU Report of a Joint Expert Consultation on Energy and Protein Requirements. WHO Technical Report Service. No. 724. Geneva. 1985.

8. FAO/WHO Report of a Joint Expert Group on Requirements of Vitamin A, Iron, Folate, and Vitamin B12. In Press. 1987.

9. FAO/WHO Report of a Joint Expert Committee on Requirements of Ascorbic Acid, Vitamin D, Vitamin B12, Folate and Iron. WHO Technical Report Series No. 452. Geneva. 1970.

Chapter 7

ANTHROPOMETRY

The Nutrition CRSP Kenya Project conducted anthropometric measurements to assess the effects of food intake on body size, composition and growth. A variety of measurements were carried out monthly on the target individuals of 247 study households. Heights and weights were also measured at least once on the non-target members of study households. The anthropometry data provide a description of the study population's nutritional status over time, and are amenable to the testing of a wide variety of nutrition-related hypotheses.

RESEARCH OBJECTIVES

While nutritional status is known to be dependent, at least in part upon food intake, the relationship between the two variables is not fully understood, particularly among mildly to moderately malnourished populations. Because anthropometric measurements of body size and gross composition are particularly useful for assessing growth failure and undernutrition (1), a variety of anthropometric measurements were conducted monthly on target individuals. While the anthropometry data are invaluable in themselves for better understanding relationships between food intake, nutritional status, and physical growth, the data also provide a better understanding of the impact of pregnancy, lactation, disease, socioeconomic status, and other variables upon nutritional status and growth.

THE SAMPLE

Anthropometric measurements were carried out monthly on the target lead males, lead females, schoolers, toddlers, and infants of each study household for a minimum of one year, between January 1984 and December 1985. Data were collected on 247 lead males, 247 lead females, 139 schoolers, 111 toddlers, and 130 infants from 247 households. The heights and weights of non-target household members were also measured on at least one occasion.

The types of measurements selected were those considered 1) necessary to accomplish the research objectives, and 2) capable of being attained under field conditions. Thus, for example, the measurement of fatfolds was the appropriate method under field conditions to estimate energy stores with these have been found to correlate satisfactorily with more complex and sophisticated measures (2). The various categories of TI's that underwent specific types of measurements were as follows:

Lead Males and Non-Pregnant, Non-Lactating Lead Females

Height, head circumference, weight, arm circumference, and triceps, biceps and subscapular fatfolds were measured at monthly intervals.

Pregnant and Lactating Women

In addition to those measurements made for non-pregnant women, (except for height, which was not measured during pregnancy), mid-thigh, abdomen, and suprailiac fatfolds were measured on pregnant and lactating women. These were obtained at monthly intervals once the pregnancy was diagnosed, and through the first six months of lactation.

Schoolers and Toddlers

Weight, height, head circumference, arm circumference, and triceps, biceps, and subscapular fatfolds were obtained at monthly intervals.

Newborns

Weight was obtained within 72 hours of birth, and weight, length, head and arm circumferences, and triceps, biceps, and subscapular fatfolds were obtained from seven to nine days after birth, at one month of age, and at monthly intervals thereafter through the sixth month of age.

Enumerators attempted to carry out measurements on all target individuals each month during a single visit to the household. Additional visits were sometimes required, for example, to measure newborns, or target individuals who were absent during the regular visits.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The specific techniques used to conduct the anthropometry measurements are well known and highly standardized, and have been described by Jelliffe (1), Weiner and Lourie (3), WHO (4), Behar (5) and Zerfas (6). The Nutrition CRSP Kenya Project adopted such standardized procedures for collecting anthropometry data (see "Techniques of Data Collection"), and employed 24 well-trained fieldworkers to conduct these measurements.

Young women who had the equivalent of a U.S. high school education (Kenyan "O-level") were selected to carry out anthropometry measurements. Senior investigators spent several months prior to the commencement of the study training the potential fieldworkers. While certain measurements were relatively straightforward to teach, such as weight and head circumference, others were more complex and required special effort, especially length and the various skinfolds. Training also included instruction on how to interact with household members, which measurements to make on particular individuals, how to maintain and calibrate equipment and, of critical importance, how to record data. All such methodological information was outlined in a manual which all prospective trainees were required to learn thoroughly. After extensive training the majority of the trainees were highly skilled at performing all these tasks, and it was these individuals which were employed by the project (see "Quality Control" for information regarding on-going training).

While fieldworkers were being trained in the above activities, a data collection form was designed. A critical feature of the form, and indeed of the overall protocol, was that a team of two fieldworkers (enumerators) was required to conduct any given measurement for every respondent. That is, as described in more detail below, each team member was required to make a measurement and record the value independently of the other. A final step of staff training, after organizing enumerators into teams, was to extensively pre-test the protocol, with special attention placed on both the use of field equipment and the feasibility of enumerators working in pairs and recording measured values properly and independently.

The pilot testing was conducted in the project's contiguous pilot study area, and the few minor problems and questions which did arise were easily resolved. Regarding equipment, the adult Acu-Weigh Beam Balance (weighing 40 lbs.)

and the Infant Detecto Scale were rejected as it was impossible for the women to carry these from house to house without transport. The Stadiometer was rejected for the same reason.

It was also found during pilot testing that many toddlers were too frightened and uncooperative to be weighed on Salter Hanging Scales. Therefore, the Heath Digital Scale, which is light and accurate, was chosen and infants and toddlers weighed by difference. The light weight Nivotoise was introduced for measuring standing height.

The most useful consequence of the pilot testing, of course, was that the enumerators gained valuable experience of what it would be like to conduct fieldwork under actual household conditions.

TECHNIQUES OF DATA COLLECTION

All anthropometry measurements were made by both enumerators of a given measuring team. Each member of a team was designated as either Enumerator A or Enumerator B; the goal of establishing teams was to ensure the collection and recording of high quality data and each enumerator was assigned an identification number which appeared on all their forms.

Upon arrival at a house, an anthropometry team, generally accompanied by a supervisor on alternate days, verified the presence of the TI's to be measured and requested their permission to conduct the work. Enumerator A completed the header information (e.g., "TI's Name", "Date") on a separate data collection form for each TI (Form #211; see Fig. 7.1).

Measurements were carried out within the home in as sheltered and private an environment as possible. Heavy ornaments, garments, and shoes were removed, and clothing was removed to the last layer next to one's underwear, allowing for the constraints of privacy. Infants were weighed without clothing and toddlers either without clothing or wearing only a pair of light shorts.

The procedures for conducting measurements and recording data were as follows: After identifying the first TI to be measured, Enumerator A measured that TI for a given parameter (e.g., height) and recorded the value in the appropriate columns on the form under "1st Measurement, Enumerator A." Without learning this value, Enumerator B then measured the same parameter and recorded her value under "1st Measurement, Enumerator B." The difference between the two recorded values was then calculated, and if the difference was greater than the pre-set limits printed on the form (see Fig. 7.1 for pre-set limits), the measurement was repeated by each fieldworker and recorded in the appropriate columns under "2nd Measurement" (the difference between the "2nd Measurement" values was not calculated; see "Preparation of Data for Analysis" for how these data are handled for analysis). If the difference between values did not exceed the pre-set limit, columns under the "2nd Measurement" were coded with "0"'s. After completing measurements and data recording for the first parameter, the same procedure was followed for all other parameters before moving on to another TI.

Details of how the various parameters were measured are summarized as follows:

Height of Adults and Schoolers

The height of adults and schoolers was measured by use of the "Nivotoise." This highly portable device consists of a metal foot plate, a head plate, and a retractable steel tape. The head piece has a built-in carpenter's bubble level which when levelled indicates that the head piece is horizontal. The nivotoise was found to be highly reliable, and gave values comparable to a stadiometer. A stadiometer, too heavy and bulky for house to house measurements as houses were far apart, was set up for permanent use in the field clinic/laboratory to measure heights of respondents making scheduled visits for clinical exams.

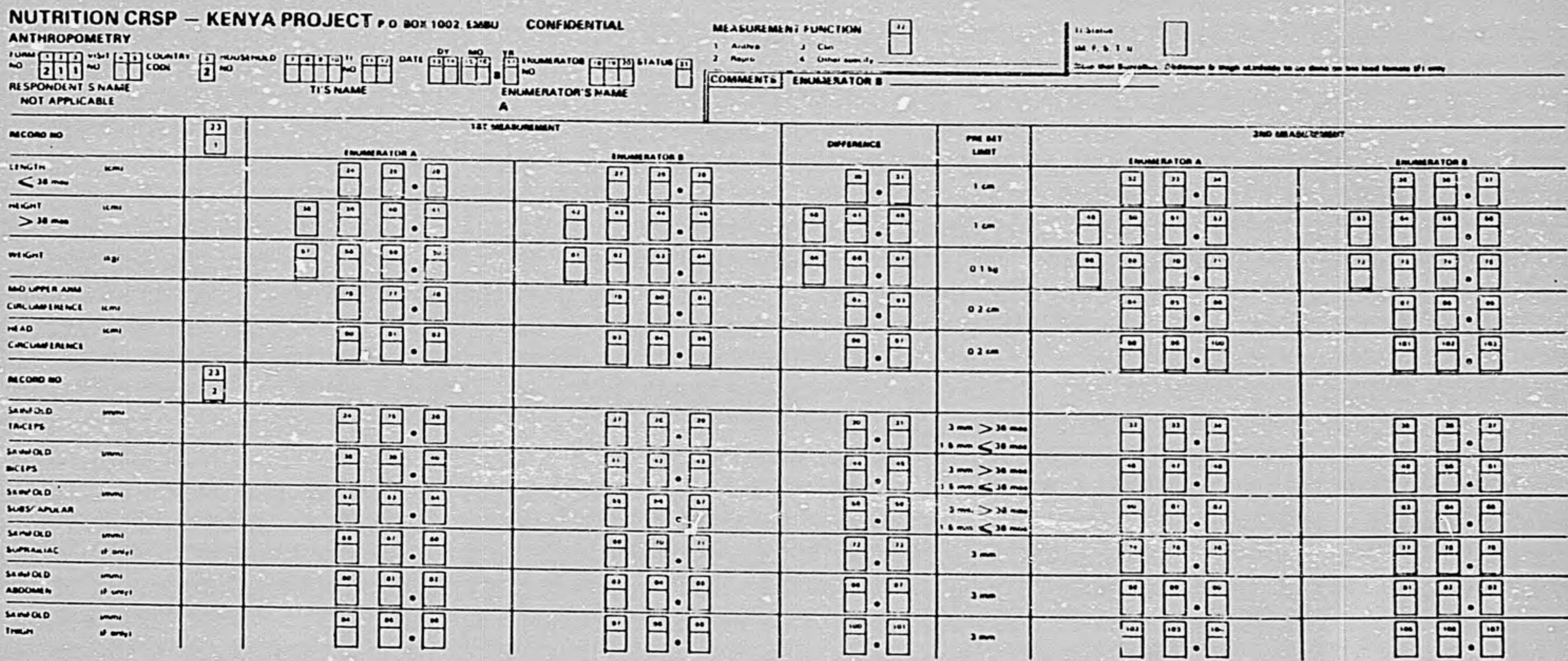


FIG. 7.1. Anthropometry form 211.

After selecting a measurement site with a hard flat ground surface next to a vertical wall, a subject was asked to remove all footwear and headgear and to stand on a nivotoise footplate with feet together. The subject was instructed to stand comfortably upright, with eyes looking ahead and arms held loosely at the sides of the body. With the bottom end of the tape attached to the footplate, the headpiece was raised (thereby extending the tape) and placed on top of the head. Care was taken to assure that the tape was parallel to the vertical wall, and not twisted or bent. By checking the bubble level, the enumerator verified that the headpiece was horizontal. Finally, after the body position and the position of the headplate were checked by the partner, the tape was locked and a reading was taken by Enumerator A to the nearest 0.1 cm and recorded on the form. Team member B then repeated the procedure.

Length

A portable, wooden measuring board with a Lucite head-piece and sliding foot-piece was used for monthly measurements of infant and toddler length. After removing all footwear and headgear and asking the mother to reassure the child, the enumerators positioned the child on the measuring board with the back of the child's head touching the headboard and eyes pointing directly upward. Foot placement was accomplished by bringing the movable footboard directly against the child's heels. The feet were straightened with toes pointing upward, and placed snugly against the vertical footboard. Finally, the knees were pushed firmly against the main board (for infants, one leg was straightened out and the knee pushed against the board), and the fieldworkers checked to see if the child was lying correctly with head against the fixed end, body and legs flat and straight, and shoulders and buttocks in contact with the main board. If the child was found to be incorrectly positioned the procedure was repeated. Once the position was felt to be correct, the length was read to the nearest 0.1 cm. by one enumerator and recorded on form #211 by the partner.

Weight of Adults, Schoolers and Cooperative Toddlers

Portable, battery-powered, digital read-out "Heath" scales were used to weigh all TI's during anthropometry visits to respondents' homes. Upon preparing to weigh a respondent, a set of scales was placed on a hard, flat, level piece of ground away from direct sunlight so that the display could be seen easily. While an enumerator "zeroed" the scale, the respondent removed any jewelry, footwear, headgear, and as much excess clothing as possible bearing in mind the constraints of privacy and warmth. The respondent was then instructed to stand comfortably but perfectly still with both feet together on the middle of the scale and facing the display. Upon steadying, the displayed weight was read by Enumerator A to the nearest 0.1 kg and recorded on the form. The subject was then instructed to step away from the scale and the procedure was repeated by Enumerator B.

It should be noted that weights were also measured of respondents during their scheduled clinical exam and/or reproduction/anthropometry visits to the field clinic/laboratory. On such instances respondents were weighed on a stationary "Accu-Weigh Bench Beam Balance." Both the Heath scales and the beam balance were calibrated regularly, and the two types of scales yielded comparable values.

Weight of Infants and Uncooperative Toddlers

For young subjects unable or unwilling to stand still on the Heath scales, the following weighment-by-difference procedure was used: briefly, the subject's mother or other caretaker was weighed both alone and while holding the child, and the difference was calculated and recorded as the subject's weight. This procedure was found preferable, and more reliable and accurate than using the "Salter Infant Hanging Scale," particularly for crying or otherwise uncooperative children who bobbed up and down. The "Infant Detecto Scale," much too heavy for house-to-house weighment, was used in the field clinic/laboratory to weigh cooperative infants and small toddlers during scheduled exam visits. Several comparisons between values from the weighment-by-difference technique and from the Infant Detecto Scale indicated that the two types of measurement methods yielded comparable values.

Head Circumference

The "Zerfas Insertion Tape" (7) was used to measure the head circumference of all respondents. The tape was applied to the head after removing headgear, scarves, pins, clips, etc., and asking the subject to sit with the head held upward and still. The tape was placed around the head with the lower border just touching the eyebrows, and the pointed end inserted through the slot. If there were brow-ridges, the tape was placed above them. The tape was moved up and down on the back of the head until the largest circumference was found, usually at the occiput. Once the tape was correctly positioned, it was tightened with firm pressure to compress the hair; this was particularly important and recorded under "comments" in the cases when the hair was plaited. The tape was checked for correct positioning and the largest circumference was measured to the nearest 0.1 cm where the two arrows point in the window. The value was recorded and the procedure was repeated by the other team member.

Mid-Upper Arm Circumference

The "Zerfas Insertion Tape" was used to measure the mid-upper arm circumference of respondents. With an adult, schooler, or cooperating toddler standing, or an infant or uncooperative toddler sitting upright in his or her caretaker's lap, an enumerator positioned herself level with the subject's left side. The subject's left arm, clear of all clothing, was placed in a relaxed position with the elbow and shoulder tip facing the fieldworker, and then bent at the elbow to a right angle with the palm of the hand facing upward. The mid-upper arm was located half way between the acromial process (posterior part of the acromium of the scapula) and the olecranon process at the elbow, by measuring along the back of the arm between these points and then calculating the mid-point distance. This point was marked with a soft, felt tip pen and the left arm was straightened so that it hung down loosely with the palm facing inward. The tape was looped around the arm with the pointed end inserted through the special slot and with the window facing the examiner. The end of the tape was pulled gently but firm enough to ensure uniform contact with the skin surface around the arm; the tape had to cover the midpoint mark and be parallel to the floor. Care was taken not to pull the tape too lightly, so as to risk slippage, or too tightly, so as to cause the skin to wrinkle. With the tape positioned correctly, the reading was taken to nearest 0.1 cm. This point was identified by the two arrows marked on the slot. The value was recorded and the partner repeated the procedure.

In cases where an infant's arm was flabby, or when the child was uncooperative, a modified technique was used. After having determined the upper arm midpoint, the mother held out the infant's hand so that the arm was extended straight out in front. The measurement was made in the manner described above with extra care taken to ensure proper tension of the tape, and a repeat measurement was also made by the partner.

Fatfolds for All Target Individuals

The "Lange Caliper" was used to measure fatfolds to the nearest 0.5 mm for all age groups. This caliper works especially well with newborns and young infants. The Lange caliper exerts 10 gm of pressure per sq mm over fatfolds ranging in thickness from 2 to 40 mm.

Fatfold measures were always taken on the left side of the body. With the enumerator holding the thumb and index finger of her left hand about 1 cm apart, a fatfold was grasped about two centimeters above the spot where the measurement was to be taken. Enough skin and fat was grasped to form a fold separating them from the underlying muscle. Holding the fatfold until after the measurement was taken, the value was read from where the needle pointed on the scale after releasing the "trigger" and waiting three seconds. Because the Lange Caliper tended to frighten some individuals due to its unfamiliar appearance, enumerators carefully explained what they were doing and demonstrated the measurement procedure on one another or the mother. Details on how specific fatfolds were measured are as follows:

Triceps - The triceps fatfold was located at the midpoint marked for the arm circumference on the subject's left arm. With the arm hanging at the side and the palm turned in toward the body, a vertical fold of skin and fat on the back surface of the arm was grasped about 2 cm above the upper midpoint. The caliper's "jaws" closed on the fatfold at the mid-upper arm mark.

Biceps - Using the same basic procedure as for the triceps, the site of this measurement was at the upper arm midpoint at the point of the maximum bulge of the biceps.

Subscapular - The fatfold was grasped on a diagonal directed downward and to the side just below and to the right of the inferior angle of the left scapula.

The following three measurements were performed only on pregnant and lactating women:

Supra-iliac - The fatfold was grasped between the thumb and forefinger 1 cm above the left supra-iliac crest of the pelvis.

Mid-thigh - The fatfold was grasped by the thumb and forefinger 1 cm above the midpoint between the inguinal crease and the tip of the patella.

Abdomen - A vertical fatfold was grasped by the thumb and forefinger 1 cm to the right of the umbilicus.

QUALITY CONTROL MEASURES

Rigorous methods were adopted to minimize measurement error and ensure high data reliability. Aside from preliminary and on-going staff training, quality control measures included: duplicate measurements of all parameters with pre-set limits of acceptability; close supervision of enumerators; standardization tests; maintenance and calibration of equipment; household "revisits" for remeasuring TI's; and a day-to-day weight variance study. These measures may be summarized as follows:

Data Form and Protocol

The anthropometry data collection protocol and form were designed to encourage the collection of valid and reliable data. In particular, the protocol required that measurements be obtained independently by two observers. If the values exceeded pre-set limits, then the measurements had to be repeated.

Supervision

Each cluster had at least one anthropometry supervisor, whose duty as to accompany enumerators daily to scheduled households and ensure that: 1) all scheduled TI's were measured; 2) all equipment was maintained in excellent working order; 3) all measurements were conducted properly; and 4) all forms were recorded properly and forwarded to the data management office promptly.

All enumerators and supervisors were supervised regularly by the project's senior investigators, one of whom spent two consecutive days almost every week in the field making household visits with teams of fieldworkers (every fieldworker received such attention every two or three weeks). The Field Director, in turn, consulted with each supervisor and most enumerators at least twice a week to solve any problems that arose, and regularly accompanied pairs of fieldworkers to households.

Standardization and "Retraining"

A standardization and "re-training" exercise was conducted by the senior investigators every six to eight weeks for all anthropometry fieldworkers. The objective of these sessions was to determine the accuracy of each fieldworker's techniques, discuss weaknesses, and review the proper execution of any measurement technique found to be lacking. The bulk of these sessions involved each fieldworker making several fatfold and other measurements independently and blindly on a volunteer and then whispering the data to a secretary. After all measurements had been made by all fieldworkers, and after the measurements were made by a senior investigator, the results were analyzed for their variability and discussed. The variation was usually impressively small. The sessions concluded with a thorough inspection of all equipment (e.g. scales were checked with combinations of 5, 10, and 20 kg. weights, calipers were checked with calibration blocks, etc.).

Equipment Care and Maintenance

All anthropometric equipment was inspected for malfunction and precision twice each month, and the results were forwarded to senior investigators. The anthropometry staff, enumerators and supervisors were instructed throughly and repeatedly on the function, care, and maintenance of the equipment and were taught to "troubleshoot", particularly for the digital scales. If any piece of equipment was found to fail a test (e.g. if a set of scales was found to vary beyond an expected limit), the defects or malfunctions were immediately reported to a supervisor and the malfunctioning piece of equipment was removed from use for repair. Field offices maintained extra scales, calipers, length boards, etc., in the event that a given piece malfunctioned.

Each enumerator was responsible for the maintenance of her own equipment. The digital scales were regularly cleaned and checked for proper and accurate functioning; one technique of checking their functioning was for enumerators to weigh themselves every time the scales were assembled. Inspection of the length boards involved checking the sliding pieces to be sure they moved easily. The tracks were cleaned daily, and a small amount of lubricant was applied to the tracks periodically. Nivotoise tapes were extended and retracted daily to check that the springs were working. Zerfas tapes were kept in their containers and not allowed to be bent sharply or torn. The skinfold calipers were both fragile and expensive and great care was taken to carry these in their boxes and keep them dust free.

Calibration of Instruments

Known standard weights from 100 gm. to 10 kg. were weighed on scales and results were recorded and percent differences noted. See Fig. 7.2. The Lange Calipers were calibrated with steel blocks of known thickness and percent differences recorded. Daily logs about the equipment and calibration forms were kept on file. Calibrations were carried out every two weeks and defective equipment was reported and replaced immediately.

Household "Revisits"

Household "revisits" were made monthly for the primary purpose of evaluating intra-observer measurement variability. In particular, three or four households per cluster were randomly selected for revisits each month, and the fieldworkers who made the initial measurements were instructed to repeat the same measurements at a later time. Ideally, the revisit measurements were performed within a few hours or on the same day, or if not possible, on the next day (at the same time of day) as the original measurements. However, because of difficult field logistics, a small percent of the quality control measurements were repeated several days after the original measurements. The standard anthropometry form (# 211) was used for quality control purposes with column 17 (year) coded with a "9". Table 7.1 shows the results of the household revisits.

NUTRITION CRSP - KENYA PROJECT

ANTHROPOMETRY/REPRODUCTION

INSTRUMENT CHECK

MAIN STUDY '84

DATE ____________

CLUSTER ____________

A SCALES

1 INVENTORY NO:

Expected weight (kg)	10.0	20.0	30.0	40.0	60.0
Actual weight (kg)					
Difference (kg)					
% difference					

PASS FAIL

2 INVENTORY NO:

Expected weight (kg)	10.0	20.0	30.0	40.0	60.0
Actual weight (kg)					
Difference (kg)					
% difference					

B SKINFOLD CALIPERS

1. INVENTORY NO:

Expected width (mm)	10	20	30	40	50
Actual width (mm)					
Difference (mm)					
% difference					

PASS FAIL

2 INVENTORY NO:

Expected width (mm)	10	20	30	40	50
Actual width (mm)					
Difference (mm)					
% difference					

C OTHER EQUIPMENT

CONDITION

		Good	Adequate	Needs attention	Needs replacing
1 Nivotoise	a				
	b				
2 Length board	a				
	b				
3 Zerfas tape small	a				
	b				
4 Zerfas tape large	a				
	b				

FIG. 7.2. The instrument check form for anthropometry/reproduction.

Weight Variance Study

In order to help establish the "error terms" for weight observations, a day-to-day study on variance among infant, toddler, pregnant, and non-pregnant females was conducted for one week in April 1985. Briefly, a group of infants, toddlers and lead females were weighed at the same time each morning for 6-7 consecutive days. Each subject was measured by the same two enumerators throughout the trial. The time of last defecation and urination were noted, and the same scales were used throughout.

The variance for infants, toddlers, and pregnant females has been analyzed, and the results show that the "between subjects" variance is much greater than both the "within subjects" variance (which was small; infants = 5.68%, toddlers = 1.55%, women = 2.33%) and the "within measurement" variance (which was negligible at %). See Table 7.2. The day-to-day variance study will be of particular help in interpreting changes in weight over time.

All quality control exercises other than the weight variance study were continued through the end of the project.

PREPARATION OF DATA FOR ANALYSIS

Because at least two values, and in some cases, four, were recorded for each measurement parameter, a single mean value for each parameter for every TI visit was obtained by computer as follows: 1) if the difference of the first pair of measurements fell within the pre-set limit, the mean was calculated from this pair of values; 2) if the difference of the first pair of measurements fell outside the pre-set limit, the mean was calculated from the four values obtained by both pairs of measurements.

Anthropometric variables can be presented as means or medians ± SD or ± SE of actual measurements for given ages or time periods, or may be converted by the Center for Disease Control (CDC) computer program as % Standard (median), percentiles, or Z-scores. The CDC program is based on the National Center for Health Statistics reference data for children (1976) less than or equal to 5 years of age. Composite variables such as weight for height or length, body mass index (wt/ht^2 (m)) were constructed.

TABLE 7.1
Correlation for evaluating intra-observer measurement variability by T1.

Measurement	n	R	p value
<u>Lead Males</u>			
Weight	68	.980	<.001
MUAC	68	.925	<.001
Fatfolds			
Triceps	68	.938	<.001
Biceps	68	.938	<.001
Subscapular	68	.851	<.001
<u>Lead Females</u>			
Height	26	.992	<.001
Weight	85	.981	<.001
MUAC	51	.978	<.001
Head Circumference	19	.951	<.001
Fatfolds			
Triceps	51	.943	<.001
Biceps	51	.909	<.001
Subscapular	51	.953	<.001
Suprailiac	30	.926	<.001
Abdomen	30	.955	<.001
Thigh	30	.839	<.001
<u>Infants and Toddlers</u>			
Length	44	.808	<.001
Weight	43	.908	<.001
MUAC	44	.923	<.001
Head Circumference	44	.882	<.001
Fatfolds			
Triceps	44	.784	<.001
Biceps	44	.782	<.001
Subscapular	44	.704	<.001
<u>Schoolers</u>			
Weight	30	.986	<.001
Height	30	.955	<.001
MUAC	30	.950	<.001
Head Circumference	30	.969	<.001
Fatfolds			
Triceps	30	.868	<.001
Biceps	30	.729	<.001
Subscapular	30	.501	<.004

TABLE 7.2
The day-to-day weight variance study of infants, toddlers, and lead females.

Subject	# of Observations	Comparison	Variance	SD	CV
Infants (N = 12)	72	Within measurement	<0.001	0.033	0.57%
(mean wt = 5.81 kg)		Within subjects	0.109	0.329	5.68%
		Between subjects	1.236	1.112	19.16%
Toddlers (N = 12)	72	Within measurement	<0.001	0.330	0.29%
(mean wt = 11.40 kg)		Within subjects	0.031	0.177	1.55%
		Between subjects	1.061	1.030	9.03%
Women (N = 11)	66	Within measurement	<0.002	0.043	0.076%
(mean wt = 56.35 kg)		Within subjects	1.725	1.313	2.33%
		Between subjects	79.820	8.934	15.86%

Child growth may be expressed in terms of attained growth (percentile, % standard, Z-scores) growth velocity (i.e., rate of increase over time), or incremental growth (i.e., positive or negative change over time).

Body composition may be described in terms of energy stores, and expressed as: 1) the percent body weight that is fat (2,8); 2) the sum of fatfolds (triceps, biceps, subscapular, etc.); 3) the arm fat area (9); and, 4) the ponderal index (ht/cubed root of weight). Finally, body composition may also be described in terms of its protein stores, which may be expressed as arm muscle circumference and arm muscle area (9).

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

This section presents descriptive anthropometric data on target individuals. These findings are presented in several formats. For adults, mean values of measurements are given by season and by age. Anthropometry data on lead females are presented only on non-pregnant, non-lactating women (NPNL), as data on pregnant and lactating women are presented in Chapter 10. For children, results are given by age, sex, percentiles, Z-scores, percent of median and categories of PEM. The statistics used are: weight for age (WA), weight for height (WH), length for age (LA), height for age (HA), and weight for length (WL). All are based on the NCHS reference data (10) so as to make comparisons possible with data from Mexico and Egypt. The justification for using the NCHS reference data is that Kenyan urban middle class and wealthy children, as well as children of wealthy rural families, are at or above NCHS median (standard) values (11). Incremental growth is described to reflect the rate of change over time (12). Fat stores are expressed by several variables: arm circumference (MUAC), sum of fatfolds (SFF), percent fat comprising body weight (PF) and arm fat area (AFA). Estimates of protein stores are presented as arm muscle area (AMA) and arm muscle circumference (AMC).

Lead Males

Lead males are generally short, thin and have low body fat. The means, SD's and ranges of all anthropometric measurements are presented in Table 7.3. The distributions of weight and height are also illustrated in Figs. 7.3 and 7.4, respectively.

Reference data based on the 1959 Metropolitan Life Insurance tables for weight and height (1,13) which have been widely applied in Africa, show that 50% of the lead males are between 80 to 85% of the median WH and 25% are below 80% median WH. The age group between 45-54 years appears to have the highest proportion of undernourished individuals.

The weights and heights of lead males are as follows: mean weight is 55.0 ± 7.2 kg and mean height is 165.5 ± 12.7 cm. There appears to be a seasonal fluctuation in weight, with a drop occurring from April through June which is a period of high rainfall preceding a major harvest. Actually, this was seen only in 1985, since the pattern was obscured in 1984 by the food shortage which brought about a precipitous drop in weight.

Body fat, as indicated by the sum of three fatfolds, S_3FF (triceps, biceps, subscapular) is low: and percent of body weight that is fat, based on Durnin's equation (2), is approximately 12%. Mean arm fat area is 7.0 cm^2, and triceps FF is 6.2 ± 2.9 mm. Protein stores estimated by mean AMA is 46 cm^2, below the 5th percentile (14). The mean head circumference (55.5 cm) is about -0.5 SD, using international and interracial reference data (15).

Non-Pregnant, Non-Lactating Lead Females

The means, SD's and ranges for age of anthropometric measurements for NPNL lead females are presented in Table 7.4. The women are generally short but their weights are appropriate for height. Distributions for weight and height are presented in Figs. 7.5 and 7.6, respectively. Lead females, with a mean weight of 51.3 ± 8.8 kg and a mean height of 155 cm, are smaller than women of the Kenyan urban middle class (16).

TABLE 7.3
Summary of anthropometry for 247 lead males, all seasons combined.

	Mean	SD	Range
Age (years)	37.0	7.6	24.0 - 74.0
Height (cm)	165.5	12.7	155.2 - 181.4
Weight (kg)	55.0	7.2	33.0 - 89.2
Head Circ. (cm)	55.5	4.9	48.5 - 56.5
MUAC (cm)	25.7	2.3	19.0 - 32.2
Triceps FF (mm)	6.2	2.9	1.5 - 30.0
Biceps FF (mm)	3.0	1.0	1.2 - 10.7
Subscapular FF (mm)	7.9	3.0	2.0 - 30.5
Sum3FF (mm)	17.1		4.7 - 71.2
Arm Fat Area (cm^2)	7.0*		
% of BW as Fat	12.2*		
Arm Muscle Circ. (cm^2)	23.7		
Arm Muscle Area (cm^2)	46.0		

* These are calculated on the group mean values and not on individuals and are only for purposes of description and not analyses.

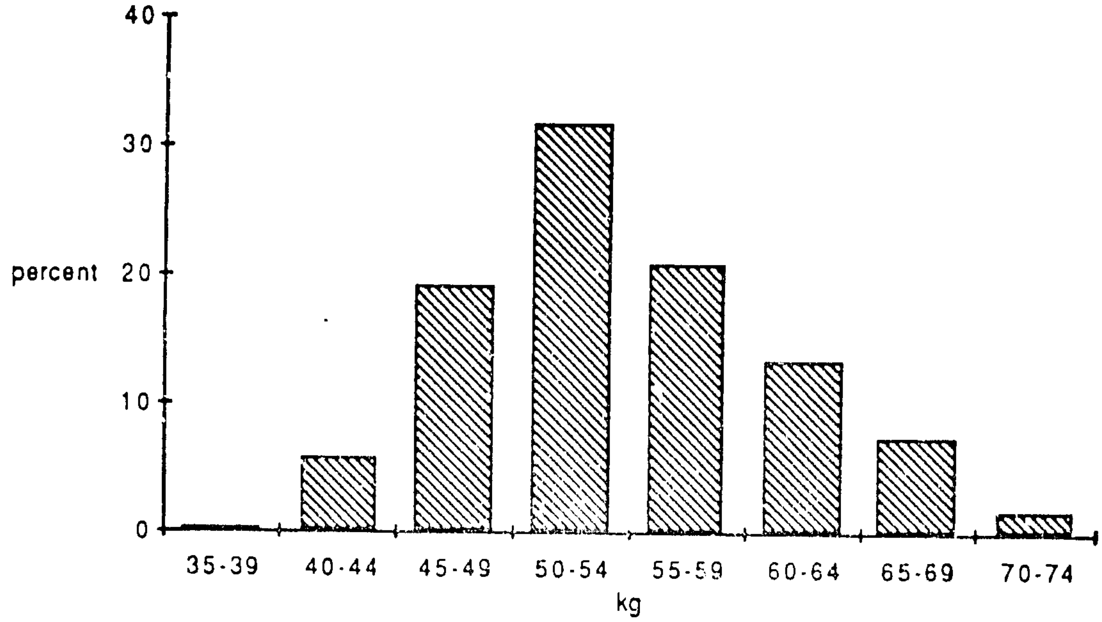


FIG. 7.3. Distribution of lead male body weights in January 1984 (n = 120).

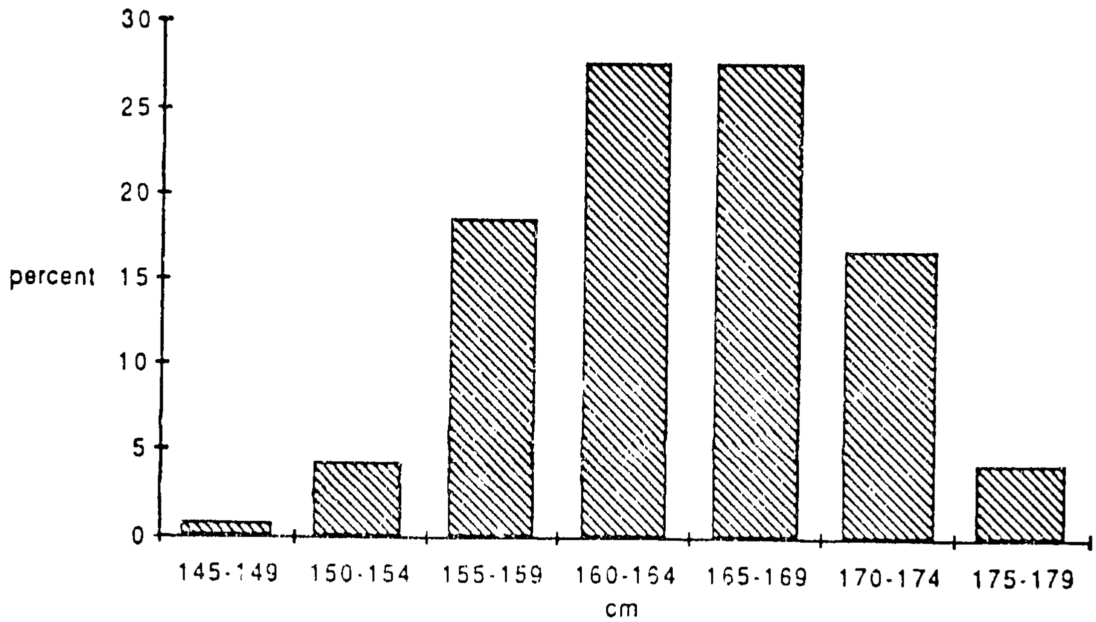


FIG. 7.4. Distribution of lead male heights in January 1984 (n=120).

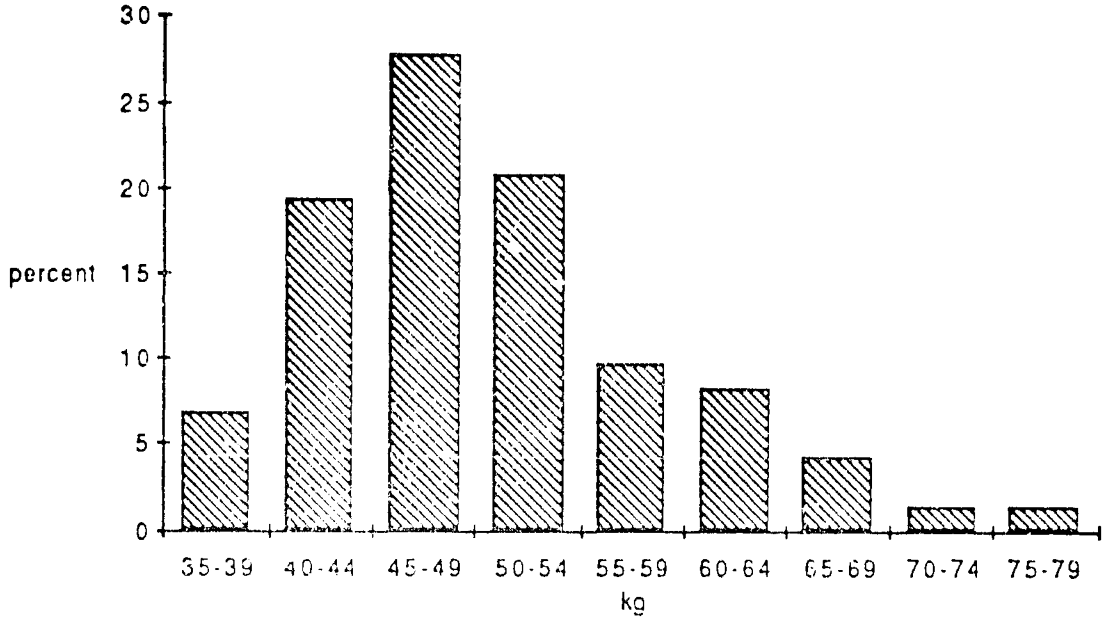


FIG. 7.5. Distribution of non-pregnant, non-lactating lead female body weights in January 1984 (n = 72).

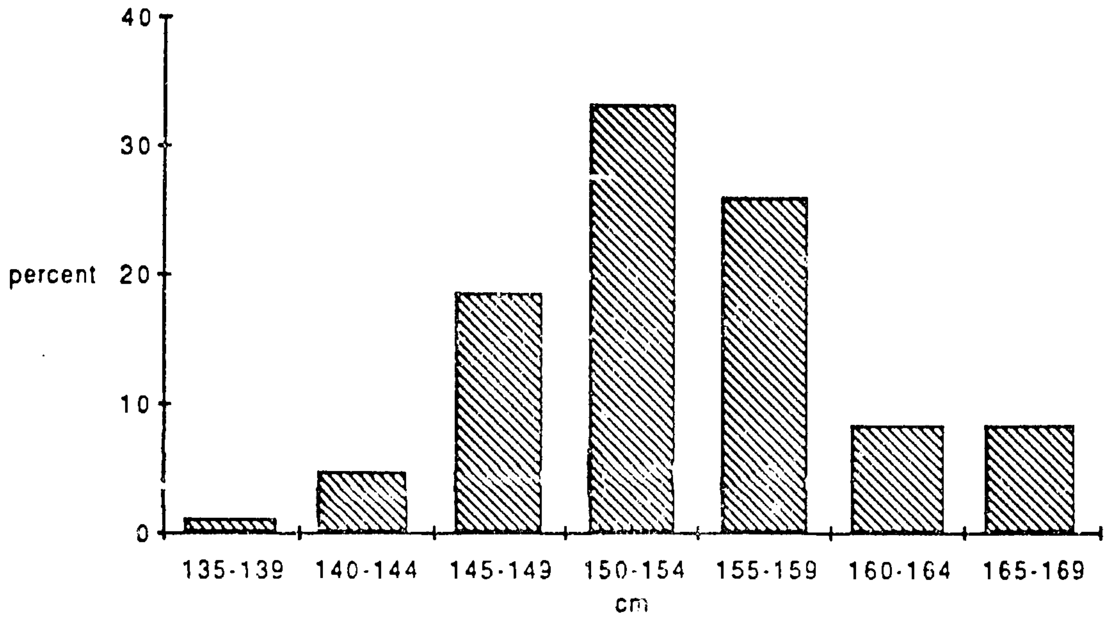


FIG. 7.6. Distribution of non-pregnant, non-lactating lead female heights in January 1984 (n = 108).

TABLE 7.4
Summary of anthropometry for non-pregnant, non-lactating females; for all months combined.*

	Mean	± SD	Range
Age (years)	33.0	5.8	21.0 - 55.0
Height (cm)	155.0	6.0	136.4 - 167.9
Weight (kg)	51.3	8.8	35.4 - 80.7
Head Circ. (cm)	54.0	1.7	46.2 - 58.6
MUAC (cm)	23.7	1.1	20.0 - 25.0
Triceps FF (mm)	17.6	7.8	2.0 - 50.0
Biceps FF (mm)	6.9	4.6	1.7 - 27.5
Subscapular FF (mm)	14.5	7.4	3.2 - 48.5
Sum3FF (mm)	39.0	18.5	11.6 - 121.5
Arm Fat Area (cm^2)	19.9†		
% of BW as Fat	24.0†		
Arm Muscle Circ. (cm^2)	20.6†	1.8	15.3 - 26.1
Arm Muscle Area (cm^2)	34.1	5.8	18.6 - 54.1

* These figures are based on all observations over a two year period. Sample size fluctuated each month.
† These are calculated on the group mean values and not on individuals.

The mean monthly values for weight range from 49.4 to a high of 52.9 kg. Approximately 27% of women are below 45.5 kg, or 100lbs, and 45% are below 152.4 cm, or five feet; these values are considered risk factors for obstetrical problems and pregnancy outcome. There is a slight seasonal fluctuation seen in body weight for NPNL women, with weight loss during April through June, but not as marked as that seen in the lead males. The 1959 Metropolitan Life Insurance Tables for WH (13) place about 28% of lead females in the underweight group and 6% in the wasted group. The mean WH is approximately 96% of median.

In examining maternal anthropometry by age, weight and fat tend to increase until 44 years of age, but this group also contains the highest percent of undernourished women. Body fat, as indicated by the S3FF, percent of body weight as fat, and AFA is generally normal or only slightly reduced. Mean triceps fatfold is 17.6 + 7.8 mm, or at the 25th percentile (14). Protein stores, as indicated by AMC and AMA, are approximately at the 25th percentile for AMC and the 30th percentile for AMA (14). Head circumference, using the international and interracial standard (15), is like that for males, about -0.5 standard deviation.

<u>Infants</u>

Male infants are born at an average weight of 3.17 ± .40 kg, and females at 3.04 ± .45 kg. Average birthlength is 49 ± 2.3 cm, with males being slightly longer than females. See Table 7.5. Head circumference for both sexes is at about the 75th percentile (10). Head circumference for the male infants starts at the 75th percentile (38.1 cm at one month), but then gradually falls to the 50th percentile by three months and to the 25th percentile by six months (43.3 cm). For female infants the head circumference follows a similar pattern, also falling gradually to the 25th percentile at six months (42.3 cm).

Regarding weight, infants grow along the NCHS median (50th percentile) for the first few months. Males start to drop below the NCHS median weight (10) at three months, and females at four months, and both reach the 25th percentile values by six months. See Figs. 7.7 and 7.8 and Table 7.6.

Both male and female infants are slightly below the median for length at birth. They remain at this level until four months when they begin a downward trend such that by six months males and females are at the 5th and 10th percentiles, respectively. See Table 7.6 and Figs. 7.9 and 7.10. This decline in linear growth increases with age so that by the time infants become toddlers, 25 to 30% are stunted. A follow-up study of infants studied by the Nutrition CRSP Kenya Project is now in progress; the data will be of great value in understanding the stunting by age.

Incremental growth percentiles presented in Table 7.7 show the rate of growth in comparison with the NCHS and Fels. reference data (17) Infant linear incremental growth (0 to 6 months) for males is at the 11th percentile with a six month total increase of 13.79 cm and a daily increase of .076 cm. For females linear growth is at the 15th percentile with a total increase of 13.62 cm and a daily increase of .075 cm.

TABLE 7.5
Head circumference, arm circumference, and sum of fatfolds* for infants 0-6 months, sexes combined.

	Months	n	Mean	SD	Range
Head Circ. (cm)	0	118	35.7	1.3	32.4 - 39.8
	1	107	37.6	1.4	34.3 - 44.8
	2	115	39.4	1.4	35.4 - 42.5
	3	114	40.5	1.4	35.1 - 43.5
	4	118	41.8	1.3	39.0 - 44.9
	5	116	42.6	1.4	38.8 - 47.0
	6	110	42.9	1.4	39.0 - 46.3
MUAC (cm)	0	118	10.4	0.9	8.0 - 12.5
	1	107	11.4	1.0	8.6 - 14.9
	2	115	12.4	1.0	9.0 - 15.9
	3	115	12.8	1.1	8.6 - 15.6
	4	118	13.3	1.1	10.5 - 16.5
	5	117	13.5	1.1	10.6 - 17.0
	6	110	13.3	1.1	10.6 - 16.1
Sum FF (mm)	0	118	14.3	3.2	27.7 - 24.7
	1	107	19.4	4.7	8.9 - 32.3
	2	114	21.5	4.3	12.4 - 35.4
	3	112	21.2	4.9	10.6 - 36.4
	4	118	21.4	4.4	13.5 - 39.4
	5	117	21.2	4.8	11.2 - 38.0
	6	109	21.8	4.8	11.4 - 37.5

* Biceps, triceps, and subscapular.

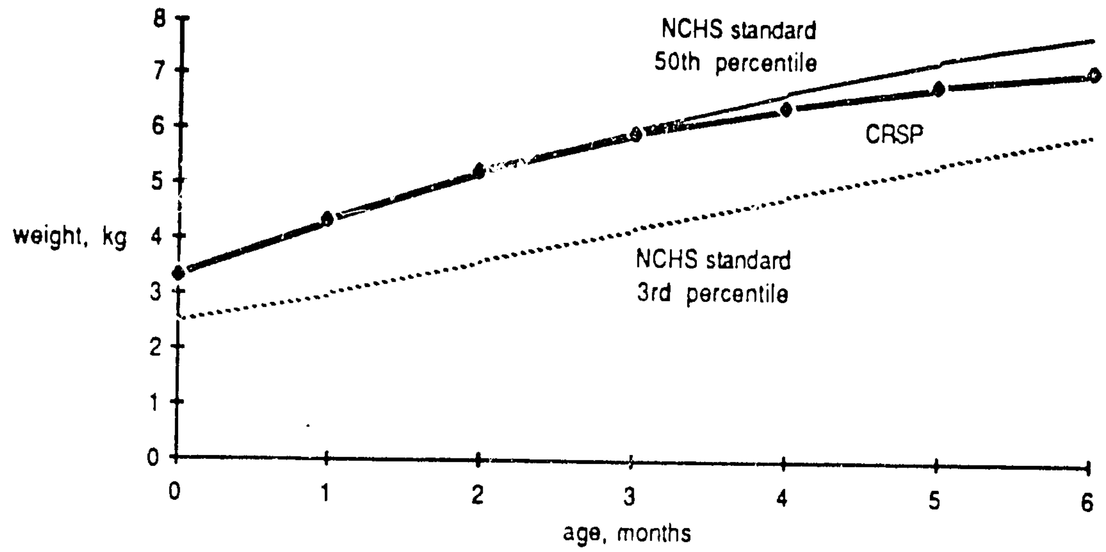


FIG. 7.7. Comparison of male infant weights by month of age with the NCHS standard.[1]

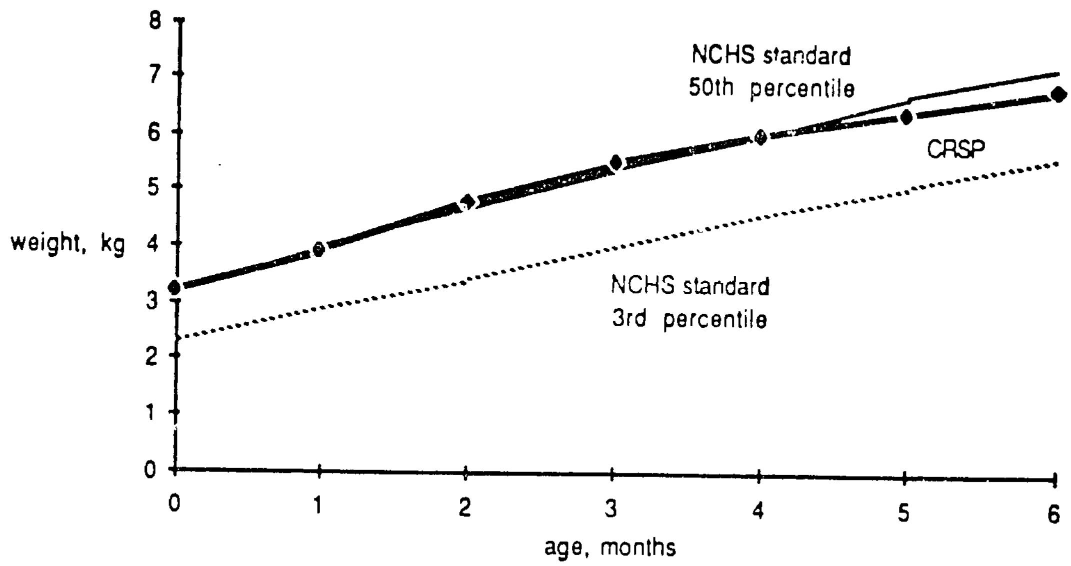


FIG. 7.8. Comparison of female infant weights by month of age with the NCHS standard.[1]

[1] Measurements were taken on the same children with some fluctuation in monthly sample size (see Table 7.6).

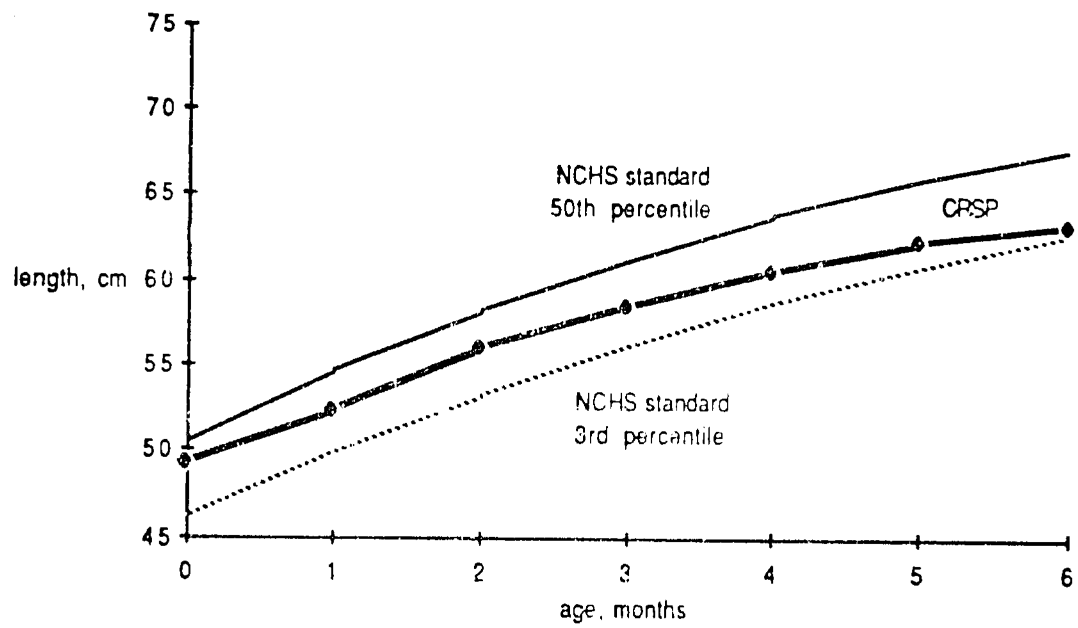


FIG. 7.9. Comparison of male infant lengths by month of age with NCHS standard.[1]

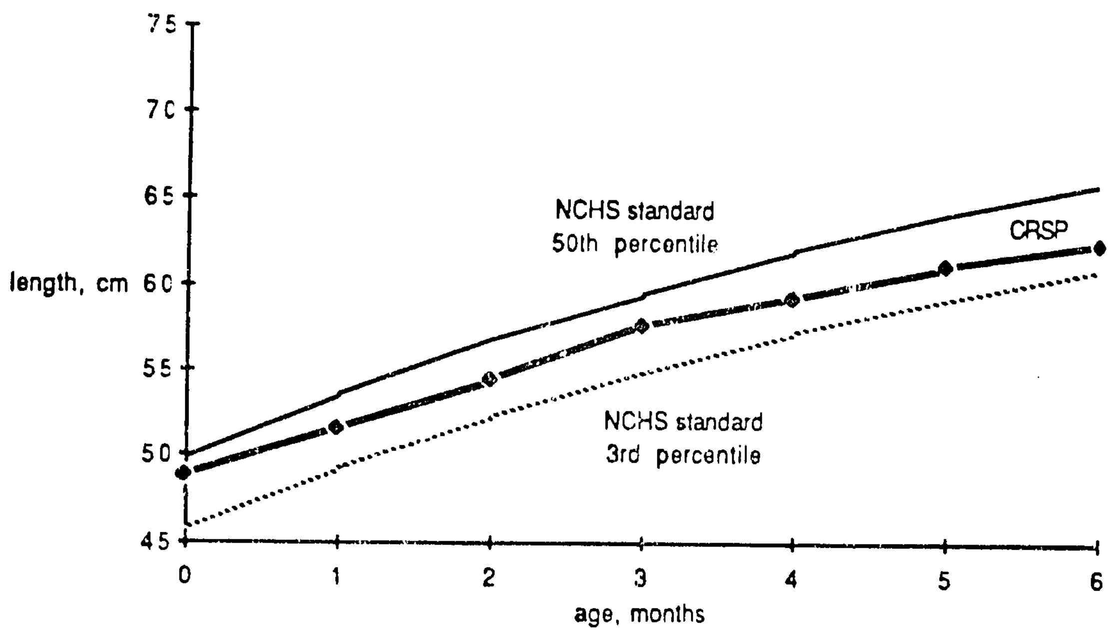


FIG. 7.10. Comparison of female infant lengths by month of age with NCHS standard.[1]

---

[1] Measurements were taken on the same children with some fluctuation in monthly sample size (see Table 7.6).

TABLE 7.6
Length and weight of infants 0-6 months of age, by sex.

	Age	Males n	Males Mean	Males SD	Females n	Females Mean	Females SD	Both Sexes Range
Length (cm)								
	0	63	49.3	2.3	53	48.7	2.3	43.9 - 57.4
	1	60	52.3	2.4	46	51.5	2.3	45.1 - 57.7
	2	62	55.9	2.3	52	54.3	2.4	49.2 - 60.9
	3	67	58.3	2.3	48	57.5	2.4	52.5 - 63.6
	4	64	60.4	2.3	51	59.2	2.2	54.6 - 66.1
	5	65	62.1	1.9	50	61.0	2.3	56.7 - 67.3
	6	59	63.1	2.2	48	62.4	2.1	57.8 - 69.1
Weight (kg)								
	0	67	3.3	0.4	55	3.2	0.4	2.1 - 4.7
	1	60	4.3	0.5	47	3.9	0.6	2.7 - 5.8
	2	63	5.2	0.6	51	4.8	0.6	3.5 - 7.0
	3	67	5.9	0.8	48	5.5	0.9	3.2 - 8.7
	4	66	6.4	0.9	52	6.0	0.9	4.5 - 9.6
	5	66	6.8	0.8	51	6.4	0.9	4.8 - 9.8
	6	62	7.1	0.9	48	6.8	1.1	4.8 - 10.9

TABLE 7.7
Incremental growth for mean length, weight and head circumference for 0-6 month old infants by sex based on NCHS-CDC reference data (10).

	Growth Increment (based on group means) Males				Females			
	n*	per day	per 6 mos	NCHS-CDC percentile	n*	per day	per 6 mos	NCHS-CDC percentile
Length (cm)	59	.076	13.79	11	48	.075	13.62	15
Weight (kg)	62	.021	3.79	20	48	.020	3.55	28
Head (cm)	62	.040	7.22	18	48	.039	7.04	25

* n represents the sample size in the last month of the interval; sample sizes for the first months of the intervals are as follows: males - length=63, weight=67, head cir=65; females - length=53, weight=55, head cir=53.

Regarding weight, incremental gain for males (0 to 6 months) follows the 20th percentile and for females it follows the 28th percentile. Six month weight gain for males and females is 3.79 kg and 3.55 kg, respectively.

Head circumference gain for males is at the 18th percentile and for females it is at the 25th percentile. The six month gains are 7.22 cm for males and 7.04 cm for females. With regard to all three measures of incremental growth, female infants grew at slightly higher percentiles than male infants.

Toddlers

Toddler anthropometry is described more fully than for the other TI's in order to provide a basis for the more detailed toddler analyses presented in Chapter 25. The major finding of the toddlers is that 30% are already underweight for age and 26% already stunted by 18 months of age. Very little wasting or severe forms of malnutrition are seen, however. The means, SD's, and ranges for length and weight measurements at selected ages are presented in Table 7.8, and as percentiles, Z-scores and percent of median for the group as a whole in Table 7.9.

Toddler growth by season as percent of median for LA, WA, and WL is presented in Tables 7.10, 7.11, and 7.12. In January and March of 1985, a decrease in the percentage of stunted children was observed, which perhaps represented catch-up growth following famine relief and the return of the rains. The trend reversed itself from July to December of 1985, when stunting increased as many of the children approached 30 months of age. Fig. 7.11 and Table 7.13 show toddler LA by month.

TABLE 7.8
Length and weight of toddlers at selected ages, sexes combined.

	Months	n	Mean	SD	Range
Length (cm)*					
	18	94	75.1	3.1	67.9 - 84.3
	21	103	77.2	3.1	70.3 - 86.3
	24	110	79.2	3.2	72.0 - 86.8
	27	109	81.1	3.5	73.3 - 89.8
	30	102	83.2	3.5	74.0 - 92.9
Weight (kg)†					
	18	94	9.2	1.1	6.4 - 13.8
	21	103	9.7	1.1	6.9 - 13.7
	24	110	10.2	1.2	7.3 - 13.5
	27	109	10.7	1.2	8.1 - 15.3
	30	102	11.3	1.3	8.1 - 15.4

* Rate of growth: .045cm/day; 1.35cm/month.

† Rate of growth: .088 kg/day; .35 kg/month.

TABLE 7.9
Weight, length and weight/length for 111 toddlers, ages and sexes combined; as percentiles, Z-score, and % of median NCHS standard (10).

	Percentile	Z-Score	% Median
Length (cm)	8.6 ± 13.0 (.1 - 75.9)	-1.95 ± 1.0 (-4.1 - 0.7)	92.2 ± 3.8 (79.9 - 102.7)
Weight (kg)	12.3 ± 15.6 (0.1 - 99.8)	-1.51 ± 0.90 (-3.8 - 2.6)	84.0 ± 9.5 (58.1 - 121.5)
Wt/Length	34.7 ± 24.3 (0.1 - 99.8)	-0.43 ± 0.84 (-3.2 - 3.9)	86.7 ± 9.1 (73.4 - 126.5)

TABLE 7.10
Distribution of toddler length/age by season as percent of median NCHS standard (10).

Season		n*	Percent of Median Length for Age			
			≤ 80%	81-90%	91-100%	>100%
1984						
Jan-Mar						
	Male	20	0.0	15.0	75.0	10.0
	Female	45	2.2	28.9	68.9	0.0
	(M + F)	65	1.5	24.6	70.8	3.1
Apr-June						
	Male	118	0.0	32.2	63.6	4.2
	Female	142	0.0	34.5	65.5	0.0
	(M + F)	260	0.0	33.5	64.6	1.9
July-Sept						
	Male	153	0.0	33.3	63.4	3.3
	Female	168	0.0	32.1	6[illegible].7	1.2
	(M + F)	321	0.0	32.7	65.1	2.2
Oct-Dec						
	Male	150	0.0	36.0	61.3	2.7
	Female	151	0.0	28.5	70.9	0.7
	(M + F)	301	0.0	32.2	66.1	1.7
1985						
Jan-Mar						
	Male	125	0.0	36.0	62.4	1.6
	Female	129	0.0	22.5	77.5	0.0
	(M + F)	254	0.0	29.1	70.1	0.8
Apr-Jun						
	Male	55	0.0	34.5	61.8	3.6
	Female	50	0.0	24.0	76.0	0.0
	(M + F)	105	0.0	29.5	68.6	1.9
July-Sept						
	Male	15	0.0	46.7	33.3	20.0
	Female	10	0.0	20.0	80.0	0.0
	(M + F)	25	0.0	36.0	52.0	12.0
Oct-Dec						
	Male	4	0.0	50.0	0.0	100.0
	Female	1	0.0	0.0	100.0	0.0
	(M + F)	5	0.0	40.0	20.0	40.0

* Total number of monthly measurements taken over the three month period.

TABLE 7.11
Distribution of toddler weight/age by season as percent of median NCHS standard (10).

Season	n*	Percent of Median Weight For Age ≤ 70%	71-80%	81-100%	>100%
1984					
Jan-Mar					
Male	20	5.0	25.0	70.0	0.0
Female	45	6.6	26.7	66.7	0.0
(M + F)	65	6.1	26.2	67.7	0.0
Apr-June					
Male	118	5.0	30.5	62.7	1.7
Female	142	4.9	33.1	62.0	0.0
(M + F)	260	5.0	31.9	62.3	0.8
July-Sept					
Male	155	7.7	19.4	72.9	0.0
Female	172	6.4	28.5	63.4	1.7
(M + F)	327	7.0	24.2	67.9	0.9
Oct-Dec					
Male	154	9.7	20.8	69.5	0.0
Female	160	6.9	27.5	63.1	2.5
(M + F)	314	8.3	24.2	66.2	1.3
1985					
Jan-Mar					
Male	125	4.8	28.8	66.4	0.0
Female	129	5.4	29.5	62.0	3.1
(M + F)	254	5.1	29.1	64.2	1.6
Apr-Jun					
Male	55	5.5	29.1	61.8	3.6
Female	50	10.0	30.0	54.0	6.0
(M + F)	105	7.6	29.5	58.1	4.8
July-Sept					
Male	15	0.0	40.0	40.0	20.0
Female	10	10.0	20.0	20.0	50.0
(M + F)	25	4.0	32.0	32.0	32.0
Oct-Dec					
Male	4	0.0	25.0	25.0	50.0
Female	1	0.0	0.0	0.0	100.0
(M + F)	5	0.0	20.0	20.0	60.0

* Total number of monthly measurements taken over the three month period.

TABLE 7.12

Distribution of toddler weight/length by season as percent of median NCHS standard (10).

Season	n*	Percent of Median Weight For Length		
		≤ 80%	81-100%	>100%
1984				
Jan-Mar				
Male	20	5.0	80.0	15.0
Female	45	2.2	68.9	28.9
M + F)	65	3.1	72.3	24.6
Apr-June				
Male	118	0.8	72.0	27.1
Female	142	2.8	74.6	22.5
(M + F)	260	1.9	73.5	24.6
July-Sept				
Male	153	0.0	66.0	34.0
Female	168	0.6	73.8	25.6
(M + F)	321	0.3	70.1	29.6
Oct-Dec				
Male	150	1.3	76.0	22.7
Female	151	0.7	71.5	27.8
(M + F)	301	1.0	73.8	25.2
1985				
Jan-Mar				
Male	125	1.6	68.0	30.4
Female	129	0.8	66.7	32.6
(M + F)	254	1.2	67.3	31.5
Apr-Jun				
Male	55	0.0	54.5	45.5
Female	50	2.0	68.0	30.0
(M + F)	105	1.0	61.0	38.1
July-Sept				
Male	15	0.0	46.7	53.3
Female	10	0.0	40.0	60.0
M + F)	25	0.0	44.0	56.0
Oct-Dec				
Male	4	0.0	25.0	75.0
Female	1	0.0	0.0	100.0
(M + F)	5	0.0	20.0	80.0

* Total number of monthly measurements taken over the three month period.

Low WA was seen in toddlers for all seasons, ranging from 29% for the moderately underweight group (71-80 percent of median) to 37% for the mildly underweight group (81-90 percent of median). Fig. 7.12 and Table 7.14 show toddler WA by month. Only a small percent of toddlers presented wasting, with 1-3% found to be below 80 percent of median for WL.

TABLE 7.13
Toddlers' length for age as percent of median by month, sexes combined.

Month	n	Mean	SD	Range
1984				
January	6	92.38	6.76	79.9 - 97.9
Febuary	19	92.63	3.47	88.1 - 102.3
March	40	92.29	3.47	86.5 - 101.0
April	60	92.48	3.56	85.7 - 101.6
May	97	91.95	3.52	82.4 - 101.4
June	103	92.23	3.39	84.4 - 101.4
July	100	91.76	3.77	82.6 - 100.7
August	107	91.92	3.53	83.4 - 100.5
September	114	92.21	3.85	82.5 - 101.8
October	106	92.42	4.00	83.9 - 102.1
November	104	92.23	3.64	84.8 - 101.3
December	91	92.54	3.85	84.8 - 102.2
1985				
January	96	92.47	3.77	84.6 - 100.6
Febuary	84	92.35	3.70	83.7 - 101.3
March	74	92.30	3.82	84.2 - 99.2
April	53	92.80	3.64	84.2 - 99.2
May	32	91.50	3.89	84.8 - 100.6
June	20	92.24	4.49	85.7 - 101.8
July	11	91.16	5.54	83.7 - 101.4
August	8	93.08	5.68	86.2 - 102.0

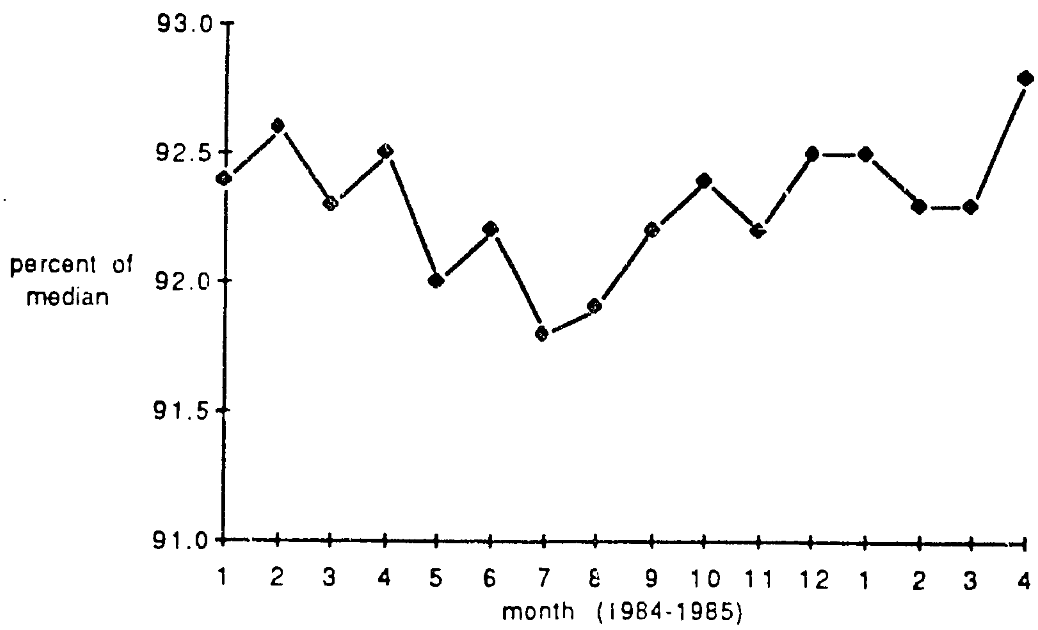


FIG. 7.11. Toddlers' length for age as mean percent of median by month, sexes combined.

TABLE 7.14
Toddlers' weight for age as percent of median by month, sexes combined.

Month	n	Mean	SD	Range
1984				
January	6	82.33	14.00	59.7 - 99.8
Febuary	19	84.06	6.00	74.8 - 95.4
March	40	82.93	8.83	59.1 - 98.8
April	60	83.57	8.36	58.1 - 103.1
May	97	83.07	8.19	61.9 - 100.7
June	103	82.75	8.52	60.0 - 99.4
July	102	83.21	9.16	61.6 - 99.7
August	107	84.36	9.10	60.5 - 110.8
September	118	84.65	9.55	62.2 - 127.5
October	119	83.35	9.47	64.5 - 120.8
November	104	83.64	8.80	64.8 - 102.9
December	91	84.68	9.40	66.5 - 120.5
1985				
January	96	84.51	9.47	61.9 - 120.4
Febuary	84	84.71	9.65	63.8 - 121.1
March	74	83.62	9.37	62.2 - 114.4
April	53	84.13	10.01	64.1 - 116.5
May	32	83.65	12.20	63.3 - 118.6
June	20	87.92	13.02	70.1 - 123.1
July	11	86.17	18.10	63.0 - 123.5
August	8	92.05	16.10	74.6 - 120.0

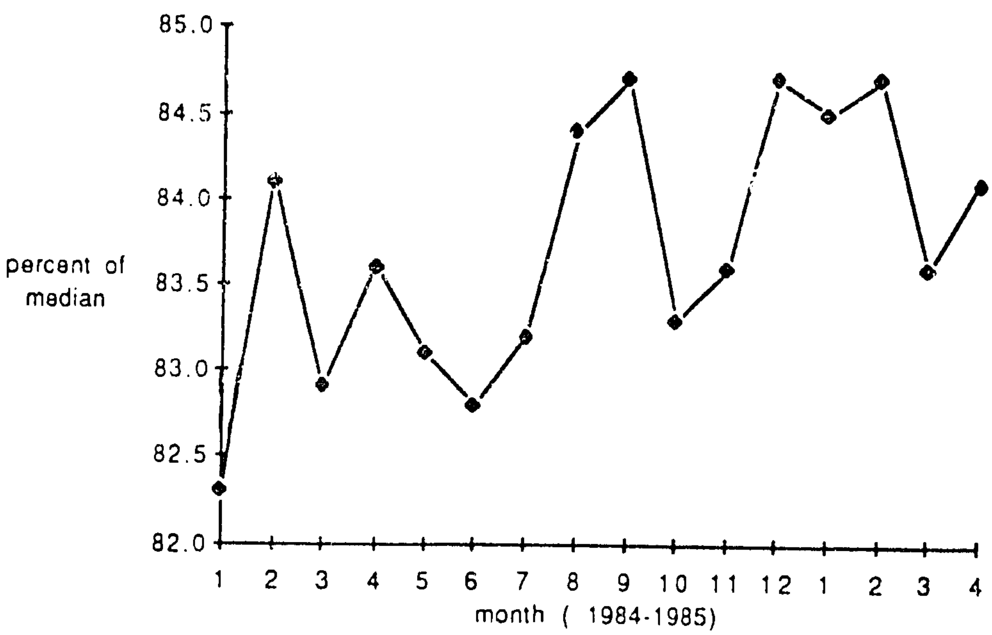


FIG. 7.12. Toddlers' weight for age as mean percent of median by month, sexes combined.

In describing the rate of increase for length, weight, and head circumference, incremental growth references (17) were applied to the data. The comparisons of male and female toddlers' weight with NCHS standards (50th and 3rd percentiles) are illustrated in Figs. 7.13 and 7.14, respectively; similarly, the comparisons of male and female toddlers' length with the NCHS standards are provided in Figs. 7.15 and 7.16. Using three-month intervals (Table 7.15), the toddlers grew in length at rates following the ninth to tenth percentiles for males and the fourth to 20th percentiles for females up to 27 months. Between 27 and 30 months the rate increased to the 50th percentile for males and remained at the 20th percentile for females. For weight, incremental growth ranged from the 40th to the 80th percentiles for males with the highest rate occuring between the 27th and 30th months. For females incremental weight gain ranged from a low of the 5th percentile between the 18th and 21st months to a high of the 50th percentile between the 24th and 27th months. See Table 7.15.

Regarding head circumference male's growth during the 18th to 21st months was the 35th percentile and reached a high of the 50th percentile between months 24 and 27. Female toddlers followed a similar pattern attaining a high of the 75th percentile betwen the 24th and 27th months. See Table 7.15.

The accelerated rates of growth between the 27th and 30th months of age may represent an attempt at catch-up growth. However, despite this catch-up growth, the attained growth status by 30 months of age showed an increase in stunted and underweight children. The increased growth rate could not overcome the earlier decrease in growth performance.

<u>Comparison of CRSP Toddlers to Toddlers Studied by the Child Nutrition Survey in Kenya</u>

The Central Bureau of Statistics Survey in 1982 (17) found that children (1-4 years) in Embu district ranked 13th out of the 27 districts for stunting; similarly, Eastern Province ranks third out of the seven Provinces. The CBS study, which used NCHS reference data, also found 2% of Embu children to be wasted. See Tables 7.16 and 7.17.

With regard to infants and toddlers from the national and Eastern Province samples, stunting but not wasting, increased as age increased from the first to the third year. See Table 7.18. It appears that the CRSP toddlers are comparable to the CBS sample.

Male infants, and especially male toddlers, are particulariy disadvantaged with regard to linear growth in both the CBS and the CRSP studies. This higher prevalence of male stunting reverses in the schooler group and females, at least in the CBS study, show more stunting and underweight than in the males.

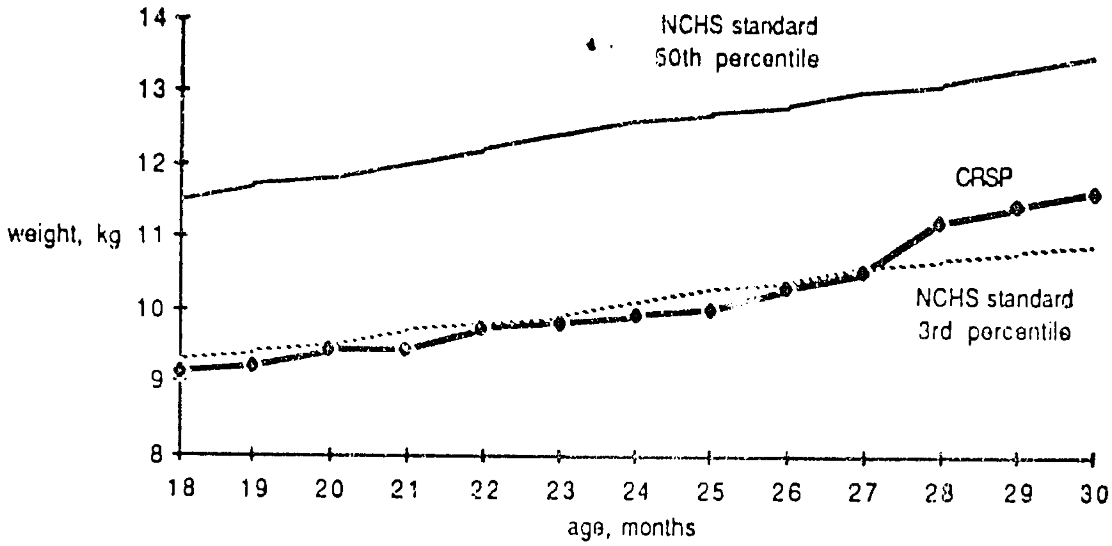


FIG. 7.13. Comparison of male toddlers' mean weight by month of age with NCHS standard.[1]

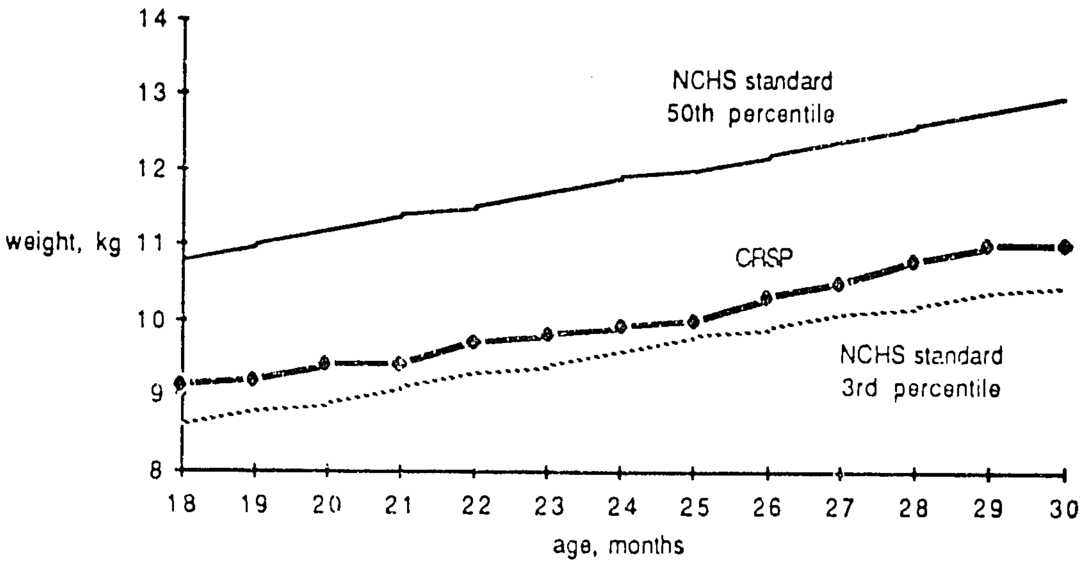


FIG. 7.14. Comparison of female toddlers' mean weight by month of age with NCHS standard.[1]

[1] Measurements were taken on the same children with some fluctuation in monthly sample size.

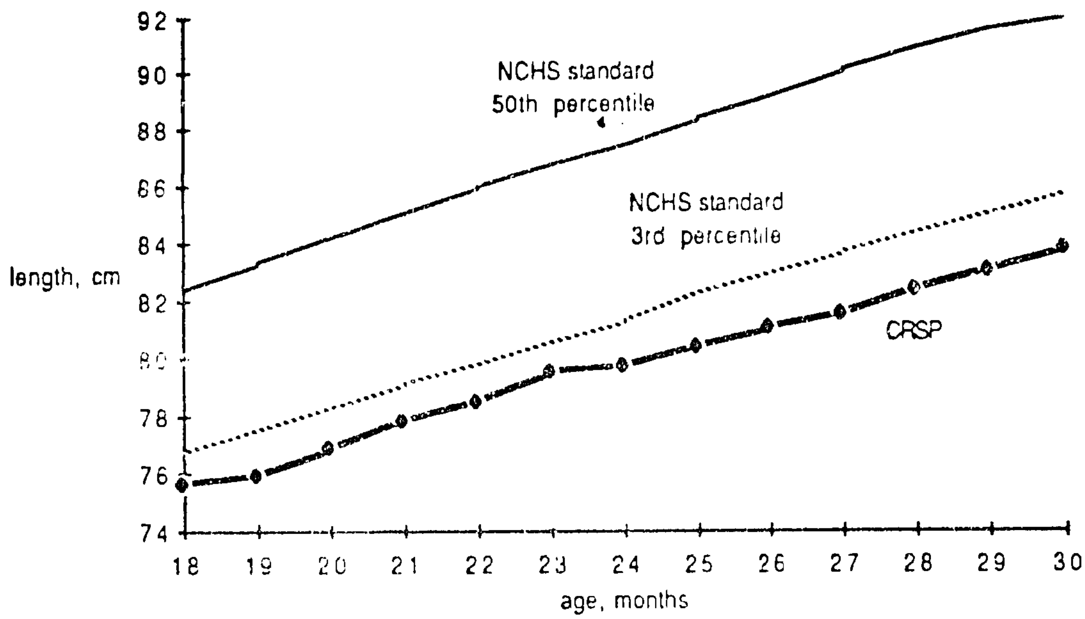


FIG. 7.15. Comparison of male toddlers' mean length by month of age with NCHS standard. (NCHS standard has been adjusted to reflect recumbent length through 30 months; CRSP data is recumbent length).[1]

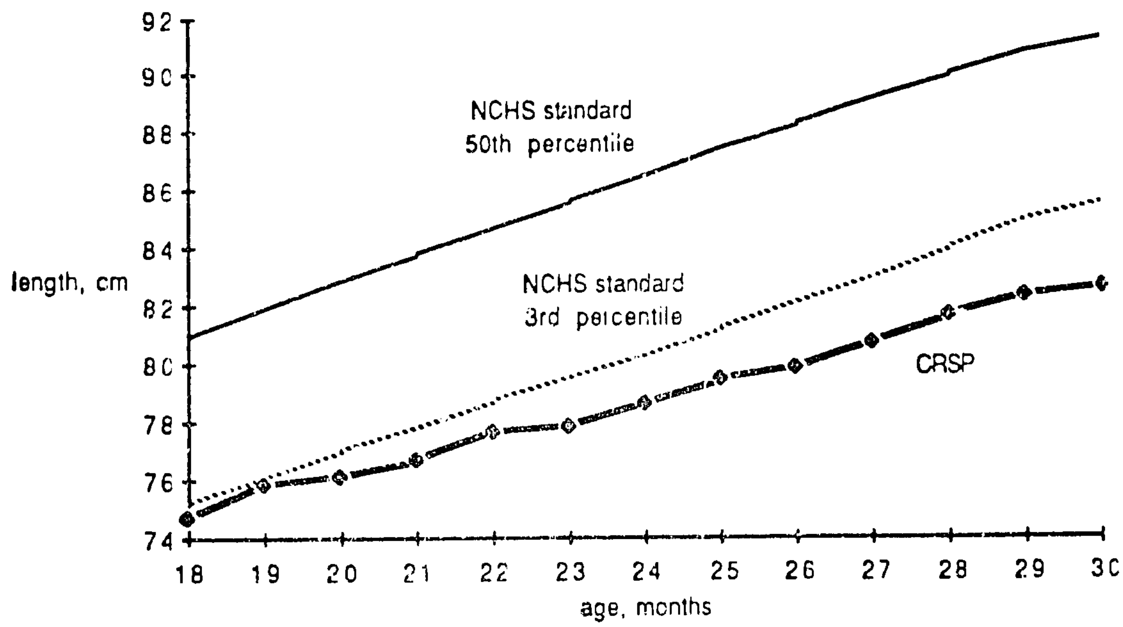


FIG. 7.16. Comparison of female toddlers' mean length by month of age with NCHS standard. (NCHS standard has been adjusted to reflect recumbent length through 30 months; CRSP data is recumbent length).[1]

---

[1] Measurements were taken on the same children with some fluctuation in monthly sample size.

TABLE 7.15

Incremental growth for mean length, weight and head circumference for toddlers by sex based on NCHS-CDC reference data (10).

	Males				Females			
Interval	n*	per day	per 3 mos	NCHS-CDC percentile	n*	per day	per 3 mos	NCHS-CDC percentile
Weight (kg)								
18-21	51	.008	.70	70	52	.003	.24	5
21-24	53	.006	.54	40	57	.006	.56	40
24-27	54	.005	.41	40	55	.006	.58	50
27-30	49	.007	.65	80	53	.005	.47	48
Length (cm)								
18-21	47	.024	2.22	10	51	.022	1.96	4
21-24	53	.021	1.89	9	55	.022	1.99	7
24-27	54	.020	1.79	10	55	.024	2.14	20
27-30	49	.026	2.33	50	53	.021	1.89	20
Head Circumference(cm)								
18-21	47	.006	.53	35	52	.005	.44	25
21-24	53	.004	.32	20	55	.003	.30	20
24-27	54	.006	.54	50	55	.006	.51	75
27-30	49	.003	.48	40	52	.001	.12	10

* n represents the sample size in the last month of the interval; sample sizes for the 18th month are as follows: males - weight=39, length=39, head cir.=37; females - weight=55, length=55, head cir.=45.

Toddlers studied by the CRSP Project are currently being followed for a full year, which will furnish data on their growth during the ages of four and five. These data will supplement the CRSP data and provide a more comprehensive picture of child growth.

Schoolers

In general, schoolers in the CRSP study (7-9 years old) are underweight, stunted, and thin compared to other Kenyan children, particularly those of urban middle class and wealthy families, and to children in the United States (10). Height and weight data for schoolers are presented in Table 7.19.

TABLE 7.16

Comparison of stunting among CRSP toddlers (18-30 months of age) with that of samples of 1-4 year old children from all Kenya, Eastern Province, and Embu District reported in the Child Nutrition Survey of 1982 (17).

Samples	Percent stunted <90% median H/A	Mean z-score H/A	Mean % of median H/A
All Kenya	24.0	-1.47	94.2
Eastern Province	22.6	-1.54	94.0
Embu District	22.3	-1.60	93.7
CRSP Toddlers	31.6	-1.96	92.2

TABLE 7.17

Comparison of underweight and wasting among CRSP toddlers (18-30 months of age) with that of samples of 1-4 year old children from all of Kenya, Eastern Province and Embu District reported in the Child Nutrition Survey of 1982 (17).

Samples	% underweight 80-89% Med WH	% wasted <80% Med WH	Mean Z-score WH	Mean % of Median WH
All Kenya	17.5	3.0	-0.06	100.7
Eastern Province	16.5	2.7	-0.17	99.2
Embu District	17.0	2.0	-0.24	98.5
CRSP Toddlers	NA*	1.1	-0.44	95.9

* CRSP toddler data have not been analyzed using this interval and so a comparison figure is not available.

TABLE 7.18
Percent stunting and wasting in infants and toddlers in the 1982 Child Nutrition Survey (based on Z-scores of -2.0) (17).

	3 - 11 mos	12 - 23 mos	24 - 35 mos
Height/age (< 90% median)			
Kenya			
Male	36.5	52.3	63.3
Female	25.2	49.4	55.9
Eastern			
(M +F)	31.9	49.8	61.8
Weight/Height (< 80% median)			
Kenya			
Male	10.2	18.6	9.4
Female	6.2	13.0	6.4
Eastern			
(M + F)	8.0	15.9	6.0

Comparisons with NCHS reference data show the means for HA, WA, and WH of 84 month old schoolers to be at 92.8, 85.2 and 97.0 percent of median, respectively. See Tables 7.20, 7.21, and 7.22. Stunting increases from 20.5% to 36.2% and moderate underweight from 35.9% to 40% as the schoolers approach nine years of age. See table 7.23. Depending on the season, between 27.3 and 47.8% of schoolers are in the moderately malnourished group (60-80 percent of median WA), and a maximum of 1.2% (all females) are in the severe group (60 percent of median WA). See Table 7.24.

Very little kwashiorkor was seen (< 2%). A small amount of wasting (1.2% ≤ 80% of median WH) was seen in 1984, but this gradually decreased in 1985 to 0.7%. See Table 7.25. Stunting appeared to increase over time but this may be more of an age effect than season effect, except for the famine. See Table 7.26. There is a definite seasonal effect seen in schooler growth. The famine accented the weight loss and lack of weight gain during the period from July to December of 1984, but in April to July of 1985, at the time of the long rains and prior to the harvest, food supplies were reduced and a decrease or lack of weight and height gains was observed.

When compared with NCHS standard growth curves schoolers stay above the 5th percentile for height. See Figs. 7.17 through 7.20. Head circumference is -0.5 SD at 84 months, and -1 SD at 102 months using the international, interracial head circumference reference data (15).

Schooler rates of growth for height and weight compared to incremental growth curves based on NCHS data (17) are provided in Table 7.27. For height, male incremental growth rises from the 4th to the 45th percentile by the 7th year and then drops back to below the 3rd percentile during the 8th year. Females grow at the 20th to 25th percentiles during the 7th year. The data show a substantial increase up to the 90th percentile during the interval between the 96th to the 102nd months for females. This figure is somewhat suspect, however, due to rather small sample sizes in months 97 through 102.

There appears to be more stunting and underweight among male schoolers, which is a reversal from the infant and toddler groups. Girls have a higher prevalence of stunting and underweight than boys in the 7th year, and in the 8th year catch up in height only.

Schoolers have little body fat. The mean sums of their fatfolds range from 13.6mm at 84 months to 13.2mm at 102 months. Arm fat area is approximately 4 cm^2 and is below the 5th percentile (14). Arm muscle area and arm muscle circumference are approximately 16 cm2 and 14 cm respectively (5th to 10th percentiles).

Mid upper arm circumference ranges from 15.5 ± 1.2 cm at 84 months to 16.2 ± 1.1 cm at 102 months. See Table 7.28.

TABLE 7.19
Height and weight of schoolers, by age and sex.

Age in Months	Males n	Males Mean	Males SD	Males Range	Females n	Females Mean	Females SD	Females Range
Height: (cm)								
84	40	113.7	5.0	105.3-126.1	37	112.4	5.5	102.1-123.2
90	63	115.6	4.4	107.5-126.7	50	115.0	6.1	101.3-126.5
96	64	118.4	4.7	110.2-129.3	52	117.3	6.1	102.7-128.7
102	15	119.3	5.1	110.0-127.8	10	121.0	7.1	107.3-131.3
104	5	119.5	5.5	115.6-127.8	4	119.2	9.5	107.7-129.8
Weight (kg)								
84	40	19.3	2.1	15.8-24.0	38	18.8	2.7	12.8 - 24.9
90	63	19.9	2.1	16.3-25.0	50	19.4	2.6	13.2 - 26.7
96	64	21.0	2.4	16.4-26.6	52	20.7	2.9	14.3 - 27.3
102	15	21.1	2.6	16.1-25.5	10	21.9	3.5	16.7 - 27.7
104	5	22.0	2.3	20.0-24.5	4	21.6	4.9	16.6 - 27.7

TABLE 7.20
Mean schooler height/age for selected ages, sexes combined.

Age in months	n	Percentiles Mean ± SD (Range)	n	Z-score Mean ± SD (Range)	n	% Median Mean ± SD (Range)
84	76	13.9 ± 18.4 (0.1 - 80.6)	75	-1.49 ± 0.94 (-3.3 - 0.9)	78	92.8 ± 6.6 (49.0 - 103.6)
90	111	12.8 ± 17.0 (0.1 - 70.0)	109	-1.56 ± 0.90 (-3.8 - 0.5)	113	93.0 ± 4.2 (82.0 - 102.4)
96	114	13.1 ± 17.2 (0.1 - 66.8)	112	-1.53 ± 0.89 (-3.8 - 0.4)	116	93.0 ± 4.2 (81.3 - 101.8)
102	23	13.7 ± 16.8 (0.2 - 62.5)	24	-1.62 ± 0.98 (-3.4 - 0.3)	24	92.7 ± 4.6 (83.0 - 101.6)
104	8	12.8 ± 17.6 (0.4 - 47.1)	8	-2.0 ± 1.0 (-3.4 - -0.4)		NA

TABLE 7.21
Mean schooler weight/age for selected ages, sexes combined.

Age in months	n	Percentiles Mean ± SD (Range)	n	Z-score Mean ± SD (Range)	n	% Median Mean ± SD (Range)
84	78	17.4 ± 18.6 (0.1 - 76.8)	76	-1.20 ± 0.83 (-3.2 - 0.7)	78	85.2 ± 10.9 (58.6 - 114.0)
90	113	14.2 ± 15.8 (0.1 - 76.7)	110	-1.3 ± 0.74 (-3.2 - 0.7)	113	83.2 ± 9.9 (56.8 - 114.8)
96	116	15.5 ± 16.6 (0.1 - 67.6)	110	-1.26 ± 0.79 (-2.9 - 0.5)	116	83.3 ± 10.4 (57.6 - 109.9)
102	25	13.0 ± 14.7 (0.1 - 57.3)	24	-1.40 ± 0.73 (-3.0 - 0.2)	25	80.5 ± 11.1 (60.4 - 104.2)
104	9	13.8 ± 17.2 (0.4 - 53.2)	9	-1.3 ± 0.84 (-2.5 - 0.1)		NA

TABLE 7.22

Mean schooler weight/height for selected ages, sexes combined.

Age in months	n	Percentiles Mean ± SD (Range)	n	Z-scores Mean ± SD (Range)	n	% Median Mean ± SD (Range)
84	78	41.3 ± 25.7 (1.7 - 99.8)	70	-0.28 ± 0.78 (-2.0 - 1.4)	78	97.0 ± 6.9 (82.1 - 114.0)
90	113	37.1 ± 22.1 (0.3 - 86.4)	105	-0.38 ± 0.74 (-2.6 - 1.1)	113	96.7 ± 6.8 (77.2 - 114.0)
96	116	40.7 ± 24.6 (0.7 - 93.0)	110	-0.26 ± 0.77 (-2.4 - 1.5)	116	97.9 ± 7.4 (78.8 - 115.1)
102	25	36.1 ± 20.6 (0.8 - 64.1)	21	-0.50 ± 0.73 (-2.30 - 0.4)	25	96.2 ± 6.4 (79.5 - 105.4)

TABLE 7.23

Percent of schoolers with stunting, severe PEM, moderate PEM and wasting for selected ages, using percent of median NCHS standard (10).

Age in Months	n	Stunted HA < 90% med	Severe PEM WA ≤ 60% med	Moderate PEM WA 61-80% med	Wasted WH ≤ 80% med
84	78	20.5	1.3	35.9	0.0
90	113	18.0	0.9	43.4	1.8
96	116	24.0	0.9	43.1	0.9
102	43	34.9	4.0	40.0	4.0

TABLE 7.24
Distribution of schooler weight/age by season as percent of median NCHS standard (10)

Season	n*	Percent of Median Weight For Age				
		<60%	61-70%	71-80%	81-100%	>100
1984						
Jan-Mar						
Male	111	0.9	3.6	35.1	56.8	3.6
Female	85	1.2	4.7	22.4	56.5	15.3
(M + F)	196	1.0	4.1	29.6	56.7	8.7
Apr-June						
Male	155	0.0	5.2	32.9	59.4	2.6
Female	120	2.5	5.0	26.7	55.8	10.0
(M + F)	275	1.1	5.1	30.2	57.8	5.8
July-Sept						
Male	182	0.0	8.2	33.0	58.2	0.5
Female	152	2.0	8.6	34.2	46.1	9.2
(M + F)	334	0.9	8.4	33.5	52.7	4.5
Oct-Dec						
Male	190	0.0	11.1	39.5	48.9	0.5
Female	161	2.5	14.3	30.4	45.3	7.5
(M + F)	351	1.1	12.5	35.3	47.3	3.7
1985						
Jan-Mar						
Male	137	0.0	2.9	38.0	56.2	2.9
Female	121	2.5	9.1	26.4	53.7	8.3
(M + F)	258	1.2	5.8	32.6	55.0	5.4
Apr-Jun						
Male	81	0.0	3.7	33.3	58.0	4.9
Female	66	0.0	7.6	21.2	60.6	8.3
(M + F)	147	0.0	5.4	27.9	59.2	7.5
July-Sept						
Male	42	0.0	2.4	23.8	66.7	7.1
Female	35	0.0	8.6	20.0	65.7	5.7
(M + F)	77	0.0	5.2	22.1	66.2	6.5
Oct-Dec						
Male	15	0.0	6.7	33.3	46.7	13.3
Female	13	0.0	0.0	23.2	76.9	0.0
(M + F)	28	0.0	3.6	28.6	60.7	7.1

* Total number of monthly measurements taken over the three month period.

TABLE 7.25
Distribution of schooler weigth/height by season as percent of median NCHA standard (10)

Season	n*	Percent of Median Weight For Height		
		≤80%	81-100%	>100%
1984				
Jan-Mar				
Male	111	0.0	68.5	31.5
Female	85	0.0	58.8	41.2
(M + F)	196	0.0	64.3	35.7
Apr-June				
Male	155	0.0	71.6	28.4
Female	119	0.8	63.0	36.1
(M + F)	234	0.4	67.9	31.8
July-Sept				
Male	182	0.5	66.5	33.0
Female	151	2.0	63.6	34.4
(M + F)	333	1.2	65.2	33.6
Oct-Dec				
Male	190	0.5	75.3	24.2
Female	159	1.3	69.8	28.9
(M + F)	349	0.9	72.8	26.4
1985				
Jan-Mar				
Male	137	0.0	65.7	34.3
Female	121	0.0	61.2	38.8
(M + F)	258	0.0	63.6	36.4
Apr-Jun				
Male	81	1.2	65.4	33.3
Female	66	0.0	48.5	51.5
(M + F)	147	0.7	57.8	41.5
July-Sept				
Male	42	0.0	59.5	40.5
Female	35	0.0	48.0	51.4
(M+F)	77	0.0	54.5	45.5
Oct-Dec				
Male	15	0.0	53.3	46.7
Female	13	0.0	61.5	38.5
(M + F)	28	0.0	57.1	42.9

* Total number of monthly measurements taken over the three month period.

TABLE 7.26
Distribution of schooler height/age by season as percent of median NCHS standard (10).

Season	n*	Percent of Median Height/Age			
		≤80%	81-90%	91-100%	>100%
1984					
Jan-Mar					
Male	111	0.9	26.1	69.4	3.6
Female	85	1.2	20.0	61.2	17.6
(M + F)	196	1.0	23.5	65.8	9.7
Apr-June					
Male	155	0.0	23.9	70.3	5.8
Female	119	0.8	21.0	67.2	10.9
(M + F)	274	0.4	22.6	69.0	8.0
July-Sept					
Male	182	0.0	24.7	70.9	4.4
Female	151	0.0	26.5	62.9	10.6
(M + F)	333	0.0	25.5	67.3	7.2
Oct-Dec					
Male	190	0.0	27.4	68.9	3.7
Female	159	0.0	27.0	62.8	8.3
(M + F)	349	0.0	27.2	68.5	4.3
1985					
Jan-Mar					
Male	137	0.0	23.4	69.3	7.3
Female	121	0.0	28.9	62.8	8.3
(M + F)	258	0.0	26.0	66.3	7.8
Apr-Jun					
Male	81	0.0	18.5	76 5	4.9
Female	66	0.0	30.3	60.6	9.1
(M + F)	147	0.0	23.8	69.4	6.8
July-Sept					
Mal	42	0.0	28.6	69.0	2.4
Female	35	0 0	34.3	60.0	5.7
(M + F)	77	0.0	31.2	64.9	3.9
Oct-Dec					
Male	15	0.0	26.7	73.3	0.0
Female	13	0.0	38.5	61.5	0.0
(M + F)	28	0.0	32.1	67.9	0.0

* Total number of monthly measurements taken over the three month period.

TABLE 7.27

Incremental growth for mean height and weight for schoolers by sex based on NCHS-CDC reference data. (10)

Interval age in mos	Male				Female			
	n*	per day	per 6 mos	NCHS-CDC percentile	n*	per day	per 6 mos	NCHS-CDC percentile
Height (cm)								
84-90	63	.011	1.9	4	50	.014	2.6	25
90-96	64	.016	2.8	45	52	.013	2.3	20
96-102	15	.005	0.9	<3	10	.021	3.7	90
Weight (kg)								
84-90	63	.003	0.6	10	50	.003	0.6	10
90-96	64	.004	0.8	20	52	.007	1.3	40
96-102	15	.001	0.1	3	10	.006	1.1	25

* n represents the sample size in the last month of the interval; n's for the 84th month are as follows: males (weight and height) = 40, females (weight and height) = 37.

TABLE 7.28

Head circumference, arm circumference and sum of fatfolds for schoolers by age with sexes and seasons combined.

	Months	n	Mean	SD	Range
Head circ. (cm)	84	64	50.3	2.6	33.7 - 54.4
	90	106	50.7	1.5	44.6 - 54.5
	96	116	50.8	1.5	44.4 - 54.5
	102	25	51.2	1.6	48.0 - 54.0
	104	9	50.6	1.6	48.0 - 52.3
MUAC (cm)	84	78	15.5	1.2	12.8 - 18.3
	90	113	15.6	1.1	13.0 - 18.7
	96	116	16.1	1.2	13.7 - 19.4
	102	25	16.1	1.1	13.2 - 18.2
	104	9	16.4	1.1	14.7 - 17.8
Sum FF (mm)*	84	78	13.6	3.1	8.2 - 22.6
	90	112	13.5	3.1	8.7 - 26.7
	96	116	14.0	3.1	9.0 - 23.2
	102	25	13.9	2.7	8.5 - 18.2
	104	9	14.1	2.6	10.9 - 18.5

* Biceps, triceps, subscapular.

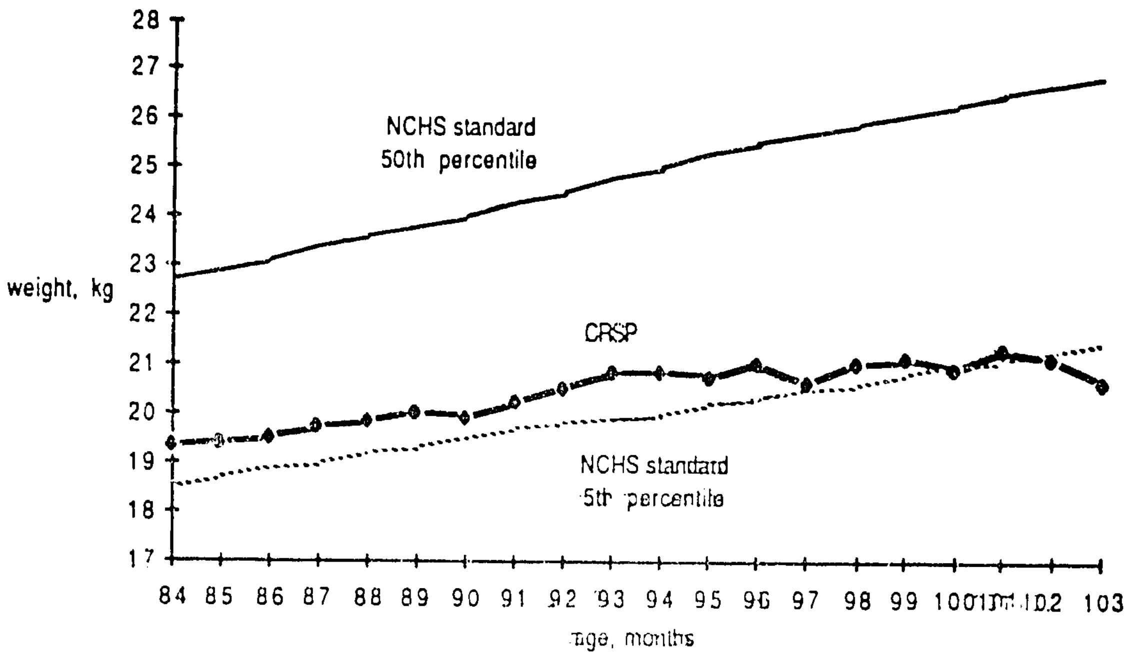


FIG. 7.17. Comparison of male schoolers' mean weight by month of age with NCHS standard.[1]

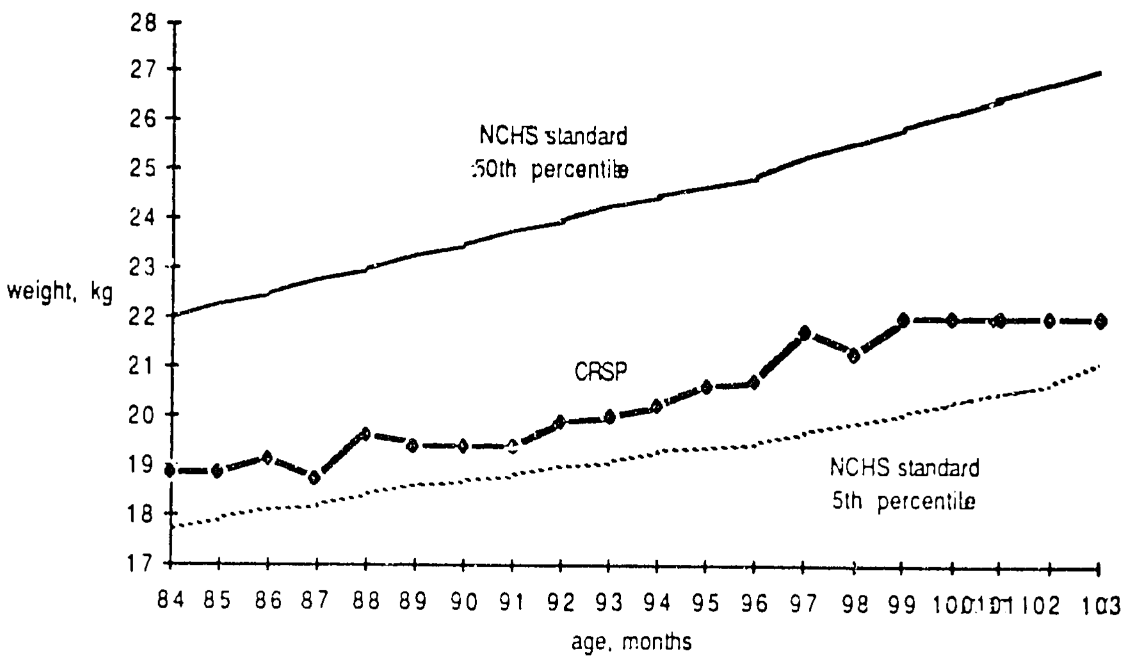


FIG. 7.18. Comparison of female schoolers' mean weight by month of age with NCHS standard.[1]

---

[1] Measurements were taken on the same children with some fluctuation in monthly sample size.

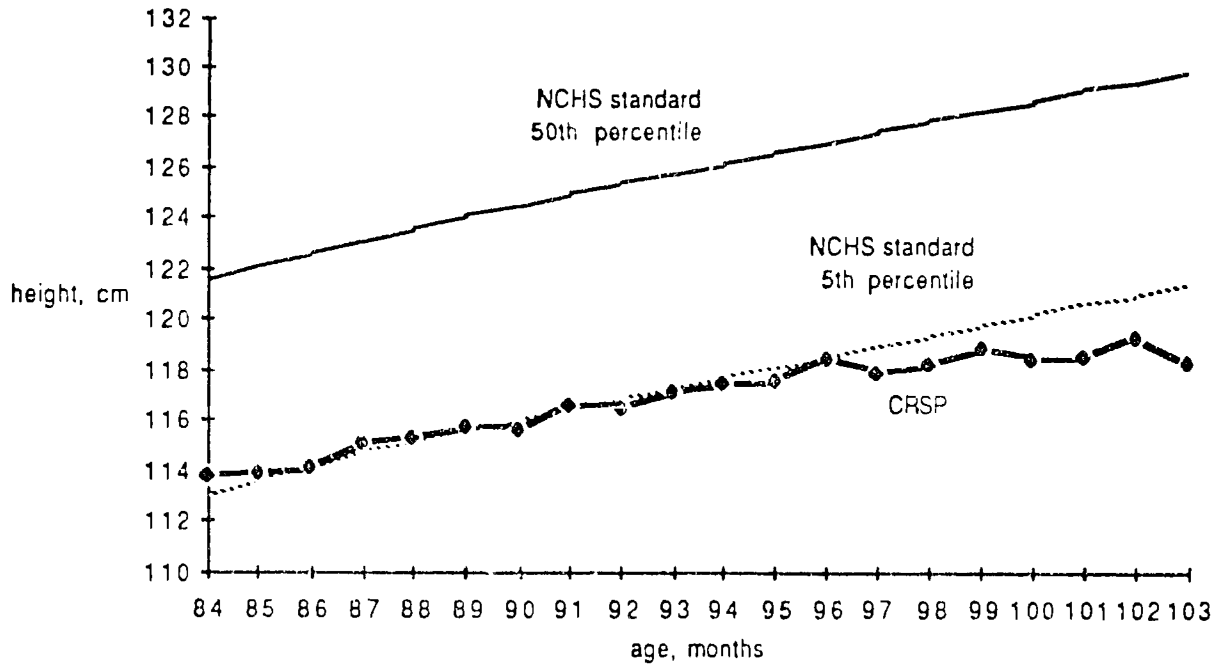


FIG. 7.19. Comparison of male schoolers' mean height by month of age with NCHS standard.[1]

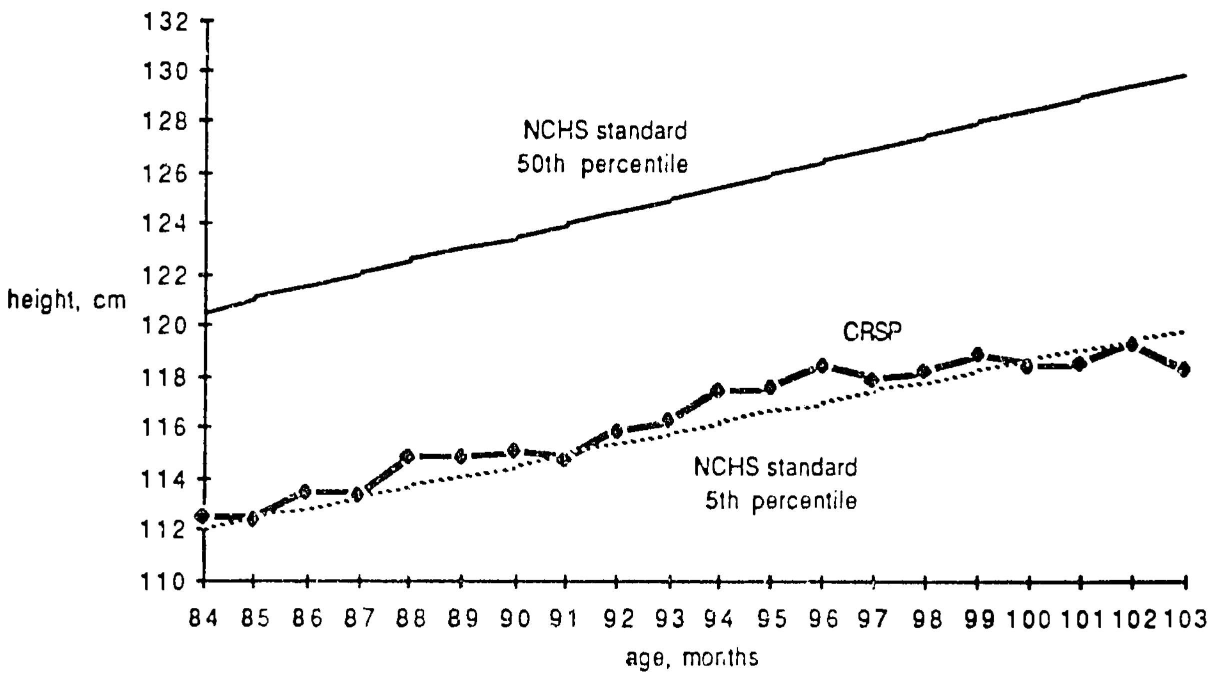


FIG. 7.20. Comparison of female schoolers' mean height by month of age with NCHS standard.[1]

[1] Measurements were taken on the same children with some fluctuation in monthly sample size.

Summary

At birth the Nutrition CRSP children are within the normal range for length and weight, although birthweights are 200 to 300 gms less than western birth weights. For the first three or four months their length, weight, and head circumference grow along the 40-50th percentile levels but then decline to consistently low levels. By the time infants become toddlers, stunting emerges as a widespread phenomenon and they grow at about the 10th to 12th percentile for length and weight. When they reach school age they are even more stunted and underweight, and are very lean.

Adults, particularly men, are generally short, underweight, and thin by comparison to urban upper class Kenyans. Women are also short, but fewer are underweight and low in body fat.

There appears to be a seasonal fluctuation for weight but this was confounded by the famine in 1984. There was a period of weight loss from April to June during the long rains and just prior to the harvest in 1985.

REFERENCES

1. Jelliffe D.B. Assessment of nutritional status of the community. Geneva: WHO, 1966.

2. Durnin J.V.G.A., Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16-72 years. Br J Nutr 1974;32:77-97.

3. Weiner J.S., Lourie A.J. Human biology: A guide to field methods. Oxford: Blackwell, 1969.

4. World Health Organization. Nutritional status of populations: A manual on anthropometric appraisal of trends. WHO/Nutr 1970;70:129.

5. Behar M. The appraisal of nutritional status of population groups. In: Beaton G.H., Bengoa J.M., eds. Nutrition in Preventive Medicine. Geneva: WHO, 1975.

6. Zerfas A.J. Anthropometric Field methods: General. In: Jelliffe D.B., Jelliffe E.F.P., eds, Human nutrition -- A comprehensive treatise, Vol. 2.New York: Plenum Press, 1975.

7. Zerfas A.J. The insertion tape: A new circumference tape for use in nutritional assessment. Am J Clin Nutr 1975;28:782.

8. Dugdale A.E., Griffiths M. Estimating fat body mass from anthropometric Data. Am J Clin Nutr 1979;32:2400-2403.

9. Gurney J.M., Jelliffe D.B. Arm anthropometry in nutritional assessment: monogram for rapid calculations of muscle-circumference and cross-sectional muscle and fat areas. Am J Clin Nutr 1973;26:912.

10. Hamil P.V.V., Drisa T.A., Johnson C.L., Rea R.B., Roche A.F., Moore W.N. Physical Growth: National Center for Health Statistics percentiles. Am J Clin Nutr 32:607-629, 1979.

11. Stephenson L.S., Latham M.C., Jansen A.A.J. A comparison of growth standards: similarities between NCHS, Harvard, Denver and privileged African children and differences with Kenyan rural children. Cornell University, Program in International Nutrition Number 12. 1983. Ithica, NY.

12. Roche A.F., Hines J.H. Incremental growth charts. Am J Clin Nutr 33:204-208. 1980.

13. Society of Actuaries. Build and blood pressure study. Chicago; 1959. Val I and II.

14. Frisencho A. R. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr. 1981; 34, 2540-2545.

15. Nelhaus G. Head circumference from birth to 18 years. Practical composite international and interr--ial graphs. Pediatrics 1968; 41: 106.

16. Jansen A.A.J., Horelli H.T. The relation between weight and height in different ethnic groups in Kenya. Voeding-Jaargang 45, 1984;12,397-401.

17. Republic of Kenya. Third rural child nutrition survey, 1982. Central Bureau of Statistics, Ministry of Financeand Planning, December, 1983. Nairobi, Kenya.

Chapter 8

DISEASE

The Nutrition CRSP Kenya Project conducted a comprehensive investigation of disease among the project's study population. The disease component consists of data collected by the 1) quarterly chronic illness survey, 2) weekly morbidity survey, 3) biannual physical examinations, and 4) laboratory examinations (See chapter 9) for hematologic and immunologic status, intestinal parasites, and malaria. In combination, the various data sets on disease provide a detailed description of the health status of project households and individuals.

RESEARCH OBJECTIVES

The objectives of disease assessment were to measure household and target individual (TI) disease burden (including "hidden" disease which is best detected by laboratory determinations), and to determine how morbidity is affected by energy intake. The disease variables investigated by the project can serve as functional outcomes in themselves, or as confounding or explanatory variables in the analysis of other functions. Almost all other functional outcome variables are expected, if not known, to be affected by disease to some degree.

THE SAMPLE

Data on disease were collected from 247 households for a minimum of at least one year each. The household (TI or non-TI) was the basic unit of study for the chronic illness and morbidity surveys, although chronic illness and morbidity data were collected in more extensive detail on target individuals i.e., lead adults, schoolers, toddlers, and infants. Morbidity data were collected weekly from each household. Physical examinations and laboratory studies were conducted on the target individuals every six months.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Development of data collection techniques commenced with an intensive enthnomorbidity survey in the pilot area to obtain local terms used for diseases, perceptions about causation, severity, effective and appropriate modes of "modern" and "traditional" treatment, and related issues. This "Ethnomorbidity Study" was designed and carried out by the anthropologist and her staff. Aside from interviewing the pilot study population, interviews were also conducted with field staff members and health care providers trained in "scientific" as well as "indigenous" practices. This information was used extensively to construct questionnaires, train field staff, and acquaint the field physicians with the study area. The ethnomorbidity survey is available on "microfiche".

Data collection instruments were developed to collect initial chronic disease and disability histories. A knowledge of chronic disease and disability was considered important in order to interpret the weekly morbidity information and, especially, to understand how episodes of illness were related to any chronic conditions. Chronic disease and disability might also be expected to relate to different levels of energy intake and, more importantly, to interfere with ability to do physical work. Chronic illness is least likely to be detected by weekly morbidity surveys, and sometimes is not fully reported in the semi-annual physical examinations.

The decision to collect morbidity data on a weekly basis was based on the investigators experiences with other morbidity studies which demonstrated that recall for a given informant falls off greatly after one week. Thus, in order to document illness duration, weekly visits are required. The trade-off for conducting frequent visits and collecting accurate data on illness duration and other variables was weighed against increases in staff time and household burden, but it was considered important to record illness duration as an indicator of illness severity as accurately as possible. Also, by visiting a household once a week, a substantial amount of actual illness was encountered and observed which decreased the need to otherwise be highly dependent upon recall.

Illnesses for all household members (TI and non-TI's) were coded into broad rather than specific diagnostic categories as it was found that a higher level of precision was not possible for all household members. Individual morbidity reports were compiled for each TI who had signs or symptoms of illness. Based on information collected from the pilot study, the worksheet included the following 14 diagnostic categories: skin, eyes, ears, mouth, respiratory, cardiovascular, digestive, genito-urinary, musculoskeletal, nervous, communicable, nutritional, fever and miscellaneous. Each category contained specific signs and symptoms.

All data collection instruments were translated into Kiembu by well-qualified bilingual translators and translated back into English to check that the meaning was not altered. Pre-testing was performed in the pilot area to detect confusing or ambiguous questions, to eliminate items which were difficult to evaluate, and to train enumerators to conduct their interviews in a uniform and standardized fashion. Pre-testing also provided an opportunity for project physicians and nurses to see how well high school graduates, untrained as health professionals, functioned in the collection of morbidity data.

Eight forms were designed to record data related to disease. Disability and chronic disease data were recorded on Form 301, which was used both as the worksheet and as the final coded form (Fig. 8.1).

Form 323 (Fig. 8.2) was used to record data on physical examination, immunization history, signs of nutritional deficiency and results of hearing and vision assessment. Results of toddler vision assessments are recorded on the Cognitive Form No. 521. Physical examinations were carried out initially to provide baseline information on the types of illness and disease conditions present in the target individuals. Special attention was paid to standardizing observations for signs of nutritional deficiency using the WHO grouping of major types of deficiencies for which there are specific physical signs. The physical examination, as with the Chronic Disease Survey, was an attempt to pick up conditions that were not acute and unlikely to be detected by the weekly morbidity survey. These were performed by the project physicians.

Form 341 was used to record hematology, urinalysis, parasitology, and immunologic data (percent of T cells), and Form 342 for information on immunoglobulin (see Chapter 9) and bacteriologic water contamination (see Chapter 14), and skin test results. The presence of bacterial contamination will be incorporated into the household sanitation-hygiene score at a future time.

Morbidity data were recorded on Forms 312, 313, 314, and 315. More specifically, Form 312, the morbidity worksheet, was used for the household visits. This form included a household morbidity face sheet, and the individual morbidity form (Fig. 8.3). Forms 313 and 314 were the individual four-weekly morbidity code forms (Figs. 8.4 and 8.5): Form 313 was used for the first ten coding periods, and was replaced by Form 314 in November of 1984. Form 314 differed from Form 313 by eliminating the illness subroutine items, change in appetite (change in activity and food intake were maintained), weight, arm circumference, and triceps, biceps, and subscapular skinfolds, and by adding task reassignment. Form 314 also corrected for the number of columns for treatment by being adjusted to the number by designated categories. Finally, Form 315 was the Household Morbidity code form (Fig. 8.6).

The morbidity team in each of the four clusters of nearly 75 households consisted of one enrolled community nurse (a qualified nurse with public health training) or clinical officer and three enumerators who had the equivalent of a U.S. high school diploma (0-level). Two physicians, a part time Kenyan physician and a full-time physician from UCLA, worked with the morbidity teams. The enumerators were all from the area, and many took up residence in the clusters in which they worked.

The physicians were responsible for training the nurses and enumerators (both initial and ongoing), overseeing data collection, performing physical examinations on the respondents, seeing all seriously and critically ill people in the project area, checking the morbidity forms, and ensuring that quality control was carried out.

The nurses were responsible for training and supervising the enumerators, seeing ill respondents and giving minor treatment or referring them to the physician, overseeing completion of the morbidity forms, and sending completed forms to the data management unit. If an enumerator was ill, the nurse was responsible for reassigning that enumerator's households to another enumerator, or personally making the household visit.

Enumerators were responsible for making the weekly household visits and filling out morbidity worksheets (Form 312) for each visit, transcribing specified worksheet information onto the morbidity forms, revisiting households that were missed, reporting any seriously ill respondents to the cluster nurses, reading intradermal test results 48 hours after being administered, and enrolling respondents for scheduled biannual physical exams and RMR's. Each enumerator made four to seven household visits a day, and each visited the same household every week for three or four months before being reassigned by the cluster nurse to a new set of households to minimize any bias.

Enumerators were trained intensively for six to eight weeks before the start of the study and supervised throughout the study by the project physicians and PI's. Enumerators were oriented to the overall research objectives, taught about the common illnesses in the area, taught to recognize the signs of common diseases, and trained to interview and ask questions about morbidity. They were also shown a variety of patients of all ages in clinics and hospitals in order to recognize various clinical signs. Examples of these included common rashes; signs of dehydration; diarrheal stools; eye conditions such as conjunctivitis, trachoma, gonococcal opthalmitis, and strabismus; a variety of sputum samples; nasal and ear discharges; chest retraction and rapid respiration due to pneumonia; a variety of coughs; asthmatic wheezing; pertussis; measles; chicken pox; mumps; streptococcal tonsilopharyngitis; etc. The enumerators were trained to do systematic inspections of TI's of all ages to detect signs of illness, including how to count respiratory rates and take body temperatures. Nurses made household training visits with each enumerator at least once a week to observe enumerator performance, provide additional training, and ensure high quality work.

In order to standardize tonsillar grading, thyroid size and assessment of nutritional status, the physicians spent extensive periods of time reviewing physical signs of nutritional deficiency using personal slides collections, a color atlas (1) and reviewing cases in the surrounding hospital clinics and study population.

NUTRITION CRSP — KENYA PROJECT P.O BOX 1002, EMBU **CONFIDENTIAL**

DISABILITY AND CHRONIC DISEASE QUART. UPDATE

FORM NO 3 0 1 | VISIT NO | COUNTRY CODE 2 | HOUSEHOLD NO | TI NO | DATE DY MO YR 8 | ENUMERATOR NO | STATUS

Missing data: use 8,-8,-88 etc.
Not applicable use: 9,-9,-99 etc.

RESPONDENT'S NAME NOT APPLICABLE | TI'S NAME | ENUMERATOR'S NAME

1) Code section as per section 2) below

NAME	ID No.	CONDITION	ICD CODE (select from above; where blank refer to ICD book)
		1 = New: within last 3 months 2 = Pre-existing: onset earlier than 3 months ago.	
______	22 23	24	25 26 27 28
______	29 30	31	32 33 34 35
______	36 37	38	39 40 41 42
______	43 44	45	46 47 48 49
______	50 51	52	53 54 55 56
______	57 58	59	60 61 62 63

2) Does anyone in the household have or has had any of the following: (complete details in code section above);

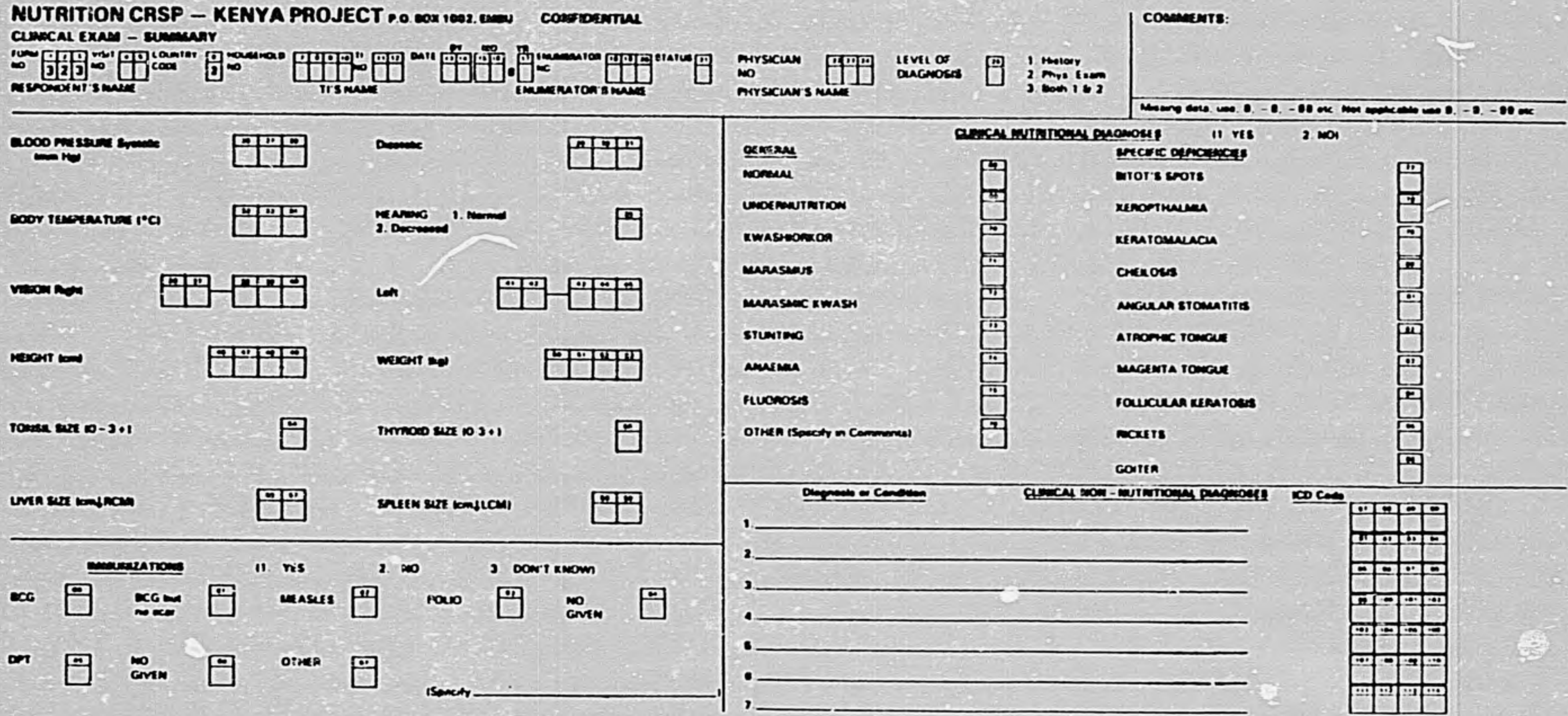
Trouble hearing	3 8 9 9	Asthma/Wheezing	4 9 3 9	Epilepsy	3 4 5 9
Trouble seeing	3 6 9 9	Arthritis	7 1 6 9	Heart disease	4 2 9 9
Trouble walking	7 1 9 7	Severe Backache Unable to move/work	7 2 4 5	High blood pressure	4 0 1 9
Paralysis	3 4 4 9	Cancer	1 9 9 1	Stroke	4 3 6 7
Lost an arm/hand	8 8 7 0	(Site	)	Peptic ulcer	5 3 3 9
Lost a leg	8 9 7 0	Discharging ear	3 8 8 6	Vomiting blood	5 7 [illegible]
Lost a foot	8 9 6 0	Diabetes	2 5 0 0	Mental disturbance	2 [illegible]
Tuberculosis	0 1 0 9			Other	*

If the answer is yes to one or more of the above, use codes given & complete the code section above.

3) For anyone in the Household admitted to a hospital in the past 3 months provide details as follows:

I.D. No.	Name	Date (Mo. Yr.)	Reason	Hospital	Diagnosis Given

FIG. 8.1. The disability and chronic disease quarterly update form 301.



NUTRITION CRSP — KENYA PROJECT P.O. BOX 1082, EMBU CONFIDENTIAL

CLINICAL EXAM — SUMMARY

FORM NO 3 2 3 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TI NO DATE DY MO YR ENUMERATOR NO STATUS PHYSICIAN NO LEVEL OF DIAGNOSIS 1. History 2. Phys. Exam 3. Both 1 & 2

RESPONDENT'S NAME TI'S NAME ENUMERATOR'S NAME PHYSICIAN'S NAME

COMMENTS:

Missing data, use 8, -8, -88 etc. Not applicable use 9, -9, -99 etc.

BLOOD PRESSURE Systolic (mm Hg) Diastolic

BODY TEMPERATURE (°C) HEARING 1. Normal 2. Decreased

VISION Right Left

HEIGHT (cm) WEIGHT (kg)

TONSIL SIZE (0 - 3 +) THYROID SIZE (0 3 +)

LIVER SIZE (cm) (RCM) SPLEEN SIZE (cm) (LCM)

IMMUNIZATIONS (1. YES 2. NO 3. DON'T KNOW)

BCG BCG but no scar MEASLES POLIO NO GIVEN

DPT NO GIVEN OTHER (Specify ______)

CLINICAL NUTRITIONAL DIAGNOSES (1. YES 2. NO)

GENERAL

NORMAL

UNDERNUTRITION

KWASHIORKOR

MARASMUS

MARASMIC KWASH

STUNTING

ANAEMIA

FLUOROSIS

OTHER (Specify in Comments)

SPECIFIC DEFICIENCIES

BITOT'S SPOTS

XEROPTHALMIA

KERATOMALACIA

CHEILOSIS

ANGULAR STOMATITIS

ATROPHIC TONGUE

MAGENTA TONGUE

FOLLICULAR KERATOSIS

RICKETS

GOITER

CLINICAL NON - NUTRITIONAL DIAGNOSES

Diagnosis or Condition ICD Code

1. ______

2. ______

3. ______

4. ______

5. ______

6. ______

7. ______

FIG. 8.2. The clinical examination summary form 323.

NUTRITION CRSP KENYA PROJECT

INDIVIDUAL MORBIDITY - WEEKLY VISIT
FORM 312

CONFIDENTIAL

Page 1 of 5

HH No. / / / / / TI Name ______________

TI No. / / /

Respondant Name ______________

Enumerator Name ______________ ID No. / / / /

	Day	Mo	Yr
Date of Regular Visit			8
Actual Date if Different			8

REPORTED ILLNESS RECALL		DURATION	OBSERVATIONS		ILLNESS SUBROUTINE REVISITS (1=YES 2=NO)					
GENERAL	1=YES 2=NO	Circle Day of Visit Su M T W Th F Sa	On Day of Home Visit	1=YES 2=NO	Reported No. ____ Date: __/__		Reported No. ____ Date: /		Reported No. ____ Date: /	
					Reported	Observed	Reported	Observed	Reported	Observed
a. Fever		- - - - - - -	1. Temperature actual		a.	1.	a.	1.	a.	1.
b. Chills		- - - - - - -	2. Obviously ill		b.	2.	b.	2.	b.	2.
c. Fever		- - - - - - -	3. Pale		c.	3.	c.	3.	c.	3.
d. Fever+other signs symptoms			4. Edematous		d.	4.	d.	4.	d.	4.
e. Headache		- - - - - - -			e.		e.		e.	
SKIN **		Su M T W Th F Sa			Reported	Observed	Reported	Observed	Reported	Observed
a. Rash		- - - - - - -	1. Abcess(es)-boils		a.	1.	a.	1.	a.	1.
b. Infected sores		- - - - - - -	2. Impetigo		b.	2.	b.	2.	b.	2.
c. Severe itching		- - - - - - -	3. Jiggers		c.	3.	c.	3.	c.	3.
d. Injury		- - - - - - -	4. Infected bites		d.	4.	d.	4.	d.	4.
e. Insect bites		- - - - - - -	5. Scabies		e.	5.	e.	5.	e.	5.
f. Chronic skin condition			6. Ringworm			6.		6.		6.
		- - - - - - -	7. Rash		f.	7.	f.	7.	f.	7.
g. Other			8. Burn w/bruise			8.		8.		8.
		- - - - - - -	9. Ulcers			9.		9.		9.
			10. Other		g.		g.		g.	
						10.		10.		10.
EYES		Su M T W Th F Sa			Reported	Observed	Reported	Observed	Reported	Observed
a. Watery discharge		- - - - - - -	1. Watery discharge		a.	1.	a.	1.	a.	1.
b. Purulent discharge		- - - - - - -	2. Purulent discharge		b.	2.	b.	2.	b.	2.
c. Redness-itching		- - - - - - -	3. Redness		c.	3.	c.	3.	c.	3.
d. Pimple/abcess on lid		- - - - - - -	4. Stye			4.		4.		4.
e. Foreign body injury		- - - - - - -	5. Eye hemmorhage		d.	5.	d.	5.	d.	5.
			6. Other		e.		e.		e.	
f. Very painful eye		- - - - - - -			f.	6.	f.	6.	f.	6.

** SKIN: Describe here location of rash or burn and how widespread (size) ______________

FIG. 8.3. The individual weekly visit morbidity report form 312, page 1 of 5.

MORBIDITY HH No. /__/__/__/__/ TI No. /__/__/ DATE ______________

REPORTED ILLNESS RECALL	YES=1 NO=2	DURATION (Circle day of visit)	OBSERVATIONS	YES=1 NO=2	ILLNESS SUBROUTINE REVISITS (1= YES 2=NO) Revisit No. ____ Date: __/__/8_		Revisit No. ____ Date: __/__/8_		Revisit No. ____ Date: __/__/8_	
EARS		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Pain in ear			1. Ear discharge		a.	1.	a.	1.	a.	1.
b. Ear discharge			2. Tender swelling behind ear		b.		b.		b.	
c. Swelling/soreness					c.	2.	c.	2.	c.	2.
d. Sudden hearing loss			3. Tender, swollen outer ear		d.		d.		d.	
e. Other (describe)						3.		3.		3.
			4. Bangs/holds ear (infant to toddl)		e.	4.	e.	4.	e.	4.
MOUTH, TONGUE, LIPS, TEETH		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Sores, blisters			1. Ulcers, sores, blisters		a.		a.		a.	
b. White spots					b.	1.	b.	1.	b.	1.
c. Tooth ache			2. White spots, thrush		c.		c.		c.	
d. Sore gum/tooth					d.	2.	d.	2.	d.	2.
e. Dental caries			3. Gum/tooth abs.		e.	3.	e.	3.		3.
			4. Other			4.		4.		4.
			5. Dental caries			5.		5.		5.
RESPIRATORY TRACT		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Sneezing, watery nasal discharge			1. Watery, nasal discharge		a.	1.	a.	1.	a.	1.
b. Purulent nasal discharge			2. Purulent nasal discharge		b.	2.	b.	2.	b.	2.
c. Sore throat/tonsils			3. Nasal flaring		c.	3.	c.	3.	c.	3.
d. Cough			4. Cough		d.	4.	d.	4.	d.	4.
e. Cough w/sputum			5. Cough w/sputum		e.	5.	e.	5.	e.	5.
f. Cough w/blood			6. Cough w/blood		f.	6.	f.	6.	f.	6.
g. Whoop, vomiting after repeated cough			7. Repeat cough w/whoop or vomit		g.	7.	g.	7.	g.	7.
h. Rapid breathing, panting			8. Retractions			8.		8.		8.
			9.* Respirate (actual)		h.	9.	h.	9.	h.	9.
i. Trouble breathing			10. Wheezing		i.	10.	i.	10.	i.	10.
			11. Trouble breathing			11.		11.		11.

* Resp. rate per minute

FIG. 8.7. (Continued) The individual weekly visit morbidity report form 312, page 2 of 5.

MORBIDITY HH No. _/ _/ _/ _/   TI No. __/__   DATE ______________

REPORTED ILLNESS RECALL	YES=1 NO=2	DURATION (Circle day of visit)	OBSERVATIONS Description of Stools (if stool available)	YES=1 NO=2	ILLNESS SUBROUTINE REVISITS (1 = YES 2 = NO) Revisit No. ____ Date: __ __/__ __		Revisit No. ____ Date: __ __/__ __		Revisit No. ____ Date: __ __/__ __	
DIGESTIVE SYSTEM		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Vomiting		__ __ __ __ __ __ __	1. Stools-watery		a.	1.	a.	1.	a.	1.
b. Vomitin, Blood		__ __ __ __ __ __ __	2. Stools-bloody		b.	2.	b.	2.	b.	2.
c. Heartburn		__ __ __ __ __ __ __	3. Stools-mucous		c.	3.	c.	3.	c.	3.
d. Abdominal Pain		__ __ __ __ __ __ __	4. Vomiting seen		d.	4.	d.	4.	d.	4.
e. Heartburn, pain better w/food		__ __ __ __ __ __ __	5. Vomiting-bloody			5.		5.		5.
			6. Worms observed		e.	6.	e.	6.	e.	6.
f. Diarrhea*		__ __ __ __ __ __ __	DEHYDRATION		f.		f.		f.	
g. Stool Number					g.		g.		g.	
-actual: day + night		__ __ per 24 hours	7. Sunken eyes		actual __ __	7.	actual __ __	7.	actual __ __	7.
-usual: day + night		__ __ per 24 hours	8. Sunken		usual __ __	8.	usual __ __	8.	usual __ __	8.
h. Stools: watery/loose		__ __ __ __ __ __ __	9. Dry Mouth/lips/tongue		h.	9.	h.	9.	h.	9.
i. Stools: bloody		__ __ __ __ __ __ __	10. Tenting of skin		i.	10.	i.	10.	i.	10.
j. Stools: mucous		__ __ __ __ __ __ __			j.		j.		j.	
k. Worms passed		__ __ __ __ __ __ __			k.		k.		k.	
GENITO URINARY		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Pain, burning on urination		__ __ __ __ __ __ __	1. Pain on voiding		a.	1.	a.	1.	a.	1.
b. Frequent urination		__ __ __ __ __ __ __	2. Blood in urine		b.	2.	b.	2.	b.	2.
c. Blood in urine		__ __ __ __ __ __ __	3. Brown colour		c.	3.	c.	3.	c.	3.
d. Dark brown urine		__ __ __ __ __ __ __	4. Purulent material		d.	4.	d.	4.	d.	4.
e. Discharge "below"		__ __ __ __ __ __ __			e.		e.		e.	
f. Sores "below"		__ __ __ __ __ __ __			f.		f.		f.	
g. Itching "below"		__ __ __ __ __ __ __			g.		g.		g.	
BREAST		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Lump/mass		__ __ __ __ __ __ __	1. Mass/lump		a.	1.	a.	1.	a.	1.
b. Soreness		__ __ __ __ __ __ __	2. Swollen		b.	2.	b.	2.	b.	2.
c. Swelling		__ __ __ __ __ __ __	3. Sore-cracked		c.	3.	c.	3.	c.	3.
d. Other			4. Yellow discharge		d.		d.		d.	

* Change in usual consistancy to loose watery stools and/or increase in usual number.

FIG. 8.3. (Continued) The individual weekly visit morbidity report form 312, page 3 of 5.

MORBIDITY HH No. /_/_/_/_/   TI No. /_/_/   DATE ______________

REPORTED ILLNESS	1=YES 2=NO	DURATION	OBSERVATIONS	1=YES 2=NO	ILLNESS SUBROUTINE REVISITS (1=YES 2=NO) Revisit No.___ Date: __ __/__ __		Revisit No.___ Date: __ __/__ __		Revisit No.___ Date: __ __/__ __	
ARMS & LEGS MUSCULO SKELETAL		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Joint pain		__ __ __ __ __ __ __	1. Warm joint(s)		a.	1.	a.	1.	a.	1.
b. Joint swelling		__ __ __ __ __ __ __	2. Swollen joint(s)		b.	2.	b.	2.	b.	2.
c. Multiple joints		__ __ __ __ __ __ __	3. Multiple joints		c.	3.	c.	3.	c.	3.
d. Swelling hands/feet		__ __ __ __ __ __ __	4. Edema of feet		d.	4.	d.	4.	d.	4.
e. Stiff neck		__ __ __ __ __ __ __	5. Diff. extrem.		e.	5.	e.	5.	e.	5.
f. Stiff back, back pain		__ __ __ __ __ __ __	6. Other:		f.	6.	f.	6.	f.	6.
NERVOUS SYSTEM		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Fits (convulsions)		__ __ __ __ __ __ __	1. Convulsions (fits)		a.	1.	a.	1.	a.	1.
b. Unconscious		__ __ __ __ __ __ __	2. Unconsciouness		b.	2.	b.	2.	b.	2.
c. Headache		__ __ __ __ __ __ __	3. Bizarre behavior		c.	3.	c.	3.	c.	3.
d. Mentally upset		__ __ __ __ __ __ __	4. Weakness/Paralysis		d.	4.	d.	4.	d.	4.
e. Infection; meningitis		__ __ __ __ __ __ __	5. Other		e.	5.	e.	5.	e.	5.
INJURY/ACCIDENT		SU M T W TH F S			Reported	Observed	Reported	Observed	Reported	Observed
a. Burn			1. Burn		a.	1.	a.	1.	a.	1.
b. Cut		__ __ __ __ __ __ __	2. Cut		b.	2.	b.	2.	b.	2.
c. Fracture		__ __ __ __ __ __ __	3. Fracture		c.	3.	c.	3.	c.	3.
d. Poisoning		__ __ __ __ __ __ __	4. Other		d.	4.	d.	4.	d.	4.
e. Other		__ __ __ __ __ __ __	5. Site		e.	5.	e.	5.	e.	5.

Do you suspect this was a case of: Measles ____ Mumps ____ Chicken Pox ____ Whooping Cough ____ Dehydration ____

CHANGES IN FOOD INTAKE (Fill in appropriate code number) SU M T W TH F S

CODES:
1. Usual Intake
2. Decreased
3. Caloric Liquids-no solids
4. Water, clear fluids
5. Nothing taken

__ __ __ __ __ __ __

__ __ __ __ __ __ __

CHANGE IN ACTIVITY
1. No change in usual activity
2. Moderate reduction
3. Bedridden
4. Critical

__ __ __ __ __ __ __

__ __ __ __ __ __ __

COMMENTS:

Revisit No.____ Date: __ __/__ __	Revisit No.____ Date: __ __/__ __	Revisit No.____ Date: __ __/__ __
FOOD INTAKE Use codes 1-5 ____ ____	____ ____	____ ____
ACTIVITY Use codes 1-4 ____ ____	____ ____	____ ____
WEIGHT kg. __ __ __ . __	kg. __ __ __ . __	kg. __

FIG. 8.3. (Continued) The individual weekly visit morbidity report form 312, page 4 of 5.

MORBIDITY HH. / / / / / TI No. / / / DATE /__ __ / __ __ / 8 __

ILLNESS SUBROUTINE REVISITS (1=YES 2=NO)

TASK REASSIGNMENT (LM, LF only)

TASK	Revisit No.____ Date: __ __/__ __		Revisit No.____ Date: __ __/__ __		Revisit No.____ Date: __ __/__ __	
	Helper	Extent of Help	Helper	Extent of Help	Help	Extent of Help
Salaried Job	___	___	___	___	___	___
Animal/Farm Work (own Shamba)	___	___	___	___	___	___
Housekeeping Compound Care	___	___	___	___	___	___
Child Care	___	___	___	___	___	___
Food Obtaining, Preparing, Cooking	___	___	___	___	___	___
Fetching water, fuel, etc.	___	___	___	___	___	___

HELPER CODES:

- 01 LM
- 02 LF
- 27 37 Target Schooler
- 10 Nontarget HH adult or adolescent (> 14 y.o.)
- 11 Nontarget HH schooler
- 12 Outside HH (neighbor/relative)

EXTENT OF HELP CODES:

1. Helped sick LM, LF
2. Took over task
3. No help given
8. Not applicable

ILLNESS SUBROUTINE TODDLERS - TODDLER RECALL FOOD INTAKE

24 Hour Recall

Revisit No. 1	Revisit No. 2

COMMENTS BY ENUMERATORS, NURSES, PHYSICIAN

(Impression, Treatment, Referrals, etc.)

FIG. 8.3. (Continued) The individual weekly visit morbidity report form 312, page 5 of 5.

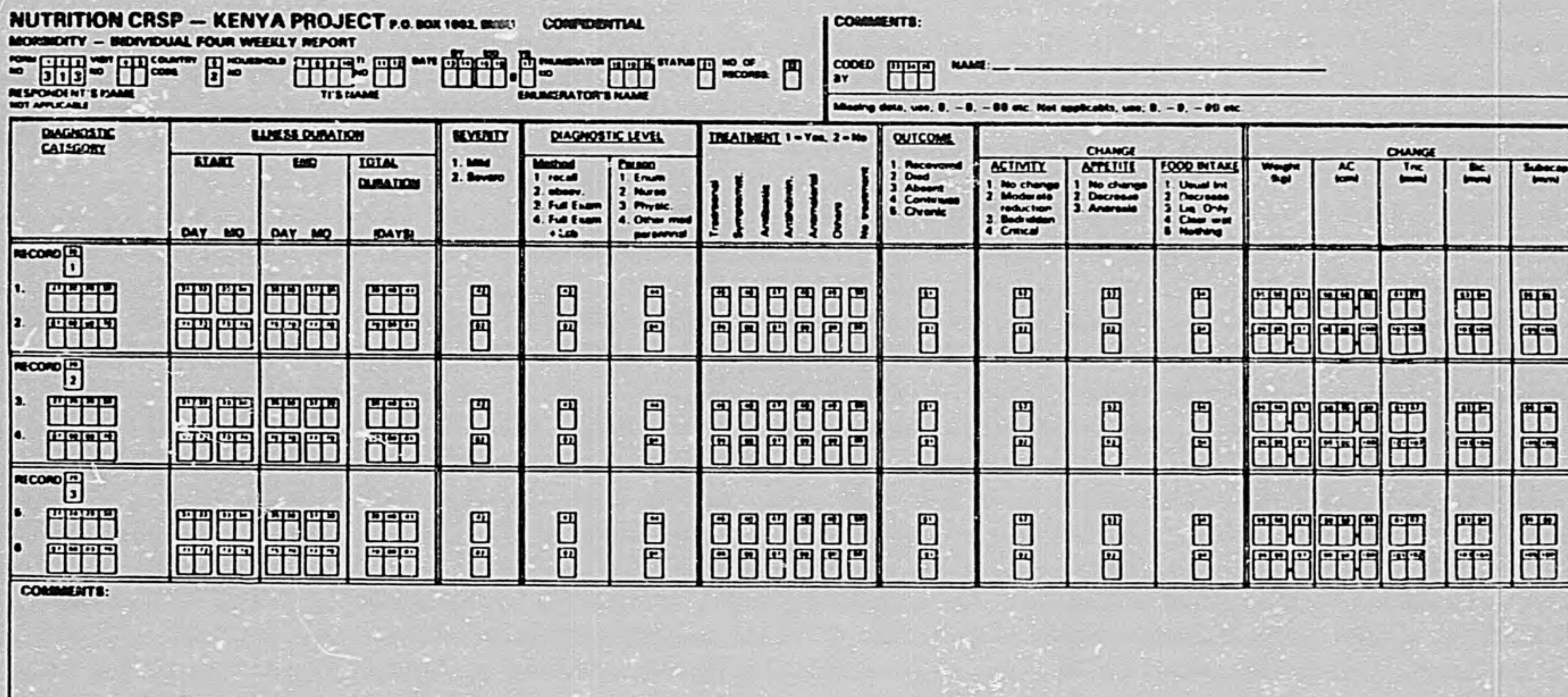


FIG. 8.4. The individual four weekly morbidity report form 313.

NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU **CONFIDENTIAL**

MORBIDITY — INDIVIDUAL FOUR WEEKLY REPORT

FORM NO 3 1 4 VISIT NO - 9 COUNTRY CODE 2 HOUSEHOLD NO TI NO DATE DY MO YR ENUMERATOR NO STATUS NO OF RECORDS

RESPONDENT'S NAME TI'S NAME ENUMERATOR'S NAME

NOT APPLICABLE

COMMENTS:

CODED BY NAME

Missing data, use 8, −8, −88 etc. Not applicable, use 9, −9, −99 etc.

DIAGNOSTIC CATEGORY	ILLNESS DURATION			SEVERITY	DIAGNOSTIC LEVEL		TREATMENT 1 = Yes, 2 = No						OUTCOME	CHANGES IN		TASK REASSIGNMENT LM and LF only						WEIGHT CHANGE
	START	END	TOTAL DURATION	1 Mild 2 Severe	Method: 1 recall 2 observ 3 Full Exam 4 Full Exam + Lab	Person: 1 Enum 2 Nurse 3 Physic 4 Other med personnel	Traditional	Symptomatic	Antibiotics	Antihelminthics	Antimalarials	Others	1 Recovered 2 Died 3 Absent 4 Continues 5 Chronic	FOOD INTAKE: 1 Usual int 2 Decrease 3 Liq only 4 Clear wat 5 Nothing	ACTIVITY: 1 No change 2 Moderate reduction 3 Bedridden 4 Critical	Salaried Job	Animal and Agric work in shamba	House keeping compound care	Child care	Obtaining of food preparation cooking	Fetching water, fuel	
	DAY MO	DAY MO	(DAYS)													Helper %	Helper %	Helper %	Helper %	Helper %	Helper %	D Kg
RECORD																						
1																						
2																						
RECORD																						
3																						
4																						
RECORD																						
5																						
6																						

COMMENTS:

Helper
01 = TI LM
02 = TI LF
27 37 = TI Schooler
03 = M HH Adult
04 = M HH adoles
05 = M HH Schooler
06 = person outside HH (relative, neighbour)

% (% share of help)
Helper acts LM & LF = 1
Took over task completely = 2
No help received = 3

D
Wt Loss = 1
Wt Gain = 2

FIG. 8.5. The individual four weekly morbidity report form 314.

144

NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002 EMBU **CONFIDENTIAL**

MORBIDITY — HOUSEHOLD FOUR WEEKLY REPORT — TARGET AND NON-TARGET INDIVIDUALS

FORM NO 3 1 5 · VISIT NO · COUNTRY CODE 2 · HOUSEHOLD NO · TI NO 1 1 · DATE DY MO YR 8 · ENUMERATOR NO · STATUS · NO. OF RECORDS

RESPONDENT'S NAME NOT APPLICABLE · TI'S NAME NOT APPLICABLE · ENUMERATOR'S NAME

COMMENTS:

CODED BY · NAME:

Missing data, use: 8, −8, −88 etc. Not applicable, use: 9, −9, −99 etc.

RECORD 1–6 · INDIVIDUAL ID · POSITIVE PROBE RESPONSES · INDIVIDUAL ID · POSITIVE PROBE RESPONSES

CODES FOR PROBE QUESTIONS (from face sheet).

01 Chills/Fever
02 Skin rash-Sores
03 Eye pain-Discharge
04 Ear Pain/Discharge
05 Sore throat/Cold
06 Cough/difficulty of breathing
07 Diarrhea
08 Vomiting/Abdominal pain
09 Pain on Urination
10 Genital Discharge
11 Joint Pain/Swelling
12 Convulsions
13 Headache
14 Other Communicable diseases (chicken pox, etc.)
15 Accident/Injury
16 Other illness

FIG. 8.6. Household four weekly morbidity report form 315 for target and non-target individuals.

TECHNIQUES OF DATA COLLECTION

Chronic Disease and Disability

The initial disease and disability history (Form 301) was completed for each member of a household (TI's and non-TI's) upon entry into study and thereafter at four monthly intervals. The presence of 21 different chronic and/or disabling conditions was asked for each household member. These 21 conditions were precoded with ICD code numbers (2). Other chronic or disabling conditions were recorded by name, and coded later with ICD codes by a physician. In-patient hospital admissions for illness and surgery were also recorded. This information was reviewed by the supervising nurse and project physician, and was important for the interpretation of weekly morbidity information.

An expanded version of Form 301 was introduced in March 1985 which allowed to be listed any household member who had been an inpatient in a hospital during the previous four months. The name of the hospital, reason for hospitalization, diagnosis, and treatment were recorded if available. In order to code this information, an additional 57 columns (64-120) were added to the form; more specifically, columns were devoted to the ID No. of the household member, dates of admission and discharge, primary and secondary diagnoses, and name of the hospital. All forms were checked by the project physician before data entry onto computer tape. Prior to March 1985 hospitalizations were entered under "comments" on Form 313 or 314.

Weekly Morbidity Data Collection

Morbidity data on illness episodes were collected through weekly home visits by enumerators. Visits were always made on the same day of the week for a given household. Although this may have introduced some bias, logistics dictated this technique, and illness by day of the week is being analyzed for possible "day" effect. A detailed description of the conduct of the visits is fully described in the morbidity manual.

After arrival at a home, an enumerator asked in Kiembu, "Has anyone in the household been sick today or in the past 6 days?" If the answer was "yes," the enumerator recorded a description of the illness using the respondent's own words. This applied to all members of the household. A set of probe questions was then used to remind the respondent of illnesses that may have been overlooked. The questions were asked for each TI and non-TI in a standardized way. Examples of these probe questions included: "In the past week or today has anyone had: Chills or fever? Pain, redness or discharge from eyes? Pain or discharge from the ears? A sore throat or cold? A cough or trouble breathing? Diarrhea or vomiting? Pain or joint swelling? A convulsion? Any accident or injury? Any other health problems?"

If illnesses not included in the probe were described, then these were noted in the space provided. If, during the probe inspection, an enumerator found a household member to be sick, even though illness had been denied on the probe, this was recorded and questioning proceeded using the individual morbidity report. The morbidity of all household members was recorded on the morbidity face sheet.

If a target individual was reported to have become sick in the past week or on the day of a visit, the appropriate sections of the individual morbidity report were completed and a physical inspection of the sick individual was carried out. If a question was not understood, it was repeated but no explanation or re-wording was given. Details of the illness including where the person had gone for medical care, who provided such care, the diagnosis, type of treatment, and medication were recorded. If a health center, clinic, or hospital was visited, the enumerator requested to see the clinic or hospital card and reviewed the finding and treatment given if these were recorded. In order to track the duration of an existing illness, enumerators carried the worksheets from previous illness episodes reported in earlier visits in order to record when the episode ended.

If a probe was negative and if no obvious illness was noted among the household members present, the interview ended and the enumerator proceeded to the next household.

To summarize, the weekly household morbidity face sheet (Form 312) was filled out for illness among household members during the weekly home visit, and the more detailed individual morbidity form was filled out for TI's found to be ill.

Target Individual Morbidity Report

If illness was reported for a TI, either during initial questioning or in response to a probe question, the enumerator filled in the Individual Morbidity Worksheet (Form 312). One worksheet was completed for each TI in the household who had signs and/or symptoms of illness. Both general signs and symptoms (fever, chills, headache) and the specific signs and symptoms listed under the appropriate category were asked for each TI's complaint(s). If a probe was negative for a given TI, yet illness was observed, an individual morbidity report was filled out and the illness added to the household morbidity sheet. For example, if a person had discharge from the eyes and/or a cough, questions were asked from the general section as well as from the eye and respiratory sections. If diarrhea was reported, the actual number of stools (day and night), the number of usual stools, and a description of the stools (watery/loose, bloody, mucous) were recorded. For any reported injury, the details were recorded as to where and how it occurred, the size of the injury and its location on the body.

Household Morbidity Report

Morbidity among non-TI's was coded by diagnostic categories onto Form 315 rather than by more specific diagnoses as was made for TI's. Household morbidity was reported as period prevalence without duration and no true incidence, as no attempt was made to ascertain the starting or ending dates of the illness. Questions that were not applicable to certain age groups, were coded as "not applicable."

Observations Of Illness Signs

Enumerators were trained to look for specific signs of illness on any TI reported to be sick. If the sick person was not present at the time of the visit because he or she went to the clinic or hospital, as much recall information as possible was obtained from the respondent and the sick individual was labelled "not available for inspection". The community nurse was informed about all sick individuals not present for observation and determined whether or not a sick person should be revisited later that day or on the next day.

Physical inspection procedures were standardized through repeated training of enumerators. Respiratory rate was counted as breaths per minute (counted for 15 seconds x 4). Body temperature of adults and schoolers was taken with a centigrade thermometer by mouth and axillary temperatures were taken on toddlers and infants, with the thermometer kept in place for three minutes; for infants or toddlers with serious illness or vomiting, a nurse or physician obtained rectal temperatures. If a skin problem was noted, description of lesions included size and extent, if they were raised or flat, wet or dry, etc. For children with diarrhea, the stool was inspected whenever possible to determine if it was green, watery, bloody, mucoid, etc. Also, compound grounds were inspected for evidence of diarrheal stools where a child may have defecated. For an injury, the part of the body injured was recorded as well as the extent and description of the injury itself. Ears were inspected for purulent or other discharge, and eyes were inspected for purulent discharge, loss of shininess, redness, obvious injury or other abnormalities.

The duration of each symptom and sign was reported as the actual number of days since the illness had started. Enumerators carried the "Individual Morbidity" worksheets (Form 312) from a previous week's illness to verify the number of days of illness.

At the bottom of each morbidity form, the enumerator indicated if she thought an illness was a case of measles, mumps, chicken pox, whooping cough, dehydration, pneumonia or malnutrition. This was done to flag the physician's or nurse's attention to the possible presence of the above conditions.

Qualitative Food Intake And Activity Score During Illness

Levels of food intake and activity during illness were scored on five-point and four-point scales, respectively. Scores for food intake were:

1 = Usual intake, no change in eating or appetite
2 = Decreased intake of solids and liquids
3 = Liquids with some caloric value taken, such as milk or thin gruels, thin stews or soups, or tea with milk and sugar
4 = Only water or other clear fluids taken
5 = No liquid or solids taken by mouth.

Activity scores were:

1 = No change, TI goes about usual activities as when they are well
2 = "Moderate" reduction - definite decrease in usual activities but still "up and about"
3 = Bedridden - confined to bed, carrying out few if any usual activities but able to get up for toileting, etc.
4 = Critical - completely bedridden, unable to do anything for themselves, extremely weak or hospitalized

Illness Subroutine

Nurses reviewed all forms in their clusters at the end of each day for completeness and accuracy, and to determine whether households should be revisited. Revisits were made to TI's whose illnesses started within 24 hours of the home visit or on the day of visit, except in cases of children with measles, pneumonia, severe diarrhea or whooping cough who were revisited regardless of the starting date. Revisits were not made for minor skin, eye, upper respiratory infections or for minor symptomatic ailments such as backache, indigestion, and heartburn. Revisits were carried out on any individual with any puzzling or worrying illness, and the nurse determined if a physician's visit was warranted.

Second and third revisits were carried out for serious illnesses that were not likely to be resolved before the next regular weekly visit. Revisits were conducted to verify the diagnoses and to alleviate staff concern regarding the subjects condition, not for data collection purposes. Recovery was recorded after the target individual was free of illness by recall and observation for forty-eight hours. Following an illness, at least three sign and symptom-free days had to occur before any recurrence of the same signs and symptoms were counted as a new episode of the same illness. During a revisit a nurse or enumerator asked the respondent the same questions about signs and symptoms, and carried out the same physical inspection as for the initial morbidity report. The food intake and activity scales were also completed, but obtaining body weight did not prove to be feasible.

Illness Verification

Illnesses which were considered as conditioning infections for malnutrition (e.g. measles, diarrhea) or were otherwise serious or life threatening were verified by a project nurse or physician. Conditions needing verification were: suspected pneumonia, diarrhea with stools exceeding ten per day, any diarrhea with vomiting in infant or toddlers, possible dehydration, measles, pertussis, fever over 40 degrees C in adults and schoolers, temperatures over 38.5 degrees C in infants and toddlers, headaches over seven days, rash with fever, fever and vomiting in infants and toddlers, suspected kwashiorkor or marasmus, and the death of a TI. The physician or nurse wrote their clinical impression on the morbidity form. Any deaths were recorded on a Mortality Notification form.

Illnesses with a duration of $\geq$8 weeks were designated as chronic. A person suffering from a chronic illness as diagnosed by the physician and identified on the chronic morbidity form was followed for that illness only during the regular weekly morbidity visits.

Task Reassignment Subroutine

In February 1985, enumerators began asking the task reassignment questions (Form 312, p.5) for each lead male and lead female who had a reduction in activity due to illness. Six categories of tasks were investigated: salaried job, animal/farm work, housekeeping/compound care, child care, food acquisition/preparation, and fetching water/fuel. Two questions were asked for each category: who was the helper, and what was the extent of help given. Whenever a nurse or physician visited an ill TI, the assessment and any treatment given or referrals made were recorded in the comments section of the form. If a TI was seen in a clinic or hospital or by another health care provider, the medical card was reviewed for diagnosis and treatment and this information was recorded on the worksheet.

Illness Intervention

Nurses reviewed worksheets daily to decide if any intervention was needed. When enumerators found a serious illness, such as the presence of severe abdominal or chest pain, significant trauma, early labor during pregnancy, seizures, or loss of consciousness, they reported this immediately to the cluster nurse and/or project physician. A home visit was then made by the nurse or physician who provided first aid, started treatment or made a referral to a hospital. Respondents with serious or life threatening illnesses were offered transportation to a local health facility. The field physicians were always in radio contact with the field staff.

Simple first aid was taught to enumerators to deal with minor emergencies. Minor ailments were treated symptomatically by nurses with aspirin, antacids, or decongestants. This was documented on the worksheet. Suspected malaria cases were treated with chloroquin after a blood smear was taken by the nurse. There was an awareness among project physicians, nurses, and enumerators of the importance of not interfering, to the degree possible, with the normal process of obtaining health care in the study area. This, however, proved to be increasingly difficult. A major concern of local health authorities and CRSP participant institutions was that the project not set up a temporary and unrealistic health care system that would be withdrawn when the project ended.

Coding Morbidity Data

Beginning in April 1984, all morbidity data were coded by 4-week periods. The identical period was used for all households. Prior to this, periods coinciding with actual calendar months were used. Adjustments for the earlier data have since been made.

Household Morbidity

The Egypt and Kenya projects decided to use the same basic morbidity coding system. ICD codes have also been assigned to illness entities (1) (Appendix C). Household morbidity was coded by an enumerator under a nurses's supervision for each household on a weekly basis upon return of the enumerator from a visit. The four weeks of each coding period were aggregated onto Form 315. This form lists the TI's and non-TI's by identification number, plus any illnesses recorded for each week of the coding period. Since the form is a four-week report, a symptom such as "sore throat" could be listed more than once if an illness lasted over one week. Duration was not coded; the information yielded is mainly period prevalence.

Individual Morbidity

Forms 313 and 314 were coded after the end of a four-week morbidity data collection period. Each diagnostic category which had been provisionally filled out by enumerators immediately after home visits was now definitively coded by the nurse, using the list of morbidity codes in the Morbidity Manual, and checked by the physician. Duration was coded from the information on the individual worksheet which indicated the start and end of a given illness. Prior to April 1985, if an illness continued into the next period, a "-8" was entered to flag its continuation. If the illness continued throughout an entire period, the first and last days of the period were designated as "-8". The maximum duration on a form for a given period was 28 days. As of April 1985, the actual start and end of an illness was recorded and the first and last day of the period was recorded if the illness continued for an entire period in place of -8's. The total duration was then summed by the computer combining all days from each period as necessary. Severity of illness was determined by using pre-selected criteria as stated in Appendix D.

Diagnostic level was selected from four hierarchial categories: 1) recall (no observation of illness); 2) observation by either the enumerator, nurse, or clinic or hospital staff; 3) full examination as performed in a health center or hospital or by the project physician; 4) full examination plus laboratory tests, such as blood smear or stool exam. The person making the diagnosis was also selected from four hierarchial categories: 1) an enumerator, who obtained the information by recall or observation; 2) a nurse, either from the project, clinic or dispensary; 3) a physician, either from the project, mission hospital or Embu Regional Hospital; 4) other personnel, which usually meant a clinical officer in the health center or a private practitioner.

In coding the diagnostic categories, the "best" or most "expert" diagnosis was chosen. This pertained mainly to TI's seen at a clinic or admitted to a hospital who had a specific diagnosis made based on a full physical examination or laboratory investigations.

There were six categories of treatment requiring a yes or no answer. The categories included: 1) traditional -- either a home remedy or treatment by the local healer; 2) symptomatic (antacid, aspirin, etc.); 3) antibiotics -- either self-administered or prescribed by health personnel; 4) anti-helminthics, usually prescribed by health personnel; 5) antimalarial, often self-administered; and 6) other. Duration of treatment or exact dosage was not coded.

Outcome had five categories including: 1) recovered; 2) died; 3) absent; 4) continuing; and 5) chronic. For the Activity and Food Intake section, the highest (worst) activity and food intake scores obtained on any day of an illness were assigned for the entire period of illness or concurrent illnesses. Every code sheet was checked by the project physician before the record was sent for final editing and computer entry.

Because of the possibility of confusing "absence of illness" or "wellness" with the absence of a TI or household informant, a code was used to indicate the numb[illegible] actual visits to a household with an informant present per four-week period so that data could be collected. F[illegible]uary 1984 to April 1984, the number of visits expected per coding period and the number of visits completed were recorded on Form 315 columns 72 and 73. This ensured that the proper denominator was obtained. After April 1984 since coding periods were changed to 4 weekly periods only actual number of "completed" visits were recorded on Form 315 column 73.

Physical Examination

Enrollment for Physical Examinations and RMR

One week before target individuals were to come for scheduled examination and/or RMR visits the enumerator informed the family and explained all of the procedures. The nurse or enumurator reminded the family the day before the visit and the families were instructed to bring all of their immunization records and clinic and hospital records for the target individuals. The nurse or enumerator distributed clearly labelled stool cups and instructed the parents on methods of obtaining stool specimens on all TI's within 24 hours of the examination. Also, the nurse reminded the LM, LF, and schooler (who were to have RMR studies) to refrain from eating from 7 am on the day of the RMR examination. Adults were told not to smoke or do heavy physical work the morning before they came for the testing. A vehicle brought the families to the laboratory.

Procedure for Health History and Clinical Examination

A health history and physical examination were administered to all target individuals within the first two months of entry into the study, and approximately every six months thereafter. Pregnant women were also seen at 5 and 8 months of pregnancy, in the post-partum period, and at 6 months following delivery. Newborn infants were examined within three days of birth and again at six months of age. After the initial health history, for any repeat examination, an interval history was obtained instead of repeating the full medical history. For acute illness, during a scheduled physical examination, a history of the acute illness was also obtained. The procedures were organized as follows:

1. Urine samples were obtained during the examination. For toddlers a urine collection bag was put in place prior to blood drawing and examination.

2. Vision testing was performed while the study subjects were waiting for the history and physical examination to be done.

3. Intradermal skin testing and blood drawing were performed after the physical examination (to ensure that the respondent did not become too upset to cooperate).

4. Stool specimens were brought in by the families at the time of examination. Instructions for collection of stool specimens and prelabelled stool containers were distributed during the enrollment visit by the community nurse the day before the examination.

Every effort was made to have people move through the examination and RMR procedures as quickly as possible for fear of jeopardizing their continued cooperation and good will.

<u>Specific Procedures</u>

Blood Pressure

Blood pressure was measured with subjects sitting quietly in an individual examining room. The blood pressure cuff covered 2/3 of the upper arm. Blood pressure was obtained on all schoolers and adults. In recording diastolic pressure the point at which the sound suddenly diminished was recorded, and considered the diastolic pressure. The procedure was repeated twice and, the second reading was recorded as well.

Vision

The vision testing was done at exactly 20 feet from the eye chart which was positioned at 5 to 6 feet above the ground or floor in a well lit area. Each eye and then both eyes together were tested. The Snellen scores were recorded as follows: e.g. 20/20; 20/40; 20/200. The score 20/20 is equated with normal vision, while 20/200 implies very limited vision. The first number refers to the fact that the eye chart is 20 feet from the person being tested. The next number refers to the last line that the person can read correctly. (Two errors per line were allowable). A score >20/40 was considered abnormal. For the toddlers, vision testing was carried out during cognitive testing in the homes. (The U.C. Berkeley Preferential Looking Test; see Chapter 10.)

Immunization History

A complete immunization history was obtained on all infants, toddlers and schoolers. Children's immunization cards were consulted, and BCG scars noted. Pregnant women were asked if they had received tetanus immunization. It was the policy of the project staff to urge that all infants, toddlers, and pregnant women obtain immunizations.

Body Temperature

Body temperature was obtained on all targets. Use of the paper disposable tempa-dots were discontinued as they deteriorated under field conditions, and were replaced by mercury thermometers (oral route). Rectal temperatures were obtained for 6 month old infants, and for toddlers axillary temperatures were recorded. The nurses were instructed to place the thermometer deep in the axilla in contact with the skin and not over clothing. Thermometers were left in place for 3 minutes prior to reading. Oral thermometers were placed under the tongue and left in place for 3 minutes.

Intradermal Skin Tests

Test materials were injected intradermally (not subcutaneously) so that a bleb, (a bubble), was raised upon injection of the material within the skin layer. Skin test placement was carried out uniformly according to a map on the volar surface of the lower arm. After injection, the syringe barrel was drawn back to be certain that a blood vessel was not entered. A separate disposable syringe and needle was used for each skin test; 0.1 ml of each antigen was used. The arm was cleansed with an alcohol swab before injecting test material.

Left Arm	Right Arm
PPD [Tuberculin Unit (TU)]	Candida (Monilia) 1:1000 dilution adults
Adults 1 TU	1:100 dilution children
Children 5 TU	Tetanus toxoid - used only for children who were most
(unless known to have TBC,	likely immunized against tetanus.
in which case 1 TU was used)	

Because the tests were slightly painful, subjects were told in advance that the injection would "sting." The tests were read after 48 hours. The largest diameter of induration (raised area) was reported. The edges of the induration were marked with a pen to facilitate measurement. A finger was run over the test area to detect the induration. The area of redness was not recorded. No induration was recorded as zero, a negative test. If a reading was not obtained at 48 hours post-injection, then the test was read at 72 hours and the elapsed time since injection recorded. The community nurses were informed which tests were to be read and recorded the results on the appropriate forms.

Grading of Thyroid Size

Thyroid size was assessed by visual inspection and by bimanual palpation with the head in normal position, with the head hyper-extended, and during swallowing. The following criteria for grading were used (3).

Grade 0 - not palpable

Grade 1 - palpable goiter. Cannot be seen with neck in normal position. May be visible when neck is extended.

Grade 2 - visible goiter. Visible with neck in normal position.

Grade 3 - grossly enlarged thyroid; visible from a distance of 5 meters.

Grading of tonsillar size

Tonsillar size was graded in infants, toddlers and schoolers by physical inspection. The grading method has been used in other studies of immune function and nutrition, (4,5) and it reflects the effects of PEM in lymphoid tissue and correlates with other cell mediated parameters (E rossettes, delayed cutaneous hypersensitivity). Tonsillar grading is as follows:

0 =trace or no tonsillar tissue seen.

1+ =tonsils clearly visible but do no exceed beyond faucial area

2+ =tonsils enlarge beyond arch but not beyond midpoint between arch and uvula

3+ =tonsils extend beyond midline between arch and uvula; may even touch in midline

The absence of tonsillar tissue, or the presence of 1+ tonsillar size in toddlers and schoolers is considered reduced lumphoid tissue. Infants generally have 1+ to 2+ tissue.

Physical Signs of Nutritional Deficiency

The physical signs used to detect nutritional deficiencies were those which, according to WHO, have a high degree of specificity for nutrient deficiencies (6). These assessments were carried out by the physicians and clinical officers. A color atlas (1) and colored slides and clinical case material were used for training.

QUALITY CONTROL MEASURES

Quality control measures undertaken by the Morbidity study included: intensive preliminary and ongoing staff training; monitoring of enumerators; data collection visits accompanied by supervisory nurses and project physicians; periodic evaluation of nurses by physicians; reinterviews on a random 5% subsample of households; comparison of weekly morbidity data with the physicians' biannual examination records; blind recoding 1984 data from Form 313 onto Form 314 and a comparison of percent agreement of diagnostic categories; the rotation of staff; and a validation study for diarrheal disease.

The supervisory nurses and/or the project physicians accompanied each enumerator one morning each week on household visits to observe data collection and provide instant feedback to the enumerator. The nurses also checked the morbidity forms daily and discussed problems, questions and errors with the enumerators. Physicians also spent half a day per month with each nurse to evaluate their performance and furnish instant feedback about data collection, recognition of diseases, clinical skills, and general supervisory skills.

After the initial intensive training sessions, didactic sessions were held at least once every month. The project's Morbidity Manual and a published manual were given to each nurse for constant referral by each cluster's morbidity team (7).

Starting in March 1985, formalized morbidity reinterviews were carried out whereby households were visited on the same day as the regularly scheduled enumerator visit but several hours later. This was done on a 5% subsample of households in each cluster, selected at random. The nurses performed these revisits in clusters other than their own and recorded the data on the standard morbidity forms (a "9" was coded in column 17 on Forms 314 and 315 which designated the year as 1989; the actual day and month entered in their respective columns). After two months of revisits by the nurses, the enumerators began making the quality control revisits as it was felt that their findings would be more comparable. These revisits were made either in the afternoon on the same day or sometime the next day. In order to make the comparisons valid, a one-day coding for the original visit was done. This original visit recoding was also coded with a "9" in the year but, to differentiate it from the quality control revisit, column 23 was coded with a "1" for the original visit, and with a "2" for the quality control visit. Columns 24-25 were coded with the ID of the respondent giving the information. These quality control measures were performed from June 1985 through the end of the study.

Comparisons will be made between the morbidity data reported by enumerators and the data identified by the physician at the biannual physical examination. The morbidity data collected for the week preceding, coinciding, and/or following the physical examination are to be used for comparison purposes.

Due to a turnover in project physicians and some inconsistencies in coding Form 313 in 1984, a 10% subsample of these forms were recoded "blindly" onto Form 314 by the senior field physician and his staff in 1985. This invovled the physician reviewing the morbidity raw data forms and drawing diagnostic conclusions independently of the originally coded diagnostic category. Clusters 1 and 2 showed less than a 5% disagreement in coded diagnoses, whereas Clusters 3 and 4, where the initial coding was not consistently supervised, showed disagreement as high as 25% (with 30% fewer diagnoses coded over a seven month period in 1984 based on the recorded raw data observations and recall). Because of this high disagreement for Clusters 3 and 4, the raw data for this period were recoded by the senior field physician and his staff in 1985. The final morbidity data set for 1984 thus includes seven months of recoded data for clusters 3 and 4.

Nurses were rotated from cluster to cluster at least once during the main study, and enumerators were rotated periodically to various households within a given cluster. Because of the disruptiveness and difficult logistics involved in moving enumerators, and to prevent interference with the trust built up between them and households, they were not rotated to different clusters.

A variety of measures were undertaken to ensure that quality data were collected during the biannual physical examination. Periodically, all subjects seen on a particular day were reexamined to ascertain the degree of agreement, signs of nutritional deficiency detected and of thyroid and tonsil-size recorded. Also, on occasion, two physicians compared findings and sought consultation from each other. These quality control measures were carried out approximately every two to three months after the initial training.

Blood pressure and temperature readings (taken by the nurses) were checked by the physician about once per month although not entered in the data set. Skin test reading was checked one per week by the supervising community nurse. Her readings were in turn checked by the physician. Unfortunately, these repeat quality control measures were not entered into the computerized data set.

During July 1985 a number of validation studies were done for diarrheal illness. Stools were collected for all infants and toddlers and sent to the laboratory for inspection by the technician and physician. The stool descriptions and results of the laboratory were then compared with the mother's description. Of the stools reported as representing an episode of diarrhea, 71% were classified by the laboratory as being loose or watery. Of the stools not reported as diarrhea, 15% were loose. The validity of the mother's recall of the child's stools was assessed by direct observation in 38 homes. Of the 38 mothers, 47.4% recalled the number incorrectly, 42.2% were incorrect by 1 stool and 7.9% by two stools. The average of the differences between observed and recalled numbers is -.11, the bias indicating a tendency for underestimation of recalled stool number (8).

PREPARATION OF DATA FOR ANALYSIS

Morbidity is to be used as a set of outcome or dependent variables as well as explanatory or intervening variables. Morbidity is to be described for each household and each target individual.

Household Morbidity

Household morbidity is described as period prevalence (periods of one week). No duration or incidence data is reported. Therefore, an illness that lasted for three weeks could be counted three times for a given four-week coding period. The categories used are those on Form 315, the illness categories covered by each probe question. As for household intake, the number of household members at risk for illness is based on the quarterly census forms, and prevalence will be adjusted according to the changing denominator. Household morbidity can be used as an outcome measure for household Energy Intake, sanitation and as an intervening variable for individual morbidity.

Target Individual Morbidity

Before describing the Morbidity Index, it is important to define the terms "wellness," "low-grade illness," "significant illness," and "serious illness."
Wellness is defined as episodes during which no illness was reported to be present. Wellness can be expressed as the:

1. Total number of days of wellness
2. Number of wellness episodes and average duration of wellness episodes per time period

A wellness episode is defined as a minimum of two consecutive sign and symptom free days as determined by the morbidity team personnel using the standardized probe questions and observations. As described previously, the number of visits expected per coding period and the number of visits completed were recorded as Form 315 to ensure that the proper denominators were used.

Low-Grade Illness (LGI)

Low-grade, or mild, illnesses are usually of high prevalence and often of long duration (frequently over two weeks), and may reflect poor environmental conditions rather than defects in host defenses impaired by malnutrition. There are usually few or no constitutional signs noted and little or no decrease in food intake or activity. However, this is not to say that high prevalence and long duration of LGI illnesses may not be without adverse effects on the host or be an expression of slightly impaired host defenses. Illnesses classified as low-grade are found in Appendix C. Examples include common colds, conjuctivitis, impetigo, etc.

Significant Illness (SI)

Significant or moderate illnesses may be accompanied by fever and by some diminution in activity and/or food intake. They are usually infectious diseases with systemic signs and symptoms, or deep-seated foci of infection such as abscesses. Some of the illnesses in this category had been designated as "severe" according to a pre-defined set of criteria which had been worked out in 1983 by the three Nutrition CRSP projects in common. Severity codes are "1" = mild; "2" = severe. (See Appendix D).

Serious Illness (SSI)

Serious illnesses include most of the illnesses that were previously designated as "severe" according to a pre-defined set of criteria referred to above (see Appendix D). These illnesses have profound systemic signs and symptoms, and are most often accompanied by fever with moderate to marked reduction in activity and food intake which may lead to hospitalization. Earlier preliminary analyses of the disease entities coded as "severe" ("2") showed statistically significant associations between illnesses designated as severe and decreased food intake and activity scores.

The illnesses falling within the SSI category are those that were verified and evaluated by project physicians and the frequently required intervention if not hospitalization.

There are a variety of ways to summarize morbidity experience or illness burden:

1. Total days due to all illness episodes
2. Total days sick by:
    a. Major diagnostic categories 01 to 15 or more specific categories under 01 to 14 (see Appendix C)
    b. By diseases of infectious origin
    c. By diseases of non-infectious origin
    d. By severity: See definitions below and Appendix D
        i. Low-grade illness, LGI, (mild)
        ii. Significant illness, SI, (moderate)
        iii. Serious, SSI, (severe)

Food intake is often affected during significant and severe disease (as seen in this study). However, since food intake is the independent variable, the factor "reduction in food intake" has been removed from the morbidity index, both with significant as well as serious illness so as to be able to analyze the effect of food intake on illness severity.

Morbidity Index (MI)

For analytic purposes, it is necessary that the morbidity burden or experience for each of the target individuals and the household be expressed as a single numerical value (Appendix D). Because of the known interaction of nutritional status and infection, the illnesses of infectious origin are given greatest emphasis. Illness other than infections are also included since it is well known that neurologic, emotional illness and neoplasia can interact strongly with food intake and nutritional status. The MI reflects decreased function, duration, severity, and probable metabolic impact on the sick individual (9,10).

The morbidity index is comprised of illnesses and their descriptors for a designated time period. Separate scores or indices constructed for low-grade, significant, serious illness. For each illness episode, the descriptors are a weighting factor reflecting e.g. severity, and scores for activity and duration. Each illness episode and its descriptors are summed for prescribed periods e.g., 4 weeks, 8 weeks, 12 weeks, etc.

Studies have shown that the "energy costs" attributable to selected infectious types of illness in order of decreasing magnitude are measles, fever, diarrheal disease, lower respiratory disease, and other severe infections (4). For significant and serious illness, the first week of the illness is weighted more heavily than the second week, the second week more heavily than the third week, etc. The illness designated as "serious" (SSI) receive greater weighing than those designated as "significant" (SI). For low-grade (LG) or minor illness it is assumed that all days have similar impact and no differential weighting is assigned. For detailed description please see Appendix D.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS: MORBIDITY

A summary of the major findings based on the weekly morbidity survey, quarterly chronic illness survey and biannual physical examinations are presented in the following sections.

Description of Morbidity

Morbidity is presented as total numbers of new illness episodes for each target individual (1984 and 1985 incidence) based on the summation of the four weekly morbidity reports (if an illness lasts 8 weeks it is only counted once). Various types of morbidity are presented as percentages of the total illness episodes and the number of target individuals contributing to the total.

Total Morbidity: All Target Individuals Combined

The total morbidity episodes for all targets combined are presented for 1984 and 1985 by large diagnostic categories and then for 1984 and 1985 separately. Also, diagnoses are presented month by month. This represents data from approximately 875 target individuals (contributing 875 person months of data) in 1984, decreasing to about 600 TI's in 1985 (contributing 600 person months of data) as households completed the study. The proportionate morbidity by diagnostic categories for 1984 and 1985 with all target individuals combined is presented in Table 8.1.

Respiratory illness, mainly acute upper respiratory infections and the common cold; digestive tract illness, largely diarrhea, vomiting and abdominal pain; fever which includes clinical malaria; and eye and skin infections comprise most of the "infectious" illnesses. The high proportion of illnesses attributed to the category "Extremities and Musculo-skeletal System" are mainly confined to the adults and commented on below. Headaches comprise a large portion of the illness reported under "nervous system."

Total Morbidity by Month for 1984 and 1985

Total morbidity, all targets combined, is presented for 1984 and for 1985 by large diagnostic categories and month by month in figures 8.7 and 8.8. The population contributing to the morbidity is approximately 875 person months in 1984 and 600 person months in 1985.

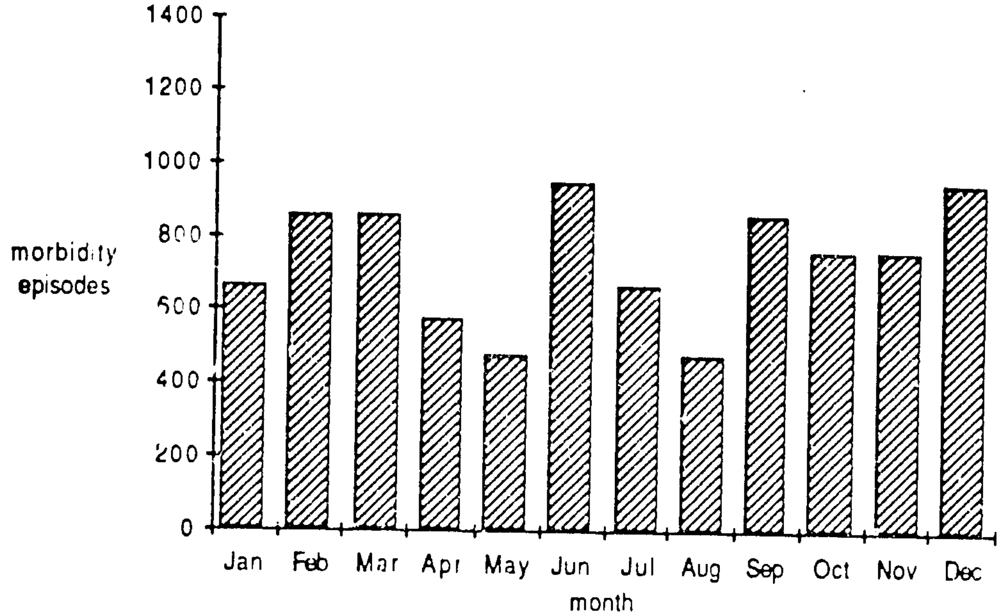


FIG. 8.7. Number of morbidity episodes (all illnesses combined) in 1984 by month for all target individuals. (total number of episodes = 5085, number of individuals approximately = 875)

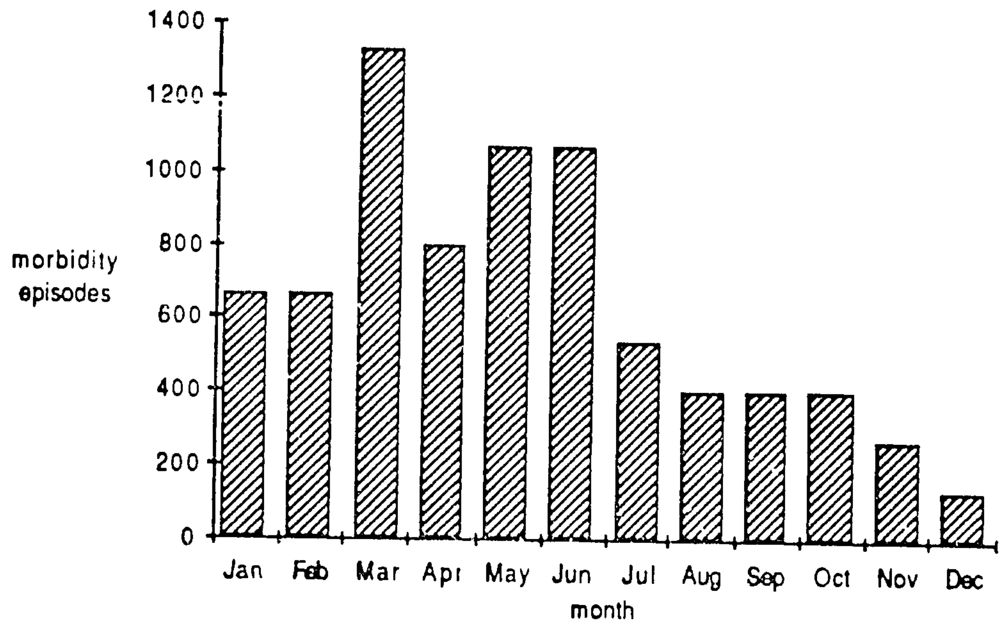


FIG. 8.8. Number of morbidity episodes (all illnesses combined) in 1985 by month for all target individuals. (total number of episodes = 2128, number of individuals approximately = 600)[1]

1 Sample size decreased drastically during the last months of 1985 with this accounting for the low number of episodes in the last 6 months.

TABLE 8.1
Proportional morbidity based on illness episodes for all target individuals by diagnostic category, 1984-1985.

Diagnostic Category	% of Total Episodes
Skin	8.4%
Eye	9.0%
Ear	1.1%
Oral Cavity, Mouth, Teeth	2.4%
Respiratory illness	35.3%
Cardiovascular illness	0.2%
Digestive Tract	10.7%
Genital Urinary	1.0%
Extremities Musculo-skeletal system	13.7%
Nervous System	6.7%
Communicable Disease	0.2%
Fever with no other signs	10.8%
Total No. of illness episodes for 1984 to 1985	1885
Population at risk	1475 person mos.

Of note is the finding that the relative illness level, in general, is higher in 1984 compared to 1985 with a slightly higher illness incidence in January and February 1984. Adjusting for the sample size, the period starting from July 1984 through December 1984 has nearly double the morbidity (1.7 times as great) compared to the same months for 1985. This is precisely the period in 1984 during which there was a drought and famine. The main difference in types of illness between the two years is that there is a slight decrease in eye, respiratory, and digestive tract infections in 1985, but none of these are greater than 3% and are not significantly different. The morbidity pattern is very similar for the two years except for the famine-associated increase in morbidity in 1984.

Morbidity by Season

There appear to be definite seasonal patterns for amount and type of illness in 1984 and 1985 (see Figs. 8.7 and 8.8). March and June in both years have the highest illness incidences. Illness in January and February in both years is also relatively high. March is usually a warm month just before the long rains and June begins the cold weather, which extends to September. Respiratory illnesses are seen mainly in the coldest months from June through August. Diarrheal disease, with a less clear seasonal pattern, seems to be most prevalent in September through November when it is beginning to become slightly warmer and the "short rains" start. Skin and eye disease seem to be prevalent throughout the entire year but with a slight increase in eye infections in September and in skin infections in January through March, the hot and dry season. Malaria is endemic and present at equal levels throughout the year. Fever shows a slight increase in August, a cold month.

Proportional Morbidity by Target Individuals

The relative frequency of episodes and the rate of the most frequent disease categories as the number of cases/1000 target individual weeks (incidence rate) for each target type are presented in Tables 8.2-8.9.

Among all target individuals, the most common illness is acute resperatory infection or referred to as URI, with 17.4% of illness days. Clinical malaria, the next most common illness, was generally diagnosed by the respondent. There was seldom laboratory confirmation of the diagnosis of malaria, but when blood smears were taken by the field nurse or enumerator, malaria parasites were frequently found. Chest pain, headache and backache are the next most frequent illnesses among LM, accounting for about 22% of all illness days. Most of these symptoms are probably accounted for by the heavy physical work performed by the men. Other musculoskeletal and soft tissue injury account for 8.5% of illness days. Abdominal pain was not a significant complaint in this population, although two men did have peptic ulcer diagnosed by x-ray. Bronchitis, a significant lower respiratory illness, accounted for 3.8% of the illness days. The category "all other" consisted of a few episodes (0.3 to 1.5%) of morbidity due to low grade illnesses, e.g. dental caries, toothache, otitis externa, sexually transmitted disease, and tuberculosis. Notable by their low prevalence are diseases of skin, eye, ear, nose, diarrhea, vomiting, and gum and tooth problems. This may represent underreporting as lead males were frequently not at home during the morbidity home visit and these low grade illnesses may not have been reported by the lead female.

TABLE 8.2
Proportional morbidity and the rate of the most frequent disease categories among lead males (n=247).

Diagnostic Category	Proportional Morbidity # of Episodes	 % of Episodes	Morbidity Rate (Incidence) # of days/ 1000 TI weeks
URI	479	19.0	404
Clinical malaria	387	15.0	291
Chest pain	219	8.6	215
Backache	117	4.6	176
Headache	171	6.7	128
Other musculo-skeletal	85	3.3	112
Abdominal pain	122	4.8	98
Bronchitis	62	2.4	89
Soft tissue injury	85	3.3	84
Other respiratory	67	2.6	73
All other	75	129.5	65
Total	2545	99.8	

TABLE 8.3
Proportional morbidity and the rate of the most frequent disease categories among lead females (n=247).

Diagnostic Category	Proportional Morbidity # of Episodes	 % of Episodes	Morbidity Rate (Incidence) # of days/ 1000 TI weeks
URI	813	18.0	792
Backache	276	6.2	429
Chest Pain	317	7.0	366
Headache	405	9.0	362
Clinical malaria	475	10.6	332
Abdominal pain	239	5.3	211
Other musculoskeletal	139	3.1	190
Conjunctivitis	133	3.0	151
Bronchitis	111	2.5	128
All other	1561	35.0	1468
Total	4469	99.7	

Upper respiratory infections (URI) for lead females is almost twice as frequent as for the lead males (792 vs 404 illness days/1000 TI weeks). In fact, women reported more illness in most categories and often twice as much. The notable exceptions are malaria (332 vs 290 days/1000 TI weeks) and chest pain (366 vs. 290 days/1000 TI weeks). Men have more soft tissue injuries, arthritis and sprains than women. Backache, chest pain and headache account for 26% of illness days in women, vs. 22% for men, but women have 1157 days/1000 TI weeks, while men only have 594 days. Backache lasts longer than other illnesses (6.2% of the episodes and 9.7% of the illness days, while clinical malaria had a shorter course than other illnesses (10.6% of episodes and 7.5% of illness days). The category "all other" consisted of mastitis (3.8%), and a variety of skin problems (21.6%)--infected cuts, bites and allergic dermitis, scabies, and several cases of otitis externa, both gingival and dental problems, asthma, congestive heart falure in pregnancy secondary to rheumatic heart disease, palpitations, pelvic inflammatory disease and vaginitis.

In contrast to the lead males, the lead female was almost always present during the morbidity visit, self-reported her own illnesses and was available for physical inspection by the morbidity team. This is probably reflected in the higher reported morbidity among the lead females.

TABLE 8.4
Proportional morbidity the most frequent disease categories among school boys.

Diagnostic Category	# of Episodes	% of Episodes
URI	205	30.5
Conjunctivitis	62	9.2
Abdominal pain	58	8.6
Clinical malaria	53	7.9
Headache	34	5.0
Soft tissue injury	27	4.0
Skin infection	22	3.2
Bronchitis	16	2.4
Other respiratory	17	2.5
All Other	178	6.4
Total	672	99.7

TABLE 8.5
Proportional morbidity of the most frequent disease categories among school girls.

Diagnostic Category	# of Episodes	% of Episodes
URI	161	26.2
Conjunctivitis	61	9.9
Abdominal pain	47	7.6
Headache	62	10.0
Clinical malaria	62	10.0
Soft tissue injury	15	2.4
Bronchitis	15	2.4
Fever & other signs	14	2.2
Joint pain	13	2.1
All Other	164	26.7
Total	614	99.5

School boys and girls (7 to 9 yrs of age) have a very similar morbidity profile. Both have about 30% of illness days as URI and 6% as clinical malaria. Two nonspecific symptoms of headache and abdominal pain make up only 9% - 10% of illness days for both boys and girls. As seen among the adults, the first nine diagnoses account for 70% of all illness days. The category "all other" includes either single or several episodes of a variety of conditions including: otitis externa and otitis media, dental and gingival problems, acute arthritis, (possible rheumatic fever) convulsions, measles, pertussis and tuberculosis. A total of 139 school boys and girls contributed to the sample.

TABLE 8.6
Proportional morbidity of the most frequent disease categories among boy toddlers.

Diagnostic Category	# of Episodes	% of Episodes
URI	299	32.9
Conjunctivitis	177	19.5
Diarrhea	84	9.2
Fever & other signs	55	6.0
Clinical malaria	37	4.0
Vomiting	28	3.0
Skin fungus	22	2.4
Bronchitis	17	1.9
Infected cuts	16	1.7
All Other	174	19.1
Total	909	99.7

TABLE 8.7
Proportional morbidity of the most frequent disease categories among girl toddlers (n = 52).

Diagnostic Category	# of Episodes	% of Episodes
URI	324	28.9
Conjunctivitis	221	19.7
Diarrhea	116	10.3
Clinical malaria	45	4.0
Fever & other signs	36	3.2
Dermatitis	32	2.8
Vomiting	27	2.4
Skin fungus	24	2.1
Abdominal pain	24	2.1
All Other	271	24.1
Total	1095	99.6

TABLE 8.8
Proportional morbidity of the most frequent disease categories among infant boys (n = 70).

Diagnostic Category	# of Episodes	% of Episodes
URI	205	39.4
Conjunctivitis	99	19.0
Diarrhea	37	7.1
Skin infection	34	6.5
Vomiting	16	3.0
Fever	16	3.0
Thrush (oral)	11	2.1
Clinical malaria	11	2.1
Other skin problems	8	1.5
All Other	83	15.9
Total	520	99.6

TABLE 8.9
Proportional morbidity of the most frequent disease categories among infant girls (n = 54).

Diagnostic Category	# of Episodes	% of Episodes
URI	155	43.1
Conjunctivitis	87	24.2
Skin infection	21	5.8
Diarrhea	15	4.2
Other skin problems	13	3.8
Thrush (oral)	9	2.5
Clinical malaria	9	2.5
Fever & symptoms	8	2.2
Fever	6	1.7
All Other	37	10.3
Total	360	100.0

Boy and girl toddlers also have a very similar morbidity profile. URI accounts for about 35% of all illness days. Conjunctivitis is a very common problem in toddlers, accounting for 23% of illness days. Diarrhea makes up 10% of illness episodes, but only 5% of illness days. The first nine diagnosis make up about 80% of all illness days. The category "all other" includes eithe single or several episodes of such conditions including otitis media, otitis externa, dental problems, urinary tract infection, and convulsions. Skin fungus refers to ring worm. Unlike the schoolers, no communicable diseases such as measles or pertussis were seen. The toddlers had excellent immunization coverage. Otitis media may be underreported in toddlers in situations where there was no ear discharge or fever with no specific complaint of ear-ache.

Upper respiratory infection (URI) and conjunctivitis account for between 60-70% of all illness days among the infants. Diarrhea was seldom reported, with only a total of 52 episodes reported for all infants. Fever accounts for 30 episodes, and clinical malaria for only 20 episodes. Infants do not have a large variety of illnesses, with the first nine diagnoses accounting for 90-95% of all illness days reported. The category "all other" includes between single and several cases of a variety of problems such as external otitis and otitis media, stomatitis, croup, bronchiolitis and dehydration associated with diarrhea.

Three infants were diagnosed as having neonatal gonococcal ophthalmitis in the first few days of life. Mothers and infants were hospitalized for treatment and the father cultured and treated. The diagnoses were substantiated by positive bacterial cultures.

Diarrhea among Toddlers and Infants

The person-time incidence of diarrhea measured in the CRSP study is less than that measured by other (predominately peri-urban) studies in Kenya (reported rates range from 1.3 to 2.0 episodes per 6 months (11)). The low incidence measured by CRSP may be due to the ommission by CRSP of data on 6- to 18-month-olds, the age group with the highest diarrhea incidence. CRSP collected data only on the 0 to 6 month olds, an age group with a much lower incidence of diarrhea. This underreporting may have resulted as well from a reaction of the mothers to the time demands of weekly morbidity interviews resulting in an underreporting of minor illnesses, such as mild diarrhea, in the interests of saving time.

Illness Duration

The low grade illnesses generally were of long duration. The common cold, coded as lasting over a month, may represent chronic purulent rhinitis in toddlers or allergic rhinitis. The long durations for skin lesions are not surprising as they represent scabies, recurring impetigo and infected insect bites. Conjunctivitis is also common, possibly due to chlamydia in the infants and toddlers, documented by extensive studies in Nairobi (12). One of the lead females has trachoma, which is endemic in the dry, lower zone.

Morbidity Diagnosis and Outcome of Treatment

The reported treatment was generally appropriate for the category of disease with relatively low use of traditional treatment except for mouth and skin conditions. Anti-malarials (available in many markets and shops) were used to treat the majority of fever cases. In contrast, anti-malarials were used to a much lesser extent in non-febrile illnesses. The exact dosage of treatment was not recorded.

Treatment and Duration of Illness

Because the exact dosage, compliance, and duration of treatment were not ascertained, we hesitate to draw conclusions on the effect of treatment on duration. It is our judgement that because most cases of illness are due to viral etiology, treatment will have little or no effect on duration.

Deaths

Over the course of the study, a two year period, three of 247 lead males died, a rate of 12.1/10,000. The causes of death were confirmed by hospital records. Two of the men died of hepatoma (one man was 70 years of age) and one died of laryngeal carcinoma. The problem of hepatoma is well known in East Africa. The current situation is that it may be due to a combination of factors -- the high rate of hepatitis, cirrhosis, possibly aggravated by the presence of aflotoxin and the problem of alchohol ingestion (13). There were no deaths among lead females. One school age child died of chronic hepatitis with obstructive jaundice and cirrhosis three months after the field work ended.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS: CHRONIC DISEASE

Data were collected on chronic disease and hospitalization in all household members. Recognizing that chronic illness may be missed by weekly morbidity queries, a chronic illness questionnaire was administered to enumerate chronic and/or disabling conditions, as well as hospital admissions for illness and surgery. A total of 79 different types of disease conditions were identified and coded according to the International Classification of Disease codes (ICD) (Appendix C). The reported illnesses were grouped by disease category and are presented in Table 8.10. A total of 489 disease conditions were reported among the target households, and 14 incidents of obstetric complications. Among the 489 disease conditions reported, there were 27 acute disease episodes with pneumonia being the most common condition. Obstetric complications included 11 ceasarian sections, one incident of obstructed labor, and two abortions. Of all, disease conditions, 42.5% were reported among the non-target children; 21.7% among the LF; 19.8% among the LM; and 6.5% were among the toddlers and the infants.

Abnormalities with the auditory system (purulent otorrhoea and hearing loss) are the most common disease conditions reported among the target households. The second most common condition was epilepsy which occurred mainly among the non-target children. Back-ache, chronic pharyngitis, nasopharyngitis, and malaria were also common and occurred in about 4% of the total reported disease conditions.

Abnormality of the digestive system was reported in 7.3% of the total disease conditions. Peptic ulcer occurred in one-sixth of these conditions; the LM were exclusively affected.

Essential hypertension was reported almost exclusively among the LF (reported only in one LM). This is the opposite of what was found in the physical examinations and points to the need for blood pressure screening. The hypertension was not documented by measurements.

Asthma with wheezing occurred mostly among the LM. Pulmonary tuberculosis, under active treatment, occurred in 1.8% of the total disease conditions.

Loss of vision, unspecified chest pain and abdominal pain were reported fairly frequently, occurring in about 3.5% of total disease conditions. Decreased visual acuity was reported mainly among the non-target children, while chest pain and abdominal pain occurred mainly among the target adults. Very few individuals reported abnormalities of the genito-urinary and endocrine systems. One case of cancer was reported among the LM aside from those that died. There were no sexually transmitted diseases (STD) reported in contrast to the health centers and hospitals which reported relatively greater rates of STD and pelvic inflammatory disease in the area.

A small percentage of chronic illness diagnoses were coded in the monthly morbidity data set if reported to the morbidity enumerator and some of the acute illness of long duration (e.g., pneumonia) were reported as chronic illness. These will be transferred to the appropriate data file.

TABLE 8.10
Proportionate morbidity of chronic disease among the target individuals (obtained by quarterly survey).

Disease Category	Target & Non-target LM	Target & Non-target LF	Schoolers	Toddlers & Infants	Non-target Children	Total
% total disease	%	%	%	%	%	%
Ear						
otorrhoea	0.6	1.6	2.9	2.0	9.8	17.0
hearing loss	1.2	1.8	1.0	0.0	4.7	8.8
Extremities/ Musculoskeletal						
backache	2.9	1.6	0.0	0.0	0.2	4.7
difficult walk	0.6	0.2	0.0	0.0	2.2	3.1
others	1.6	1.6	0.6	0.0	1.8	5.7
Gastro-Intestinal						
peptic ulcer	1.2	0.0	0.0	0.0	0.0	1.2
others	1.6	0.6	0.2	0.6	2.9	5.9
Neurological						
epilepsy	0.0	0.4	1.2	0.0	3.7	5.3
others	0.4	0.2	0.0	0.0	0.8	1.4
Eye						
trachoma	0.0	0.2	0.0	0.0	0.0	0.2
visual loss	0.8	0.6	0.0	0.2	2.2	3.8
chronic conjunctivitis	0.2	0.6	0.0	0.2	0.0	1.0
Chron.pharyngitis & nasopharyngitis	0.2	1.8	1.0	1.0	0.4	4.5
Malaria	0.4	1.8	0.0	0.0	2.0	4.2
Skin						
dermatitis	0.0	0.2	1.2	0.6	0.0	2.0
others	0.6	0.2	0.2	0.2	0.0	1.2
Cardiovascular						
essential hypertension	0.2	2.0	0.0	0.0	0.0	0.2
others	0.0	0.6	0.0	0.0	0.0	0.6
Communicable disease						
whooping cough & measles	0.0	0.0	0.0	0.2	0.6	0.8
pulmonary TB	0.8	1.0	0.0	0.0	0.0	1.8

Continued.

TABLE 8.10 continued.

Disease Category	Target & Non-target LM	LF	Schoolers	Toddlers & Infants	Non-target Children	Total
% total disease	%	%	%	%	%	%
Respiratory						
chro.bronchitis	0.6	0.0	0.2	0.0	0.0	0.8
asthma	0.8	0.0	0.2	0.0	0.4	1.4
cough	0.0	0.0	0.0	0.2	0.2	0.4
Oral cavity	0.4	0.4	0.2	0.0	0.6	1.6
Genito-urinary	0.0	0.0	0.0	0.0	0.6	0.6
Endocrine						
thyroid	0.0	0.4	0.0	0.0	0.0	0.4
diabetic	0.0	0.0	0.0	0.0	0.2	0.2
Nutritional						
marasmus	0.0	0.0	0.0	0.2	0.0	0.2
night blindness	0.0	0.2	0.0	0.0	0.0	0.0
Cancer	0.2	0.0	0.0	0.0	0.0	0.2
Miscellaneous						
chest pain	1.0	1.6	0.4	0.0	0.8	3.8
abdominal pain	1.8	0.4	0.0	0.0	1.0	3.2
lymphoedema	1.0	0.0	0.0	0.0	0.0	1.0
psychosis	0.2	0.0	0.0	0.0	0.6	0.8
venom	0.2	0.0	0.0	0.0	0.4	0.6
others	0.8	0.0	0.4	0.2	2.0	3.4

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS: PHYSICAL EXAMINATIONS

Physical examinations were carried out on each target individual approximately every six months. Target individuals participated in the examinations from 2 to 4 times with the lead males and schoolers having the lowest participation due to salaried jobs and school. These examinations were carried out to detect conditions that might not be detected by the ongoing morbidity data collection. Selected physical findings are presented for the initial four rounds of examinations (the number of participants decreased significantly during the fifth and sixth rounds). Not all targets are represented in all the rounds. Scheduling of examinations was continuous throughout the year. See Tables 8.11 and 8.12.

The different percentages for a given finding from one round to another may be due to new staff members afraid to miss findings in round 1, different physicians carrying out examinations at each round, a changing sample (persons and numbers), and attrition.

Findings of Adults

Blood Pressure

Hypertension is nearly twice as frequent in lead males (LM) as compared to lead females (LF). Blood pressure has not been analyzed by age however, and the LM are generally older than the LF.

Nearly 8% of LM and 2% of LF were found to have systolic hypertension (>140 mm Hg) in the first round. The percentage dropped during the follow up rounds; more significantly among the LM than the LF. This may be due to the fact that more LM dropped out of the study than LF, or there may have been anxiety provoked by an unfamiliar procedure. Similarly, the percentage with diastolic hypertension was also higher in the first round, (7.6% of LM and 3.7% of LF). This dropped to just over one percent of LM and LF by round 4.

A high percentage of adults exhibited a high normal diastolic pressure (80-89 mmHg) throughout the four rounds. This included nearly 32% of the LM and 29.2% of the LF in the first round with a slight drop in the percentage in the follow up rounds.

Body Temperature

In examining body temperature (BT), it was noted that particularly in the cold months (July to September) body temperatures were "low" normal. In July to September, 60-72% of LM were noted to have BT below 36.9 degrees C, a larger percent than in the warmer seasons. Fewer women were found to have a BT below 36.9 degrees C (about 15% of the women were pregnant at any one time). Techniques were checked and thermometers replaced because of the low recordings but these low values were found to be a consistent finding. Low normal body temperatures, from 35.6 to 36.6 degrees C may be consistent with low RMR values in some, or decreased energy intake.

Hearing and Vision

Hearing deficits were found (using tuning fork test) in 1.6 to 5% of all adults in different rounds. Vision impairment is nearly twice as frequent among the LM as the LF (9% and 5% were noted respectively in the first round), again possibly reflecting the slightly older mean age of the lead males.

Thyroid Enlargement

Pregnant women, in particular, showed thyroid enlargement but no large goiters (3+) were seen (see Table 8.12). Data on pregnant and non pregnant women are presented here as one group. More LF than LM show thyroid enlargement. The highest percentage of LF with Grade 1 and Grade 2 thyroid enlargement was found in round 1 (18.8 and 10.6% respectively). These percentages remain fairly stable for Grade 1 throughout the follow up rounds but decrease quite significantly for Grade 2 (2.2%). The change in percentage of grade 2 goiter may have been due to observer error in inexperienced staff. Only 1 to 2% of LM showed any thyroid enlargement.

Fluorosis

Mottling of teeth was present in 2-5% of adults examined. No other manifestations of fluorosis were found to be present.

Clinical Nutritional Disease

Clinical signs suggestive of B-vitamin deficiency were seen in about 6-7% of LF and in about 2% of LM with slightly higher frequency in the period coinciding with the severe drought The most frequent sign was atrophic tongue papillae (smooth, glossy tongue) but cheilosis and angular stomatitis were also seen. The tongue findings may be due to folic acid or iron deficiency anemia. No clinical signs of Vitamin A deficiency were found in adults, i.e., Bitot spots, Xerosis, or Xerophthalmia, in the first 4 rounds.

Hepatomegaly and Splenomegaly

In endemic malarial zones a high prevalence of splenomegaly is expected. Splenomegaly is defined as a spleen palpable below the costal margin (same definition for hepatomegaly). More target individuals were found to have splenomegaly in rounds 3 and 4 than in rounds 1 and 2. Similarly, there was an increase in the percentage of individuals with hepatomegaly in round 4 compared to earlier rounds. Significantly mor. rainfall in 1985 compared to 1984 (a drought year) could partially explain the difference in the mosquito population and hence the increase in splenomegaly. The increase in hepatomegaly cannot be explained except by observer difference due to change in personnel in round 4.

Idiopathic tropical splenomegaly and portal hypertension are well known syndromes in the Eastern Province of Kenya in the neighboring districts of Machakos and Kitui. This syndrome has been linked to endemic malaria. Fourteen to 58% of adult hospital admissions in the area are attributable to severe anemia and hemmorhage from esophagal varices. The cases of adult hepatosplenomegaly may represent the above syndromes (14).

TABLE 8.11
Selected findings on four rounds of physical examinations on lead males and lead females.

	Round 1 (early 84)		Round 2 (late 84)		Round 3 (early 85)		Round 4 (late 85)	
	LM	LF	LM	LF	LM	LF	LM	LF
No. Examined	272	261	187	249	140	144	95	109
	%	%	%	%	%	%	%	%
Hypertension								
Systolic BP (140 mmHg)	7.9	2.0	1.7	1.3	0.0	1.5	2.6	1.1
Diastolic BP† (90 mmHg)	7.6	3.7	5.2	2.2	1.7	4.0	1.3	1.2
High Normal Diastolic BP (80-89 mmHg)	31.6	29.5	20.9	9.8	28.6	12.1	20.0	15.5
Body Temperature (9-11 am)* (< 36.9 C)	47.9	34.8	60.0	42.7	58.3	37.4	72.4	58.5
Decreased Hearing	1.6	2.1	2.3	3.0	3.3	4.5	5.1	4.3
Decreased Vision (20/50)								
Right eye	9.7	4.9	1.8	2.1	0.8	0.8	5.5	0.0
Left eye	8.4	5.0	0.6	2.2	2.5	1.6	1.4	1.1
Thyroid Enlargement								
Grade 1	1.4	18.8	0.6	17.5	2.5	9.2	1.3	17.2
Grade 2	0.5	10.6	1.2	3.0	0.0	1.5	0.0	2.2
Fuorosis	2.9	2.9	0.0	2.9	5.0	0.8	15.4	5.4
On Inspection								
Abnormal Nutrition	32.7	47.1	15.6	67.1	10.7	25.6	6.4	9.7
Undernutrition	15.0	9.6	35.0	30.9	8.3	17.3	7.7	4.3
Pallor of conjunctiva and nailbeds	26.8	42.5	28.3	56.4	2.5	14.3	0.0	5.4
Signs of Vit B Deficiency								
Atrophic Tongue Papillae	1.2	4.6	1.7	5.0	0.8	3.0	0.0	0.0
Magenta Tongue	0.4	0.8	1.1	1.2	0.0	0.0	0.0	0.0
Ang. Stomatitis	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Cheilosis	0.0	0.0	0.0	0.4	0.0	0.0	0.0	1.1
Hepatomegaly	0.3	0.3	0.5	1.2	1.4	0.0	4.2	0.9
Splenomegaly	0.4	1.2	1.6	2.0	3.6	2.8	3.2	5.4

* Cold season is July-September.

† D.B. Jelliffe, 1966

Findings of Schoolers and Toddlers

Blood Pressure

Systolic hypertension and diastolic hypertension were observed in 1.7% and 6.7% of the schoolers respectively in the first round. No schoolers were diagnosed with systolic hypertension in the subsequent rounds and only 1.5% were noted to have diastolic hypertension in round 2. These children were followed up with repeated blood pressure measurements and one child was sent to the University teaching hospital for a renal disease work-up. No further abnormal blood pressure readings were detected in round 3 and 4.

Twenty-four percent of schoolers were found to have a high normal systolic pressure (110-119 mmHg) and 37.7% were detected to have a high normal diastolic pressure (80-89 mmHg) in the first round (this may reflect anxiety provoked by an unfamiliar procedure); the percentage dropped off significantly in subsequent rounds. The BP percentiles for children were used as criteria (15).

Body Temperature

Low normal body temperature (35.6-36.9 degree C) was detected in 40-70% of the toddlers and 14-44% of schoolers during the different rounds. The percentages were not consistently higher in the cold seasons and RMR's in schoolers were also lower than the "predicted" values.

Visual Acuity and Hearing

Hearing was tested by tuning fork in all target individuals. Among schoolers, the percentage with hearing deficits ranged from 1-4% in different rounds. The toddler hearing assessment by tuning fork was very crude and cooperation poor at times. There were no toddlers that did not respond to the stimuli but these results are somewhat inconclusive.

Visual acuity was tested in the toddlers by the cognitive test enumerators using the California Preferential Looking test. The infants had an i[illegible]al vision test by use of the Fugan infant memory test which depends on vision. All appeared to be in the normal range of visual acuity. As many as 12.4% of schoolers were detected to have decreased visual acuity.

Thyroid enlargement

More female schoolers showed Grade 1 thyroid enlargement than the male schoolers in round 1 (5.5% and 2.9%), this pattern was reversed however in round 3. One toddler showed Grade 2 thyroid enlargement.

Flourosis

The percentage of schoolers with fluorosis varied in different rounds and ranged from 6-20%. Only about 1% of toddlers were found to have fluorosis.

Tonsils

In protein-energy malnutrition, reduced tonsil size is correlated with decreased cellular immunity as lymphoid mass decreases. Tonsillar tissue is expected to be seen in all toddlers and schoolers (up to a grade of 3+ in toddlers). No tonsil tissues were seen in up to 21.6% of the schoolers in round 3 and up to 13% of the toddlers in round 2. Tonsil size will be examined for correlation with % Tcells, delayed cutaneous hypersensitivity, lymphocyte counts, and with food intake and nutritional status. (Tonsil size grades are described in the physical examination overview).

Immuni-·:· . Level

Immunization level among children were high prior to the start of the main study (from 90-93%). Immunization coverage increased slightly over the life of the project as field staff encouraged mothers to immunize their children. Also an active Expanded Program for Immunization (EPI) was in operation at Karurumo Health Center and Consolata Hospital.

BCG immunization coverage ranged from 93% among the schoolers to 98% of the toddlers in the first round. 100% were found to be immunized in subsequent rounds. BCG scars were examined to validate the questionnaires and were slightly lower than the above report. Polio and DPT immunization ranged initially from 93% in schoolers to 99% in toddlers. Full coverage (100%) was acheived after the first 6 months of the study. Measles immunization coverage, at 81% for toddlers and 69% for schoolers in early 1984, gradually increased to 96-100% by the start of 1985. Several cases of measles were seen in the project target toddlers but no pertussis.

Nutritional Status (determined by general inspection)

A higher percentage of abnormal findings such as abnormal nutritional status, underweight stunting, and anemia were detected among schoolers and toddlers in round 2 than round 1. Abnormal findings stabilized among the toddlers in subsequent rounds, and decreased significantly among the schoolers. Upon inspection, 63.7% of schoolers and 27.8% of the toddlers were considered to be undernourished (thin, short). In 1984, coinciding with the drought and famine, marasmus and kwashiorkor were seen in 1-3% of children. Kwashiorkor was found in one schooler. About 3% of toddlers were found to have marasmus.

Anemia is also prevalent with 41.1% of schoolers and 23.4% of the toddlers perceived to be anemic on general inspection.

Clinical evidence of Vitamin B deficiency was detected in about 15% of schoolers and 2% of toddlers during the first round. The percentage dropped in subsequent rounds. Rickets and signs of Vitamin A deficiency were not seen.

Hepatomegaly (liver palpable below the costal margin)

Hepatitis and hemolytic anemia are known to occur among the Embu children, based on local hospital records. Over 13% of schoolers and 7.9% of toddlers were found to have hepatomegaly in the first round. These percentages remained fairly stable for the toddlers but have a downward trend for schoolers in subsequent rounds.

TABLE 8.12
Selected findings on four rounds of physical examinations on toddlers and schoolers.

	Round 1 (early 84)		Round 2 (late 84)		Round 3 (early 85)		Round 4 (late 85)	
	TOD	SCH	TOD	SCH	TOD	SCH	TOD	SCH
No. Examined	114	152	117	130	71	57	29	40
	%	%	%	%	%	%	%	%
Hypertension								
Systolic BP (130 mmHg)	---	1.7	---	0.0	---	0.0	---	0.0
Diastolic BP (90 mmHg)	---	6.7	---	1.5	---	0.0	---	0.0
High normal Systolic BP (110-119 mmHg)	---	24.0	---	4.5	---	5.9	---	0.0
High normal Diastolic BP (80-90 mmHg)	---	37.7	---	1.9	---	2.2	---	4.2
Body Temperature (<36.9 C)[2]	54.0	14.0	64.3	22.2	72.4	19.2	41.7	43.8
Decreased Hearing	0.0	1.0	0.0	0.0	2.6	3.9	0.0	3.0
Decreased Vision (20/50)								
Right eye	---	10.6	---	0.0	---	0.0	---	2.3
Left eye	---	12.4	---	0.8	---	0.0	---	0.0
Thyroid Enlargement								
(1+) Males	0.0	2.9	0.0	2.8	0.0	0.0	0.0	0.0
Females	0.0	5.5	0.0	4.3	0.0	6.7	0.0	0.0
(2+) Males	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
Fluorosis	0.0	8.5	0.8	20.2	1.6	5.9	0.0	9.1
Tonsils 0	1.0	7.0	13.0	18.5	6.3	21.6	12.5	15.6
1+	40.0	60.9	47.2	63.0	71.4	56.9	70.1	53.1
2+	57.9	29.7	38.9	16.0	22.2	21.6	16.7	31.3
On Inspection								
Abnormal Nutrition	19.6	61.0	42.6	73.4	38.1	19.6	33.0	15.2
Undernutrition	14.0	41.8	27.8	63.7	28.6	15.7	25.0	9.1
Anemia	8.4	38.0	23.4	41.1	15.9	2.0	4.2	3.0
Stunting	0.9	1.4	5.2	2.4	1.5	1.9	0.0	3.0

Continued.

TABLE 8.12 continued

	Round 1 (early 84)		Round 2 (late 84)		Round 3 (early 85)		Round 4 (late 85)	
Signs of Vit BDeficiency								
Atrophic Tongue								
Papillae	1.9	14.1	0.9	8.9	0.0	0.0	0.0	0.0
Magenta Tongue	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ang. Stomatitis	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Cheilosis	0.0	0.7	0.0	0.0	1.6	0.0	0.0	0.0
Kwashiorkor	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Marasmus	0.9	0.0	2.6	0.0	3.2	0.0	0.0	0.0
Immunization								
BCG	98.0	92.6	100	100	100	100	100	100
Polio	98.0	95.0	100	100	100	100	100	100
Measles	81.0	69.2	93.6	90.6	96.8	100	100	100
DPT	99.0	93.3	100	100	100	100	100	100
Hepatomegaly	7.9	13.2	7.7	3.1	5.6	1.8	6.9	7.5
Splenomegaly	0.9	4.6	7.7	3.8	9.9	0.0	3.4	5.0

* Cold season is July-Sept

† D.B. Jelliffe, 1966

Splenomegaly (Spleen palpable below the costal margin)

Nearly 5% of the schoolers and 1% of the toddlers were found to have spleno-megaly in the first round. This would be expected in children in an endemic malaria area. It was also noted that there was a great increase in the number as well as the percentage of toddlers with splenomegaly in round 2 and 3.

EFFECTS OF ILLNESS ON FOOD INTAKE AND ACTIVITY

Severity of Disease and Effect on Food Intake and Activity

Selected categories of common morbidity in target individuals (all combined) are presented by severity and difference in effect on food intake and activity. Semi-quantitative scales were devised to describe degree of decrease in food intake and activity with mild and severe disease. (The semi-quantative scale for change in food intake and activity and disease severity criteria are described in the morbidity methods section. Paired data were used for analysis.)

There are relatively greater percentages of reduction in food intake for all three severe disease categories relative to mild disease categories in the following descending order: fever mouth respiratory disease. There was a surprising degree of decrease in food intake with mild disease in the same descending order as with severe disease. See Table 8.13.

TABLE 8.13
Difference in severity of disease category and effect on food intake.

Disease Category	Food Intake				
Respiratory disease (n=1177 episodes)	Usual %	Decreased %	Total %	(Yates corr.) Chi Square	p value
mild %	78.3	14.9	93.6	118	<.001
severe %	2.3	4.5	6.8		
Total	80.6	19.4	100.0		
Fever (n=350 episodes)					
mild	46.9	33.7	80.6	40.0	<.000
severe	2.9	16.6	19.4		
Total	49.7	50.3	100.0		
Digestive Tract (mainly diarrhea) (n=309 episodes)					
mild	57.6	17.8	85.4	37.5	<.000
severe	2.6	12.0	14.6		
Total	60.2	39.8	100.0		

As for reduction in activity level, there was a relatively greater percentage of serious febrile episodes associated with reduced activity. This was followed by greater reductions in activity in the severe respiratory disease and gastrointestinal disease groups. Mild forms of disease were also associated with considerable reduced activity. See Table 8.14

Concurrent Illness and Measured Energy Intake

An analysis was carried out to see if the presence of illness on the day of food intake measurement affected food intake compared to days when there was no illness present. This was analyzed for the toddlers only. Among the large illness categories, the mean kcal intake is significantly lower in toddlers with digestive illness (mainly diarrhea) and with fever compared to toddlers with no illness (see Table 8.15).

Review of data for specific illness category revealed that, in toddlers, the greatest decrease in food intake is associated with measles, otitis media, mouth infections (stomatitis), diarrhea and vomiting, and lower respiratory infection (see Table 8.16). Presence of abdominal pain is also associated with decrease in food intake. The reductions in food intake in the presence of the above illnesses are significantly larger than when there is no illness or with illness such as eye, ear infection, or upper respiratory infections. Given the frequency of the above illnesses, the mean kcal decreases of greater than a hundred kcals at frequent intervals becomes a significant reduction in energy intake. This once again points to morbidity as a potent intervening variable when considering the effects of food intake on growth and other outcome variables.

TABLE 8.14
Severity of disease category and reduction in activity.

Disease Category	Activity Level					
Respiratory Disease	No change	Moderate reduction	Reduction	Total	Chi Square	p value
(n=1181 episodes)	%	%	%	%		
mild %	79.2	12.6	0.4	93.2	146	<.00
severe %	2.3	4.0	0.5	6.8		
Total	81.5	17.6	0.9	100.0		
Fever						
(n=358 episodes)						
mild	41.9	37.2	0.8	79.9	51	<.00
severe	1.4	17.6	1.1	26.1		
Total	43.3	54.7	2.0	100.0		
Digestive Tract						
(mainly diarrhea)						
(n=312 episodes)						
mild	57.7	26.9	0.6	85.3	55.6	<.00
severe	2.9	9.6	2.2	14.7		
Total	60.6	36.5	2.9	100.0		

TABLE 8.15
Mean food intake (kcal) in toddlers by large illness categories.

	Well	Respiratory Disease	Digestive Illness	Fever	Other Illness
No. of episodes	821	845	144	72	643
Mean kcal	861	843	699	719	841
± SD	465	448	407	440	463
Well vs. Digestive	significant diff. p <.0000				
Well vs. Fever	significant diff. p <.0000				

TABLE 8.16
Energy intake in presence of specific illness vs. days with no illness in toddlers.

	Mean kcal	+/- SD
Skin	829	408
Eye	876	502
Ear	595*	347
Mouth	593*	246
Upper Respiratory	851	452
Lower Respiratory	683*	370
Gastro-intestinal (abdominal pain)	719*	430
Gastro-intestinal (diarrheal and vomiting)	604*	252
Genito-urinary	779	173
Extremities	739	111
Measles	560*	209
Fever	719*	440
Other		
No illness present, well	861	+465

* Significantly lower than No Illness (p <.03-.0000)

REFERENCES

1. McLaren D.S. Color Atlas of Nutritional Disorders. Chicago: Yearbook Publishers, 1981.

2. International Classification of Diseases, 9th Revision, Clinical Modification, Volume II, Diseases, Alphabetic Index, Second Edition, September 1980, DHHS Publication No. (PHS) 80-1260, U.S. Govt. Printing Office, Washington, D.C.

3. Jelliffe D.B. The Assessment of the Nutritional Status of the Community. Geneva: World Health Organization, 1960.

4. Smythe P.M., Berton-Stiles G.G., Grace H.J. Thymolymphatic deficiency and depression of cell-mediated immunity in protein-energy malnutrition.Lancet 1971; 2:939.

5. Neumann C.G., Lawlor G.J., Stiehm et al. Immunologic responses in malnourished children. Am J Clin Nutr 1975, 28: 89-104.

6. Expert Committee, Medical Assessment of Nutritional Status, WHO Technical Report Series No.258, Geneva, 1963.

7. King M., King F. Primary Child Care, Oxford University Press, London, 1978.

8. Thomas J.C. Risk factors for diarrhea among young children in rural Kenya, Doctoral dissertation, School of Public Health, University of California at Los Angeles, 1987.

9. Keusch G.T., Farthing M.J.G. Nutrition and Infection. Ann Rev Nutr 1986;6:131-54.

10. Beisel W.R. Magnitude of the host nutritional response to infection. Am J Clin Nutr 30: 1236-47.

11. Snyder J.P., Merson M.H. The Magnitude of the Global Problem of Acute Diarrheal Disease: A Review of Active Surveilience Data. WHO Bulletin 1982; 4:605-13.

12. Personal communication with Kenya Medical Research Institute, 1985.

13. Bagshawe A.F., Cameron H.M. Hepatitis B Antigen and Liver Disease. In: Health and Disease in Kenya, edited by LC Vogel et al. Nairobi, Kenya: East African Literature Bureau., 1974, pp. 285-292.

14. Bagshawe A.F., Cameron H.M. Idiopathic Tropical Splenomegaly and Portal Hypertension. In: Health and Disease in Kenya, edited by LC Vogel et al. Nairobi Kenya: East African Literature Bureau., 1974, pp. 445-452.

15. Report on Blood Pressure Control in Children, National Heart, Lung, Blood Institute. Pediatrics (Suppl.), 1977; 59:803.

Chapter 9

IMMUNOLOGY AND HEMATOLOGY

The Nutrition CRSP Kenya Project, as a component of the investigation of disease among the project's study population, conducted laboratory examinations for hematologic and immunologic status, intestinal parasites, and malaria. The laboratory results complement the health status descriptions of target individuals provided by the weekly morbidity survey, quarterly chronic illess survey, and biannual physical examinations.

RESEARCH OBJECTIVES

The objective of the laboratory examinations was to detect "hidden morbidity," specifically health problems or subclinical forms of disease not readily detected by recall, observation or physical examination. The variables can serve as functional outcomes in themselves or as confounding or explanatory variables in the analysis of other disease components or functions.

THE SAMPLE

Laboratory tests were performed on each target individual (those in the longitudinal study) in 247 households every six months for a minimum of three rounds per household. The studies were performed and biological samples obtained at the same time the physical examination was carried out.

Due to a general resistance against having blood samples taken, particularly in the toddlers and the infants, the greatest amount of missing data are in these age groups. Often, capillary blood samples were used for hematology in place of venipuncture. Also, lead males and schoolers often failed to go to the laboratory because of salaried work or school. And finally, the period of severe drought also affected the sample size, across all TI types, as families felt that drawing blood would weaken them even further. For laboratory determinations, approximately 50% of the data are missing for toddlers and infants, 30% for schoolers and lead males, and 20-25% for lead females.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Standardized techniques were used to collect and analyze blood, stool, urine, breastmilk and saliva samples. These techniques are described below.

Data collection forms were designed to record all laboratory findings. Form 341 (Fig. 9.1) was used to record hematology, urinalysis, parasitology and immunologic data (E-rossettes) and Form 342 (Fig. 9.2) was used for information on immunoglobulins and bacteriologic water contamination (see Chapt. 14).

TECHNIQUES OF DATA COLLECTION

Hematology

Blood samples were collected by physicians, nurses, and well trained laboratory technicians, under sterile conditions in the clinic laboratory using disposable needles and syringes or lancets.

White blood counts and differential white counts were carried out manually using established methods by two university-trained, experienced laboratory technicians.

Hemoglobin determinations were performed on venous blood the majority of the time, but capillary blood from infants and toddlers was occasionally used. The cyanohemoglobin method was employed. This was done using a Coleman junior spectrophotometer. The samples were analyzed on the same day of collection on EDTA anticoagulated samples of whole blood. Daily spectrophotometer calibration was performed with a known standard and blank, and a curve drawn. Duplicate readings were taken and results were reported to the nearest tenth of a gram of hemoglobin per dl.

Hematocrit, or packed cell volume (PCV), was carried out by micro hematocrit technique using the same blood sample used for hemoglobin. Samples were centrifuged on a Clay Adams microcentrifuge for three minutes and the percent packed cells read off from the hematocrit display. The remaining serum was used for serum ferritin determinations.

For determination of ferritin, enzyme immunoessay (ELISA) kits from New England Immunology Associates were used for the assays. However, in the last six months of the study, after New England Immunology Associates closed, the laboratory switched to the Abbott ferritin kits. A comparison was run using the two different kits on the same samples, and the results were comparable.

Parasitology

Blood smears and stool specimens were examined for evidence of parasites. Thick blood smears were stained with Giemsa stain and examined for malaria parasites by type of malaria. Stool specimens were collected in the homes in pre-labeled stool cups. Cups and wooden blades were distributed tc the households in the afternoon, with a pick-up scheduled the following morning. The maximum length of time a stool sample was stored in the home was overnight; most samples were stored for only a few hours. Specimens were examined for occult blood using a hemocult test; a saline emulsion was used for microscopic examination. A concentration technique was used whereby stools were concentrated using sodium peroxide. Results were reported as the number of ova per gram of stool.

Urinalysis

Urine was tested by Uristix within one hour following collection at the clinic. Ames dipsticks were used to measure pH and to detect blood, protein, ketone and reducing substances in the urine. Blood and ketone results were reported as 1-4+, and pH was read directly. The dipsticks were tested against specimens with added blood, and sugar to be certain that they reacted. For protein, a random sub-sample was tested by the heat method (1).

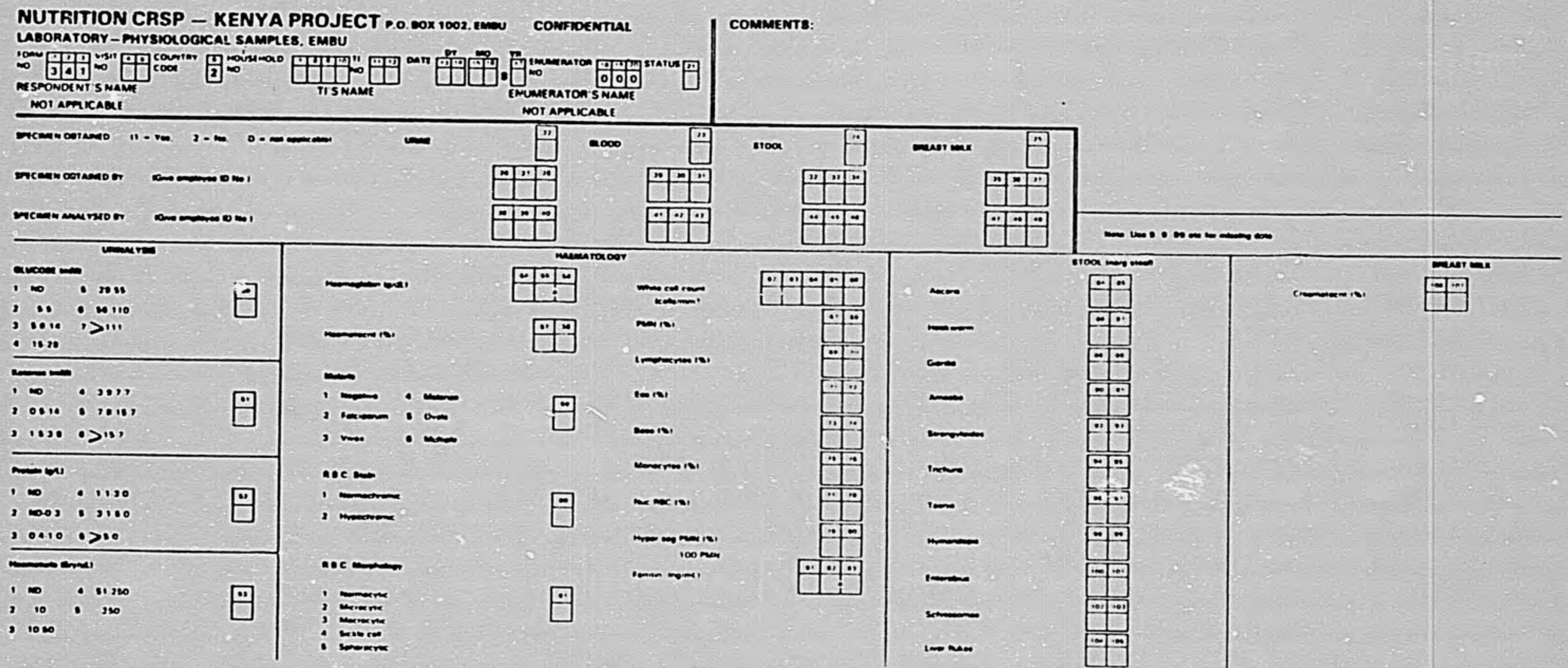
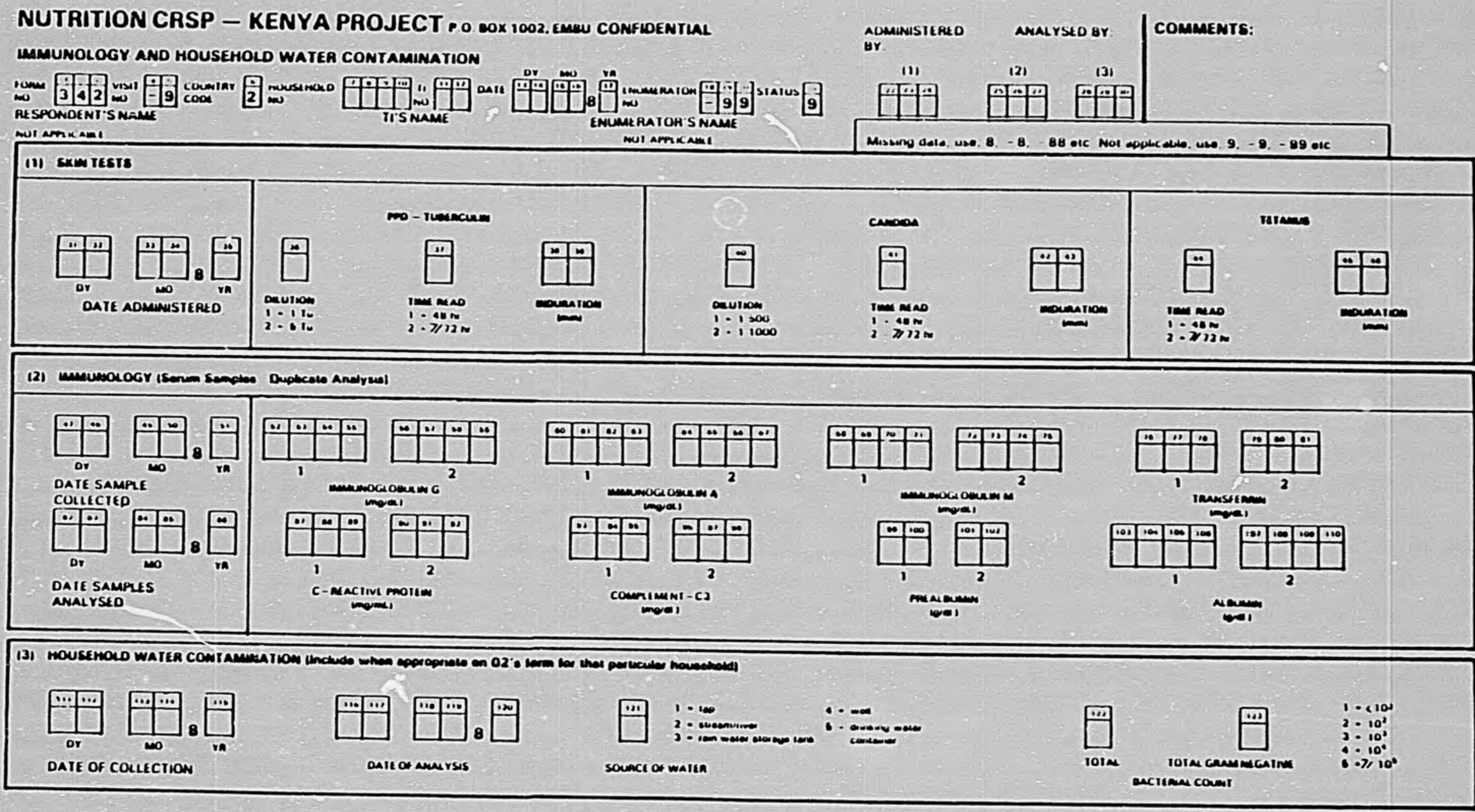


FIG. 9.1. Laboratory form 341 for physiological samples, Embu.



NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU CONFIDENTIAL

IMMUNOLOGY AND HOUSEHOLD WATER CONTAMINATION

FORM NO 3 4 2 VISIT NO - 9 COUNTRY CODE 2 HOUSEHOLD NO TI NO DATE DY MO 8 YR ENUMERATOR NO - 9 9 STATUS 9

RESPONDENT'S NAME NOT APPLICABLE

TI'S NAME

ENUMERATOR'S NAME NOT APPLICABLE

ADMINISTERED BY (1) ANALYSED BY (2) (3)

COMMENTS:

Missing data, use 8, - 8, - 88 etc Not applicable, use 9, - 9, - 99 etc

(1) SKIN TESTS

DY MO 8 YR DATE ADMINISTERED

PPD – TUBERCULIN: DILUTION 1 - 1 Tu 2 - 5 Tu; TIME READ 1 - 48 hr 2 - ≥72 hr; INDURATION (mm)

CANDIDA: DILUTION 1 - 1:500 2 - 1:1000; TIME READ 1 - 48 hr 2 - ≥72 hr; INDURATION (mm)

TETANUS: TIME READ 1 - 48 hr 2 - ≥72 hr; INDURATION (mm)

(2) IMMUNOLOGY (Serum Samples Duplicate Analysis)

DY MO 8 YR DATE SAMPLE COLLECTED

DY MO 8 YR DATE SAMPLES ANALYSED

IMMUNOGLOBULIN G (mg/dL) 1 2

IMMUNOGLOBULIN A (mg/dL) 1 2

IMMUNOGLOBULIN M (mg/dL) 1 2

TRANSFERRIN (mg/dL) 1 2

C-REACTIVE PROTEIN (mg/mL) 1 2

COMPLEMENT - C3 (mg/dl) 1 2

PREALBUMIN (g/dl) 1 2

ALBUMIN (g/dl) 1 2

(3) HOUSEHOLD WATER CONTAMINATION (include when appropriate on 02's form for that particular household)

DY MO 8 YR DATE OF COLLECTION

DATE OF ANALYSIS

SOURCE OF WATER: 1 - tap 2 - stream/river 3 - rain water storage tank 4 - well 5 - drinking water container

BACTERIAL COUNT: TOTAL; TOTAL GRAM NEGATIVE

1 - < 10^2 2 - 10^2 3 - 10^3 4 - 10^4 5 - ≥ 10^5

FIG. 9.2. Immunology and household water contamination form 342.

Immunology

Serum Immunoglobulin

Blood was collected by venipuncture and separated within 2 to 4 hours of blood collection. The serum were frozen and stored at -20^{0}C. These were then taken to the University of Nairobi and stored in a -70^{0}C deep freeze until analyses were carried out at the Kenya Medical Research Institution (KEMRI). Duplicates were shipped to UCLA.

Immunoglobulins, pre-albumin, albumin, transferrin and C-reactive protein in serum were determined by single radial immunodiffusion at KEMRI. The antisera for IgG, IgA, IgM, and C-Reactive protein (CRP) were also tested. Unfortunately, the specific antisera for each of the immunoglobulins, albumin, and pre-albumin cross-reacted thereby yielding falsely high values on each except for the C-reactive protein. Fortunately, duplicate specimens were kept at UCLA which were then analyzed using the nephelometry technique. A sample of known concentration was tested prior to the analysis of a different batch of specimens in the laboratories to ensure accurate results.

Secretory Immunoglobulin

Breastmilk specimens were collected at 1, 3, and 6 months postpartum to determine selected immune factors. All breastmilk samples were collected at midday (between 1000 and 1400 hours), 1.5 to 3 hours after the last nursing. Milk was collected from the right breast by manual expression. Samples were collected into amber plastic storage containers. Crematocrit determinations (for fat) were carried out by simple centrifugation prior to storage.

Unstimulated saliva was collected with a pledget of cotton wool which was attached to a piece of dental floss and placed between the cheeks and the gums. With young children, the dental floss was held by the mother for easy removal and to prevent the child from swallowing the pledget. The pledget was then placed in a sterile syringe, and the plunger was replaced to squeeze the saliva out of the pledget into a sterile tube (containing sodium oxide as a decontaminant) and centrifuged before freezing.

Breastmilk and saliva samples were collected, stored in a cold container, and frozen within 2-4 hours. The samples were initially kept at -20^{0}C or colder, and then at -70^{0}C until shipped frozen on dry ice to the University of St. John's in Newfoundland where they were tested for lysozyme, secretary IgA and IgG levels. Because of a shortage of funds, less than 50% of the samples have been analyzed.

Secretory IgA in saliva and breastmilk was assessed by adding 100 ul of undiluted saliva or diluted breastmilk (1:50) into antisecretory IgA antisera. The turbidity which resulted was measured by a Behring Laser Nephelometer. A reference curve was drawn with a series of six standards and the use of a control obtained from Behring Diagnostics.

Breastmilk and saliva IgG were determined using radial immunodiffusion plates from Kallested. A series of four standards and a control were used for each run. A sample of 5 ul of diluted breastmilk (1:50) or undiluted saliva were added to each hole in the immunodiffusion plates, and the resultant diameter of the ring produced was measured. Lysozyme was performed the same way. Manufacturer controls (packaged with the reagent) were measured to ensure accurate results.

Cellular Immune Function

Cellular immune function (CMI) was evaluated by total lymphocyte count, enumeration of T-cells, delayed cutaneous hypersensitivity, and tonsillar size in children.

Total lymphocyte counts were obtained by determining the percentage of lymphocytes from differential counts of blood smears, multiplied by the white blood cell count per cmm. Red blood cells (RBC) were obtained from the project sheep ("Rosetta"), who provided a constant source of fresh red blood cells which were stored in Alsevers solution. T-cells were identified by their ability to form rosettes with sheep erythrocytes, expressed as percentage of rosette-forming cells (RFC). The RBC were washed, suspended and stored at 5% concentration in Minimal Essential Media at 2-8^{0}C. Fresh human AB serum was absorbed with washed RBC from the sheep and stored at 4^{0}C. The RBC suspension and lymphocyte suspension were mixed with the absorbed AB plasma. A drop of methylene blue was added to the suspended mixture and the number of rosettes (lymphocytes attached to 3 or more SRBC) were counted by the hemocytometer counting chamber.

Delayed cutaneous hypersensitivity was assessed with a number of skin test antigens. These included tuberculin (PPD), candida, and tetanus toxoid. At the time of the physical examination, antigens were injected on the volar aspects of the arm. The following procedure was used: 0.1 ml of each antigen was injected intradermally on the volar aspect of the forearms raising a wheal or bleb. The PPD was diluted to 1 TU for adults, 5 TU for children. For tetanus toxoid, the antigen was diluted to 1:5 for children and administered undiluted to adults. With candida, the antigen was diluted 1:1000 for adults and 1:500 for children. The size of the resultant induration was measured by the enumerators and nurses of the morbidity team after 48 or 72 hours. The procedures were done under the supervision of the senior nurse and physician. Induration $\geq$ 5 mm. in diameter is considered a positive response.

Tonsillar size in children, a clinical indicator of lymphoid tissue and cell-mediated immunity, was determined during the physical examination (see Chapter 8).

QUALITY CONTROL MEASURES

Quality control measures undertaken by the immunology and hematology studies included: intensive preliminary and ongoing staff training; utilization of extensively trained and experienced laboratory technicians; "blind" analysis of samples in duplicate at the main laboratory; and comparison of analysis results between projects and laboratories.

Quality control for hemoglobin, white blood cell counts, and hematocrit determination consisted of having a 5-10% sub-sample run on the automated Coulter Counter in the Medical Research Center (MRC) laboratories in Nairobi once a week. Stained blood samples were checked manually for differential white counts by the MRC laboratory, and for description and differential counts of the red blood cells.

For the ferritin assays, quality control measures consisted of analysis of samples in duplicate, and comparison of measurement of known standards with unknown samples. Blind samples were exchanged with the Egypt project, and samples were analyzed at the Purdue University laboratories.

For the parasitology studies, duplicate stool specimens were checked in the laboratory, and a 5% sub-sample was checked by the University of Nairobi, Department of Parasitology.

For the immunology samples, quality control was provided by the main immunology laboratory at KEMRI. The KEMRI laboratory technicians periodically visited Embu and conducted independent measurements of T cells; results were then compared with the measurements taken by the Embu technician.

DESCRIPTIVE STATISTICS AND SUMMARY OF MAJOR FINDINGS

Selected laboratory findings for rounds 1 and 3 are presented in Tables 9.1 to 9.4. These rounds were chosen because of the relatively good sample size and the reasonable time lapse between them (round 2 has considerable overlap in time with round 1, and rounds 4, 5, and 6 have relatively small sample sizes). Round 1 took place from January to around April 1984, and round 2 from September to December 1984. Therefore, presentation of findings from round 1 and 3 offer the best representative picture of the general health status in the community. Hematology, serum ferritin, and parasite levels are reported for adults, schoolers, and toddlers. Relevant assessment standards were derived from the National Nutritional Survey Guidelines and Procedures (2).

Urinalysis

No significant findings were detected in the urinanalysis of the target individuals. A few scattered cases of trace glycosuria and a few cases of proteinuria were detected. No frank diabetics were detected and no ketonuria was seen.

Hematology

Anemia

Anemia is widespread among all the target groups. About 50% of the lead females and the schoolers were found to be anemic (using 12 gm/dl as the cut off point). The toddler group had the highest percentage of individuals suffering from anemia (64.7% in round 1, using 11 gm/dl as the cut off point). The lead males were least affected (12% in round 1). According to project policy, all cases of anemia with hemoglobin < 9 gm/dl were treated with ferrous sulphate. If hemolysis was present, the individuals were referred to the hospital. In round 3, the percentage of target adults found to be anemic increased, while the target children, especially toddlers, showed a decrease in the percentage of individuals with anemia. The mean hemoglobin level as well as the hematocrit for the various target groups were similar in round 1 and round 3. The increased percentage of target adults suffering from anemia in round 3 may be due to the effects of the drought and food shortage that occurred in late 1984, as well as the increased prevalence of malaria

The toddler category had the highest percentage of individuals with either macrocytic or microcytic red cells (11.6% and 16.7% respectively) detected in round 1; whereas the lead males are the least affected in both round 1 and round 3. There were significant decreases in the percentages of individuals with hypochromic red cells in all target groups in round 3. One toddler was found to have sickle cell anemia. Hypersegmented PMN nuclei, indicative of macrocytic anemia and folic acid deficiency, were noted in seven cases out of all target individuals in round 1, four of whom were lead females.

Eosinophilia

Mild eosinophilia, probably a partial reflection of parasite load, is prevalent among all the target individuals. The mean percentage of eosinophilia observed was above 6% among the lead males, the lead females, and the schoolers in round 1 (1-6% is considered normal).

The mean lymphocyte counts are in the low normal range for the lead males and lead females (about 2500 cells/cmm). The count is slightly higher among the schoolers and the toddlers. Up to 21% of the target adults and 13.7% of the schoolers were found to have true lymphocytopenia in round 1 (≤1400 cells/cmm). The percentage of target individuals with relative lymphopenia (< 2000 cells/cmm) is even higher (see cell-mediated immunity section).

Serum Ferritin

Low serum ferritin indicates low iron stores and iron deficiency anemia. The toddlers were found to have the highest percentage (49.3%) of individuals with low ferritin (defined as <10 ng/ml). This is compatible with other hematological findings whereby toddlers were noted to have the highest percentage of individuals with hematological evidence of anemia. The lead males were least affected. The percentage of target individuals with low ferritin values decreased in round 3 for all groups. This decrease may have also been due to treatment of subjects with Hg < 9 gm with iron supplements. The mean concentration of serum ferritin was in the low normal range for all groups. The lead males have the highest mean concentration (76.5 ng/ml in round 1) and toddlers have the lowest mean concentration (19.2 ng/ml).

There are a few individuals with very high serum ferritin level among the target adults and schoolers (see range for serum ferritin in Tables 9.2 and 9.4). This may indicate hemolysis or liver disease. The presence of endemic malaria with hemolysis is the most likely explanation. In addition, a pair of siblings had hemolytic anemia (non-malarial in origin). Two deaths occurred in lead males due to hepatoma, and one schooler died with chronic liver disease and cirrhosis.

Parasites

Malaria

The prevalence of malaria among all the target individuals (excluding the infants) was 1.7% in round 1. The prevalence increased to 7.9% in round 3. This finding is compatible with the increased prevalence of splenomegaly among the TI's in rounds 2 and 3 and the onset of the rainy season. The only form identified was falciparum malaria.

Intestinal parasites

About four percent of all target individuals (except infants) were found to have ascaris ova in the stool in round 1. The presence of ova was most common among the schoolers. The situation improved in round 3 with ascaris found in the stools of only 2% of the target individuals. The project policy to treat all positive cases (ova or parasites) may have contributed to the observed decrease in ascaris. The presence of even a single ascaris is potentially dangerous to health due to the active migration of this parasite.

Nearly half of all the target adults and up to one third of the schoolers were found to have hookworm infestation in round 1. This high percentage of hookworm infestation explains, in part, the prevalence of iron deficiency anemia among the target individuals. Radioisotopic measurement indicates that host blood loss can be as high as 0.15 ml per day per hookworm (3). Negligible numbers of hookworm ova were seen in toddlers, and none in infants.

No amoeba or strongyloide were noted among the stool specimens collected.

Cell Mediated Immunity

Results from the assessments in rounds 1 and 3, and the combined results from all rounds are presented in Tables 9.5 and 9.6. Rounds 1 and 3 were chosen for the same reasons listed for the laboratory findings.

Delayed Cutaneous Hypersensitivity

Skin test antigens (PPD, candida, tetanus toxoid) were used to test for delayed cutaneous hypersensitivity. A positive response is defined as having a resulting induration and erythematous at the injection site of 5mm; observed at 48 or 72 hours post injection.

A higher percentage of target children were found to have negative responses to the PPD and candida antigens than target adults. The situation was reversed, however, with the tetanus toxoid antigen. Toddlers have 88.5% of individuals showing negative response as compared with 96.6% of the lead males. Nevertheless, this is a very high level of negative response among the children since most of them have received the triple antigen (DPT). The mean skin indurations among those who showed any induration to skin tests are 11.4 ± 7.5 mm, 10.8 ± 8.0 mm, and 11.8 ± 8.0 mm for PPD, Candida and tetanus toxoid, respectively.

TABLE 9.1
Selected laboratory findings for adults: hematology.

	Lead Males		Lead Females	
	Round 1 (n=209)	Round 3 (n=143)	Round 1 (n=224)	Round 3 (n=149)
Hemoglobin mean ± SD gm/dl (range)	14.9 ± 1.8 (10.2-20.0)	14.1 ± 1.4 (9.8-17.0)	12.2 ± 1.8 (7.0-16.9)	12.0 ± 1.6 (6.5-15.3)
cutoff gm/dl*	≤12 ≤13	≤12 ≤13	≤11 ≤12	≤11 ≤12
% anemic	7.7 12.0	10.4 16.1	22.4 49.3	25.5 51.0
Hematocrit mean ± SD % (range)	43.0 ± 4.1 (30.0 58.0)	41.9 ± 4.0 (30.0-50.0)	36.8 ± 4.6 (20.0-47.0)	36.2 ± 4.4 (20.0-46.0)
cutoff %*	37.0	37.0	31.0	31.0
% anemia	12.0	22.4	16.6	18.8
Red cell Stain % hypochromic	9.1	6.9	36.7	22.8
Red cell morphology % microcytic	0.4	5.6	7.5	5.4
% macrocytic	0.0	0.6	6.3	8.7
Mean lymphocyte count cells/cmm†	2501	2693	2393	2938
% ≤ 1400	20.8	9.1	22.1	10.9
Eosinophils (% of WCC) mean ± SD % (range)	6.6 ± 5.6 (1.0-29.0)	5.3 ± 4.3 (1.0-25.0)	6.8 ± 5.0 (1.0-32.0)	6.3 ± 5.7 (1.0-36.0)
% with eosinophilia (6% of WCC)	37.8	28.9	42.1	34.6

* National Nutritional Survey Guidelines and Procedures (2).

† Lymphocyte count was obtained by multiplying the white cell count and the percentage of lymphocytes.

TABLE 9.2
Selected laboratory findings for adults: serum ferritin and parasites.

	Lead Males		Lead Females	
	Round 1 (n=209)	Round 3 (n=143)	Round 1 (n=224)	Round 3 (n=149)
Serum Ferritin				
Serum Ferritin mean ± sd ng/ml (range)	76.5 ± 87.0 (0.0-485)	86.7 ± 73.7 (10.0-375)	22.6 ± 34.9 (0.0-420)	30.0 ± 41.4 (5.0-455)
% deficiency* (ng/ml)	9.7	1.5	37.3	20.7
Parasites				
Ascaris ova/gm stool mean ± s.d (range)	6.6 ± 4.6 (1.0-13.0)	22.5 ± 29.0 (2.0-43.0)	7.3 ± 8.8 (1.0-22.0)	2.0 ± 0.0 (2.0)
specimens % positive	2.2	1.1	3.0	0.5
Hookworm ova/gm stool mean ± sd (range)	11.4 ± 14.4 (1.0-60.0)	15.0 ± 19.2 (1.0-78.0)	8.6 ± 11.6 (1.0-61.0)	9.5 ± 11.3 (1.0-43.0)
specimens % positive	48.0	15.5	55.1	22.0

* National Nutritional Survey and Procedures (2).

TABLE 9.3
Selected laboratory findings for schoolers and toddlers: hematology.

	Schoolers		Toddlers	
	Round 1 (n=124)	Round 3 (n=62)	Round 1 (n=85)	Round 3 (n=50)
Hemoglobin				
mean + sd gm/dl	12.1 ± 1.5	12.0 ± 1.3	10.7 ± 1.7	10.8 ± 1.4
(range)	(7.6-16.7)	(8.0-14.4)	(5.5-18.0)	(6.3-12.7)
cutoff gm/dl*	≤11 ≤12	≤11 ≤12	≤10 ≤11	≤10 ≤11
% anemia	19.4 55.6	19.4 54.8	27.0 64.7	18.0 42.0
Hematocrit				
mean + s.d %	36.2 ± 3.4	36.0 ± 3.6	33.5 ± 3.6	32.7 ± 4.1
(range)	(23.0-53.0)	(25.0-43.0)	(23.0-47.0)	(19.0-38.0)
cutoff %*	30.0	30.0	30.0	30.0
% anemic	4.0	8.1	11.8	20.0
Red cell Stain				
% hypochromic	47.6	14.5	80.2	50.0
Red cell morphology				
% microcytic	6.3	14.5	16.3	5.8
% macrocytic	3.2	3.2	11.6	7.7
Mean lymphocyte count cells/cmm†	3328	3989	5773	5962
% ≤ 1400	13.7	0.0	1.2	0.0
Eosinophils (% of WCC)				
mean + sd %	7.2 ± 5.3	5.8 ± 4.6	3.9 ± 3.9	4.6 ± 2.9
(range)	(1.0-28.0)	(1.0-24.0)	(1.0-30.0)	(1.0-12.0)
% eosinophilia (6% of WCC)	44.3	29.1	14.1	30.0

* National Nutritional Survey Guidelines and Procedures (2).

† Lymphocyte count was obtained by multiplying the white cell count and the percentage of lymphocytes.

TABLE 9.4
Selected laboratory findings for schoolers and toddlers: serum ferritin and parasites.

	Schoolers		Toddlers	
	Round 1 (n = 124)	Round 3 (n = 62)	Round 1 (n = 85)	Round 3 (n = 50)
Serum Ferritin				
Serum Ferritin mean ± SD ng/ml (range)	35.7 ± 39.3 (0.0-240)	40.3 ± 41.0 (10.0-280)	19.2 ± 24.4 (0.0-135)	30.0 ± 29.2 (8.0-160)
% deficiency* (< 10 ng/ml)	25.6	4.3	49.3	11.9
Parasites				
Ascaris ova/gm stool mean ± SD (range)	15.3 ± 10.3 (1.0-28.0)	11.0 ± 5.20 (3.0-14.0)	35.4 ± 43.3 (3.0-69.0)	5.5 ± 5.0 (2.0-9.0)
% positive	6.2	3.8	3.0	2.4
Hookworm ova/gm stool mean ± SD (range)	10.0 ± 9.9 (1.0-33.0)	9.3 ± 15.2 (1.0-45.0)	21.0 ± 27.0 (1.0-61.0)	4.2 ± 1.6 (2.0-6.0)
% positive	36.4	10.0	5.9	6.0

* National Nutritional Survey Guidelines and Procedures (2).

Tonsillar Size

Tonsillar size is one indicator of cell-mediated immunity status. Up to 21.6% of schoolers and 6.3 % of the toddlers showed a tonsil size of grade 0 during their physical examination. This may indicate a deficiency in cell-mediated immunity. Tonsil size findings have been presented in the section on physical examinations in Chapter 8.

Lymphocyte count

Lymphocyte counts were obtained by multiplying the white cell count with the percent differential count. The mean lymphocyte counts were in the low normal range for target adults (about 2500 cells/cmm) and were slightly higher among schoolers and toddlers. Up to 35% of the target adults and 18% of the schoolers had low lymphocyte counts (defined as < 2000 cells/cmm), as compared with 1.2% of the toddlers, in round 1.

T Cell Enumeration

The mean percentage of T cells (E-rosettes) were in the low normal range for all target groups. The mean was highest among the lead females who also had the smallest percentage of individuals with low % T cells (defined as 55% for adults and 50% for children). On the other hand, toddlers were found to have the highest percentage of individuals with low % T cells in round 1 (42.9%). The % T cells among toddlers was found to have significant positive correlations with kcal and food intake such as iron, fat, protein and animal protein. Percent T cells also correlates positively with anthropometric measures such as length and weight; especially with their slopes ($r = 0.47$ for length slope and 0.34 for weight slope). The correlation coefficient with skin fat fold is negative. Maternal literacy and ability to write also correlate positively with the % T cells. A summary of the correlation coefficients with the different variables are presented in Table 9.7. The relationships of % T cells are consistent with the other studies in that decreased CMI is seen in iron deficiency and obesity and better nutritional status is associated with higher % T cells. The positive association with food intake has not been previously reported (4).

Cell-mediated Immunity (CMI) Discussion

Preliminary examination of parameters of cell-mediated immunity in toddlers suggests the % T-cells reflect food intake, anthropometric nutritional status and a group of variables that are themselves correlated to the above factors (i.e., kcal intake and maternal literacy). Although the timing of the T-cells studies have not been coordinated with food intake and anthropometric variables as yet, the data are still suggestive of the responsiveness of % T-cells to food and nutritional factors. There are consistent positive correlations with iron, fat, protein, kcal intake, and the slopes for weight gain and linear growth. The negative correlations with diarrhea and fatness are in the expected direction. Other parameters of cell-mediated immunity appear decreased although analyses have yet to be undertaken. Children's tonsillar size appears reduced. Non-reaction to antigens with delayed cutaneous hypersensitivity appears increased and the percent of adults with a degree of lymphopenia appears increased. An analysis of all elements of CMI and their relationship to food intake and morbidity will be undertaken at a future time.

TABLE 9.5
Cell-mediated immunity: adults.

	Lead male			Lead female		
	Round 1 (n=97)	Round 3 (n=110)	All[§]	Round1 (n=89)	Round3 (n=96)	All
% T cells*						
mean ± SD	60.9±10.8	62.3±10.8	62.1±10.6	63.9±9.7	64.0±11.6	64.5±10.8
(range)	(30-80)	(30-82)	(30-84)	(40-80)	(30-90)	(30-90)
% low (< 55%)	28.9	21.8	23.3	19.1	18.7	16.5
Lymphocyte (cells/cmm)	(n=207)	(n=143)		(n=222)	(n=147)	
mean ± SD	2501±1256	2693±797	2581±991	2393±870	2938±1015	2617±953
(range)	(572-14720)	(789-5318)	(245-14720)	(273-4895)	(160-6636)	(160-7393)
% low (<2000/cmm)	33.8	22.4	26.6	36.0	15.6	26.7
DCH[†]		(n=263)			(n=278)	
PPD						
mean ± SD[‡]		11.6 ± 5.6			12.1 ± 9.3	
(range)		(1-30)			(1-75)	
% 0 or mm		71.1			68.7	
Candida						
mean ± SD		10.0 ± 4.9			11.4 ± 11.3	
(range)(1-20)(1-65)						
% 0 or mm		75.3			76.3	
Tetanus toxoid						
mean ± SD		10.5 ± 10.9			12.6 ± 8.4	
(range)		(3-42)			(2-42)	
% 0 or mm		96.6			91.0	

* Lymphocytes forming rosettes with sheep erythrocytes; values expressed as %.
† Delayed cutaneous hypersensitivity.
‡ Excludes individuals who do not show any skin induration to the skin test.
§ Combined results from the 6 rounds; individuals may be represented more than once.

TABLE 9.6
Cell-mediated immunity: schoolers and toddlers.

	Schoolers			Toddlers		
	Round 1 (n=32)	Round 3 (n=24)	All[§] -	Round 1 (n=14)	Round 3 (n=28)	All -
% T cells*						
mean ± SD	55.1 ±11.7	51.5 ±11.7	55.1 ±11.7	47.9 ±14.8	51.8 ±11.0	49.1 ±12.0
(range)	(20-80)	(30-80)	(20-80)	(10-70)	(30-65)	(10-70)
% low (50%)	12.5	33.3	18.6	42.9	28.6	40.7
Lymphocyte cells/cmm	(n=124)	(n=59)		(n=84)	(n=49)	
mean ± SD	3328 ±1842	3989 ±1140	3711 ±1982	5773 ± 2415	5627 ± 2069	5962±2932
(range)	(350-16125)	(1870-7495)	(350-23805)	(825-13426)	(1938-13877)	(825-31878)
% low (<2000/cmm)	18.5	3.4	10.0	1.2	2.0	1.0
DCH[†]		(n=146)			(n=130)	
PPD						
mean ± SD[‡]		9.8 ± 3.9			8.3 ± 4.7	
(range)		(1-15)			(2-15)	
% 0 or mm		92.5			93.1	
Candida						
mean ± SD		10.8 ± 6.6			12.4 ± 6.5	
(range)		(1-20)			(1-65)	
% 0 or mm		84.9			86.9	
Tetanus toxoid						
mean ± SD		10.4 ± 7.2			12.6 ± 6.1	
(range)		(1-22)			(2-20)	
% 0 5mm		91.1			88.5	

* Lymphocytes forming rosettes with sheep erythrocytes; values expressed as %.
† Delayed cutaneous hypersensitivity.
‡ Excludes individuals who do not show any skin induration to the skin test.
§ Combined results from the 6 rounds; individuals may be represented more than once.

TABLE 9.7
Correlation coefficients of % T cells (E. Rosette) with different variables, for toddlers.

Variables	n*	Toddler age (months)	Correlation coefficient†
<u>Food intake</u>			
Iron	51	19 - 21	0.24
	54	25 - 27	0.33
Fat	54	22 - 24	0.27
Protein	54	22 - 24	0.32
	54	25 - 27	0.35
Animal protein	54	22 - 24	0.26
Kilocalorie	51	19 - 21	0.25
	54	25 - 27	0.32
<u>Anthropometry</u>			
Length for age (percentile)	50	19 - 21	0.28
	54	22 - 24	0.22
	54	25 - 27	0.26
	50	28 - 30	0.21
Slope of linear growth	54	18 - 30	0.47
Weight for age (percentile)	54	22 - 24	0.23
	54	25 - 27	0.28
Slope of weight gain	54	18 - 30	0.34
Skin fat fold	50	19 - 21	-0.30
	54	22 - 24	-0.28
	54	25 - 27	-0.37
	54	28 - 30	-0.29
<u>Maternal literacy</u>	51	18 - 30	0.22‡
<u>Maternal ability to write</u>	51	18 - 30	0.24‡
<u>Episodes of Diarrhea</u>	54	18 - 30	-0.19

* The number of tests performed from 1984 through 1985.
† p = 0.005 - 0.05 except where otherwise noted.
‡ p = 0.05 - 0.1.

Humoral Immunity and Serum Protein

Humoral immunity was assessed by the levels of serum immunoglobulin: IgM, IgG, and IgA. They were, in general, found to be higher than U.S. values in all target groups, especially the IgG (see Tables 9.8 and 9.9). This is probably due to the high level of infections among the target individuals.

The classical and alternative pathways of complement activation play important roles in resistance to infection. The third component of complement was measured in the target individuals. The results are within the normal range for the target adults and in the high normal range for the target children.

C-reactive protein and other acute-phase reactant glycoprotein are good indicators of bacterial infection. The mean level of C-reactive protein are fairly similar among all the target groups (about 1.15 mg/ml) and are within the normal range.

Serum proteins, such as transferrin, albumin and pre-albumin are considered indicators of protein status. Iron deficiency anemia may be reflected by an elevated level of transferrin. It was found that the mean serum transferrin level is slightly higher than the reference range among the lead males and the target children, but within the normal range for the lead females. Pre-albumin level is a sensitive indicator for protein deficiency. The mean pre-albumin level was found to be within the normal reference range for all target groups except the schoolers, who have a mean level of 163.4 ug/ml (lower than the reference range). The albumin level is within the normal range for all target individuals except one lead female whose albumin level was 2.4 g/dl.

Secretory Immunoglobulins and Antibodies

Secretory immunoglobulin and antibodies are important in mucosal resistance to infection. There have been few studies done to determine the normal levels of IgA, IgG and lysozyme in breastmilk and saliva. Futhermore, a wide range of different values were found by different studies (8,9,10). These differences may be due to different techniques of measurement, different study populations, and different methods of collection. Moreover, in the case of breastmilk, there is a difference in composition of milk content at different periods during lactation.

The findings of immunoglobulin and lysozyme levels in breastmilk and lysozyme of the Kenya project are as follows:

Breastmilk

Over 200 breastmilk specimens were collected from mothers at 1, 3, and 6 months into the lactation period. Unfortunately, only 88 specimens were analyzed due to a shortage of funds. Frozen samples are still available for future analysis, should funds become avaliable. The mean level of secretory IgA in these 88 specimens of breastmilk collected from one month to six months was found to be 114.1 mg/dl which is much higher than the median (48 mg/dl).

TABLE 9.8
Serum immunoglobulin and protein levels: adults.

	US reference range[§]	Lead male (n=6)	Lead female (n=35)
Humoral immunity			
IgM mg/dl	55 - 350	402.4 ± 436.7* (113 - 1160)[†]	136.3 ± 51.4 (61 - 266)
IgG mg/dl	640 - 1350	2380 ± 754.2 (1730 - 3640)	1728 ± 427 (1150 - 3470)
IgA mg/dl	70 - 315	360.2 ± 131.5 (231 - 552)	203.5 ± 77.0 (62 - 411)
Serum protein			
C3[‡] mg/dl	80 - 180	153.7 ± 32.0 (103 - 191)	157.3 ± 39.7 (88 - 256)
C-reactive protein mg/dl	<1.2	1.13 ± 0.08 (1.10 -1.30)	1.22 ± 0.26 (1.10 - 2.0)
Transferrin mg/dl	200 - 360	414.5 ± 56.5 (337 - 479)	349.5 ± 53.6 (251 - 471)
Albumin g/dl	3.5 - 5.5	5.0 ± 0.55 (4.04 - 5.60)	4.4 ± 0.65 (2.36 - 5.52)
Pre-albumin ug/ml	190 - 430	365.5 ± 170.3 (48.0 - 500)	352.1 ± 85.5 (186 - 500)

* Mean ± SD
† Range
‡ Third component of complement
§ Reference range from the Speciality Laboratories, Inc. (5).

TABLE 9.9
Serum immunoglobulin and protein level: schoolers and toddlers.

	US reference range[§]	Schoolers (n=8)	Toddlers (n=41)
Humoral immunity			
IgM mg/dl	40 - 80	160.4 ± 128.8* (79 - 363)[†]	135.2 ± 47.1 (69 - 235)
IgG mg/dl	700 - 1100	2015 ± 487.8 (1250 - 2860)	1572.2 ± 621.9 (765 - 3730)
IgA mg/dl	40 - 100	165.1 ± 62.6 (102 - 306)	127.5 ± 87.5 (43 - 514)
Serum protein			
C3[‡] mg/dl	90 - 150	178.6 ± 29.0 (131 - 209)	151.9 ± 35.4 (86 - 265)
C-reactive protein mg/dl	<1.2	1.10 ± 0 (1.10 - 1.10)	1.17 ± 0.22 (1.10 -2.20)
Transferrin mg/dl	200 - 300	310.6 ± 47.4 (263 - 384)	331.7 ± 67.2 (245 - 475)
Albumin g/dl	≥ 2.5	4.40 ± 0.38 (3.75 - 4.97)	4.56 ± 0.56 (3.67 - 6.12)
Pre-albumin ug/ml	190 - 430	163.4 ± 144.8 (46.0 - 419)	229.7 ± 115.6 (63.0 - 500)

* Mean ± SD

† Range

‡ Third component of complement

§ Ranges derived from the Specialty Laboratory (5), Stiehm and Fudenberg (6), and Stiehm and Fulginiti (7).

The range is very wide (16 - 700 mg/dl). Similarly, there is a wide range of lysozyme level (7.4 - 860 ug/ml) with a mean of 130.4 ug/dl and a median of 29 ug/ml. IgG level were just detectable in all specimens (5.0 mg/dl). Analysis of the relationship between the breast milk findings and food intake and other variables have not yet been conducted.

Saliva

Toddlers were found to have the lowest mean level of secretory IgA. The mean levels of saliva secretory IgA were similar among schoolers and lead males (about 11 mg/dl), and highest among lead females (15.9 mg/dl). This is compatible with the study conducted by Burgio et al which showed that salivary secretory IgA level increases in childhood and reaches the adult level around the age of 6 years (11). The level of lysozyme in saliva is higher among the target adults than the target children, with mean values of about 14.7 ug/ml and 15.1 ug/ml, respectively. These values are slightly lower than the normal level (18.5 ± 3.6 ug/ml) obtained by Van Palensten Helderman (12) . Among all the specimens collected from different target groups, IgG was just barely detectable (i.e. 5 mg/dl), which is compatible with levels cited as normal in the literature (4.86 mg/dl) (13).

Summary

The immunologic data is presented at this time only for descriptive purposes. With the exception of correlation analysis of % T-cells in toddlers, no analysis relating immunologic variables to food intake or other factors have been undertaken to date.

TABLE 9.10
Levels of secretory IgA and lysosome in human breastmilk.

	Mean ± SD (range)	1st quartile	Median	3rd quartile
sIgA mg/dl	114.1 ± 153.0 (16.0-700.0)	33	48	88
Lysozyme ug/ml	130.4 ± 201.4 (7.4-860.0)	17	29	156

TABLE 9.11
Levels of secretory IgA and lysosome in saliva.

	Lead male	Lead female	Schoolers	Toddlers
sIgA* mg/dl	(n = 163)	(n = 213)	(n = 103)	(n = 53)
mean ± SD	10.8 ± 8.9	15.9 ± 15.2	11.2 ± 8.2	5.9 ± 4.9
(range)	(2.1-34.4)	(2-120)	(2.7-60.2)	(2.7-34.9)
Lysozyme†				
ug/ml	(n = 154)	(n = 204)	(n = 93)	(n = 53)
mean ± SD	14.4 ± 27.4	15.1 ± 30.7	9.5 ± 8.0	10.1 ± 17.1
(range)	(1.1-110.0)	(1.2-300.0)	(1.8-40.0)	(1.0-85.0)

* Reference value for children is 30.4 mg/dl (13)

† Reference value for adults and children is 18.5 ± 3.6 mg/dl (12)

REFERENCES

1. Boher F.J. Introduction to Medical Laboratory Technique, 5th edition. London: Butterworth's, 1978.

2. National Nutrition Survey Guidelines and Procedures. Division of Chronic Disease Program, Regional Medical Program Service. Bethesda, MD., 1969.

3. Markeil and Voge. Medical Parasitology, 3rd edition. Philadelphia: W.B. Saunders Co., 1971.

4. Chandra R.K., Newberne P.M. Nutrition, Immunity, and Infection. New York: Plenum, 1979.

5. Specialty Laboratories, Inc., 2122 Granville Avenue. Los Angeles, California.

6. Stiehm E.R., Fudenberg H.H. Serum levels of immune globulins in health and disease: A survey. Pediatrics 1966; 37: 715.

7. Stiehm E.R., Fulginiti. Immunologic Disorders in Infants and Children, 2nd edition. Philadelphia: W.B. Saunders Co. 1980.

8. Azzopardi D., Watson J.G. Gambian Children have less salivary secretory Immunoglobulin A than British children. Journal of Tropical Pediatrics 1986; 32: 120-122.

9. McMurray D.N., Humberto R., Casazza L.J., Watson R.R. Effect of moderate malnutrition on concentrations of immunoglobulins and enzymes in tears and saliva of young Columbian children. The American Journal of Clinical Nutrition, 1977; 30: 1944-1948.

10. Miranda R., Saravia N.G., Ackerman R., Murphy N., Berman S., McMurray D.N. Effect of maternal nutritional status on immunological substances in human colostrum and milk. The American Journal of Clinical Nutrition 1983; 37: 632-640.

11. Burgio G.R., Lanzavecchia A., Plebani A., Jayakar S., and Ugazio A. G. Ontogeny of secretory immunity: levels of secretory IgA and natural antibodies in saliva. Pediatr. Res. 1980; 14: 1111-1114.

12. Van Palestein Helderman, W.H. Lysozyme concentrations in the gingival crevice and at other sites in human subjects with and without gingivitis Arch. Oral. Biol. 1976; 21: 251.

13. The Harriet Lane Handbook: A Manual for Pediatric House Officers. Cole C.H. (ed). Chicago: Year Book Medical Publishers, Inc., 1984.

Chapter 10

REPRODUCTION AND LACTATION

The Nutrition CRSP Kenya Project collected data on a number of factors known to be related to reproductive outcome and lactation performance. For reproductive outcome, these variables included reproductive history; pregnancy complications; use of family planning; maternal age; height; parity; pre-pregnancy energy stores; food intake; morbidity; pregnancy duration; and presence of maternal disease such as anemia, hypertension, renal or cardiac disease, infection, malaria, or use of alcohol or drugs. During lactation, data were collected on maternal intake; morbidity; activity; body energy reserves; and breast feeding patterns and supplemental intake of the infant. Physiologic adjustments (including RMR) in the face of varying levels of energy intake are also potentially important factors in determining the outcomes of pregnancy and lactation. The analysis of the relationship of food intake to pregnancy outcome and lactation is presented in Chapter 23.

RESEARCH OBJECTIVES

The overall objective of the Reproduction and Lactation study was to examine pregnancy status, reproductive outcome, and lactation performance in relation to energy intake. Disease, socioeconomic status, literacy, and household environment were also considered as intervening variables. Specific objectives were:

1. To obtain reproductive histories on all lead females.

2. To detect pregnancies among lead females through a monthly pregnancy survey.

3. To monitor women through pregnancy in order to determine: a) pregnancy weight gain and change in body composition (e.g. fat and protein stores); and b) pregnancy outcome, as expressed by condition of the newborn (weight, length, head circumference, fat stores, gestational age and Brazelton test score) and mother and relate these to food intake.

4. To monitor the growth, development, and morbidity of the infant as an indication of maternal lactation performance, and relate it to maternal energy intake and change in body weight and composition.

5. To follow changes in maternal weight, body composition and morbidity during lactation.

6. To obtain maternal RMR measurements at 5 and 8 months of pregnancy and at 1, 3, and 6 months of lactation.

7. To obtain quantitative information on infant supplemental feeding, breast feeding frequency and feeding duration.

THE SAMPLE

The sample targeted for the reproductive history and pregnancy survey consisted of all lead females in the 247 households enrolled in the main study; the pregnancy outcome and lactation survey targeted all pregnant lead females who delivered from June 1984 through June 1985, and their offspring.

The Reproductive History questionnaire was administered to all lead females on one occasion at the beginning of the study in early 1984. The Pregnancy Survey questionnaire was administered to all lead females once per month, regardless of pregnancy status. The Pregnancy Outcome questionnaire was administered to all mothers who were pregnant and delivered a live born infant, stillborn infant, or had a miscarriage or abortion. This questionnaire was administered as close to delivery as possible, and always within 72 hours.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Development of the Reproduction and Lactation data collection techniques benefitted from a preliminary survey in the study area, visits to local hospitals and clinics, in-depth interviews with study area women, and pilot testing of questionnaires. The objective of these activities was to develop research protocols that would result in the collection of useful and reliable data on the topics of reproduction and lactation.

A preliminary survey was conducted in 1983 to collect background information on general fertility, patterns of family planning utilization, average birth interval, and such cultural practices as the perceptions and restrictions surrounding pregnancy, the care and feeding of the newborn infant, and the delivery patterns of pregnant women. This survey led to the development of the Reproductive History Form which was administered to all lead females at the beginning of the main study.

Senior field staff made visits to the two local hospitals with maternity services, the maternity unit of the health center, and local dispensaries to gain insights on pregnancy outcome and medical routines. Data were collected on birth weights, percent of preterm infants, maternal and perinatal deaths, types of complications seen, and obstetrical practices. It was found that mothers and infants were kept together and discharged within 24 to 36 hours after delivery. No eye prophylaxis was used, BCG was administered to newborns, birth weights were obtained, and Apgar scores were recorded 1 and 5 minutes after delivery. It was also found that the scales in the hospital were never calibrated.

Home visits were made to discuss pregnancy with women, and to assess how freely women could discuss this topic among themselves, with their husbands, and with fieldworkers. Occasionally, it was found that women did not want their husbands to know that they were pregnant. Pregnancy testing was acceptable to many who were unsure about their pregnancy status. Women appeared to recognize the presence of pregnancy during the 2nd and 3rd months through commonly recognized signs and symptoms. It was difficult to date pregnancies from the last menstrual period since many women rarely reported periods during the two study years, or had irregular menses, probably due to continuous cycles of pregnancy and lactation. When a menstrual history was present, the gestational age of the infant usually was found to be one to two weeks less than that indicated by a Dubowitz test, and not consistent with the infant's birth weight or length.

It was also found that the majority of women, 70% in the study area, delivered infants in a hospital, health center, or clinic aided by a trained nurse or midwife, or by a physician in the case of complications. The remaining women delivered at home on their own or with the assistance of a traditional birth attendant or relative. Women stated that they would not object to enumerators visiting their home shortly after delivery or again 7-9 days later to weigh infants and perform other research activities. Mothers usually had in their possession birth certificates for their young children (under five years old) which aided the enumerators in determining birth dates, birth intervals, and other vital data.

No dietary restrictions were imposed on women during pregnancy or lactation. Infants were given colostrum, and no special pre-lactational feeding practices were identified. Women who became pregnant during lactation tended to wean nursing children.

Information such as the above assisted in the formulation of four questionnaires: the Reproductive History (Form 411), the Pregnancy Survey (Form 412), Pregnancy Outcome (Form 413), and the Lactation Questionnaire (Form 421). All questionnaires were translated into Kiembu by well qualified bilingual translators, and back into English to be certain that the original meaning was not lost or distorted.

A Senior Investigator from the University of Nairobi and the Field Director were primarily responsible for developing the questionnaires and selecting and training the necessary staff. Female enumerators were found to be more successful with and acceptable to lead females than male fieldworkers in the Reproduction and Lactation study. Female fieldworkers could easily gain access to homes, health centers, and hospitals to collect labor and delivery data. The six women selected as reproductive enumerators were in their late twenties and early thirties, and slightly older than the average enumerator.

Extensive staff training was conducted under the supervision of the Senior Investigator from the University of Nairobi for several months prior to commencement of the main study. Aside from administering the Reproduction and Lactation forms, all enumerators were trained to collect anthropometric data as well (see Chapter 7). Enumerators were also trained to collect information from hospital labor and delivery records, to collect breast milk samples, and to collect urine samples for pregnancy testing. Pilot testing of all data collection techniques was completed prior to commencement of the main study.

TECHNIQUES OF DATA COLLECTION

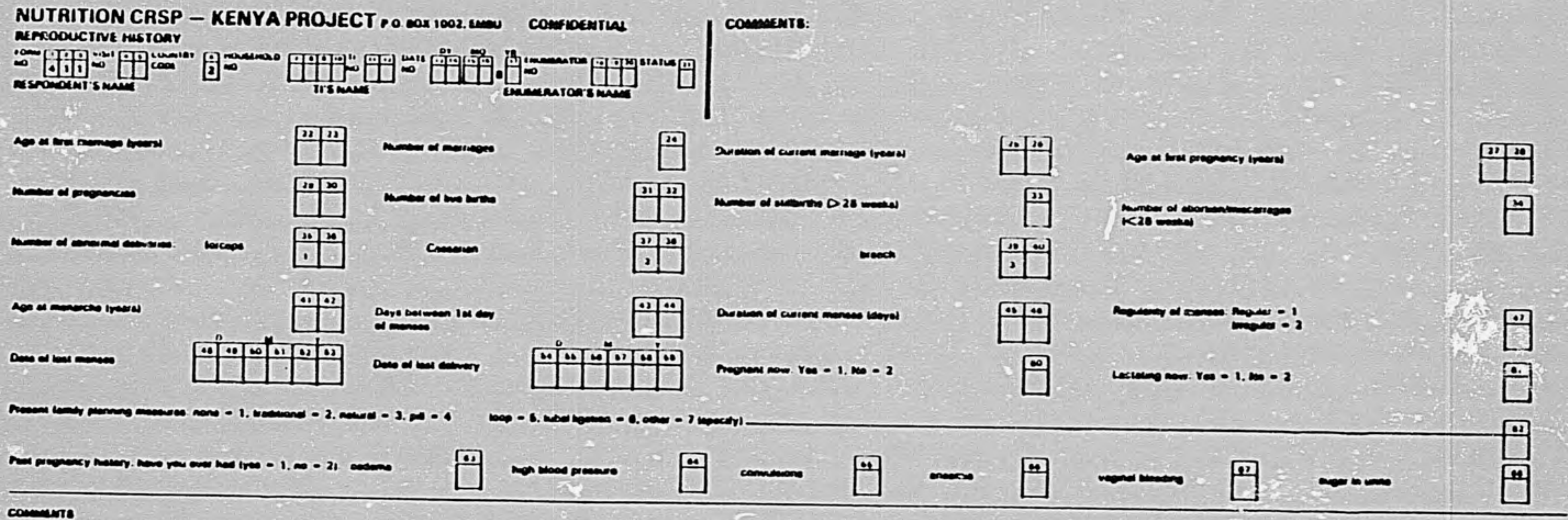
Reproduction and Lactation data were collected primarily through the administration of the Reproduction and Lactation questionnaires, pregnancy testing, Dubowitz testing, anthropometric measurements, and review of health center and hospital records.

Reproductive History (Form 411)

A reproductive history was obtained on all lead females at the outset of the Main Study in 1984. The reproductive history form was also administered to some women who were non-target lead females, however, only target lead females are reported. The reproductive history form (No. 411; Fig. 10.1) was administered by the enumerators to the lead females during a home visit. Information was collected on menstrual history, marriage history, pregnancy history, identification of high risk factors, and current pregnancy and lactation status. Questions were asked regarding complications during labor and delivery, and utilization of family planning services.

Pregnancy Survey (Form 412)

The pregnancy survey (Form 412; Fig. 10.2) was administered monthly to lead females in order to detect pregnancy. The aim was to detect pregnancy as early as possible, preferably by the fourth month. A lead female was asked about her last menstrual period, whether she thought she was currently pregnant, her expected date of delivery, presence or absence of common signs and symptoms of pregnancy, where she planned to obtain prenatal care, and/or deliver the infant, whether or not she was taking medication, vitamins, or mineral supplements, and whether she was lactating. If a woman was not certain that she was pregnant, she was offered a pregnancy test. Enumerators collected urine samples from lead females in clean plastic cups and forwarded them to the laboratory in Embu. The test used was the "Gestate Slide" screening test for the detection of human chorionic gonadotropin (HCG) (Eiken Chemical Co.), utilizing an indirect latex agglutination procedure, whereby latex particles are coated with HCG antigen which agglutinates in the



NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU CONFIDENTIAL

REPRODUCTIVE HISTORY

FORM NO 411 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TI NO DATE DY MO YR ENUMERATOR NO STATUS

RESPONDENT'S NAME TI'S NAME ENUMERATOR'S NAME

COMMENTS:

Age at first marriage (years)

Number of marriages

Duration of current marriage (years)

Age at first pregnancy (years)

Number of pregnancies

Number of live births

Number of stillbirths (>28 weeks)

Number of abortion/miscarriages (<28 weeks)

Number of abnormal deliveries: forceps 1 Caesarian 2 breech 3

Age at menarche (years)

Days between 1st day of menses

Duration of current menses (days)

Regularity of menses: Regular = 1 Irregular = 2

Date of last menses D M Y

Date of last delivery D M Y

Pregnant now: Yes = 1, No = 2

Lactating now: Yes = 1, No = 2

Present family planning measures: none = 1, traditional = 2, natural = 3, pill = 4 loop = 5, tubal ligation = 6, other = 7 (specify) ______

Past pregnancy history: have you ever had (yes = 1, no = 2): oedema high blood pressure convulsions anaemia vaginal bleeding sugar in urine

COMMENTS

FIG. 10.1. Reproductive history form 411.

NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU **CONFIDENTIAL**

COMMENTS:

PREGNANCY SURVEY

FORM NO [1 2 3] 4 1 2 · VISIT NO [4 5] · COUNTRY CODE [6] 2 · HOUSEHOLD NO [7 8 9 10] · TI NO [11 12] · DATE NO DY [13 14] MO [15 16] YR 8 [17] · ENUMERATOR NO [18 19 20] · STATUS [21]

RESPONDENT'S NAME · TI'S NAME · ENUMERATOR'S NAME

Date of last menstrual period — D M Y [22 23 24 25 26 27]

ARE YOU PREGNANT NOW: yes = 1, not sure = 2, no = 3 [28] — IF ANSWER IS YES(1) OR NOT SURE(2) ANSWER THE FOLLOWING:

Expected date of delivery — D M Y [29 30 31 32 33 34]

	Heaviness of body	Heaviness of Breasts	Cravings	Morning sickness	Quickening	Nipples enlarged	Oedema
Do you have the following symptoms? yes = 1, no = 2	[35]	[36]	[37]	[38]	[39]	[40]	[41]
If yes, for how many weeks have you had the symptoms?	[42 43]	[44 45]	[46 47]	[48 49]	[50 51]	[52 53]	[54 55]

Are you or will you obtain prenatal care? [56] — no = 1; Karurumo H.C = 2, Embu Hosp = 3, Kyeni Hosp = 4, Runyenjes H.C = 5, Kathanjuru Dsp = 6, traditional = 7, Other = 8 (Specify ________)

Where will you deliver? [57] — home = 1, Karurumo H.C = 2, Embu Hosp = 3, Kyeni Hosp = 4, Runyenjes H.C = 5, Other = 6 (Specify ________)

Are you taking medicine? [58] — none = 1, vitamins = 2, iron = 3, antimalarials = 4, others = 5 (Specify ________), don't know what = 6

Are you lactating now? [59] — yes = 1, no = 2. (If yes complete Lactation survey form)

COMMENTS:

FIG. 10.2. Pregnancy survey form 412.

presence of specific antibody. The sensitivity of the pregnancy test is 0.6 IU/ML. Technicians filtered the urine, added buffer solutions and coated latex suspension, mixed reactants and observed the agglutination. Observed agglutination was interpreted as positive for pregnancy. The laboratory notified the enumerators the following day, and the enumerators informed the woman immediately. If the agglutination was obscure, another sample was obtained and tested one week later.

Pregnancy Outcome (Form 413)

The pregnant lead females near term were monitored by weekly and then daily home visits by enumerators who documented the delivery and condition of infant and mother at the time of delivery. Upon birth, the enumerator weighed the infant (within 72 hours of delivery) and recorded the details of the delivery on the Pregnancy Outcome form (No. 413; Fig. 10.3). The information recorded included birth date, time and place of delivery, outcome of delivery, type of delivery, plurality, Apgar scores, who delivered the infant, and the number of hours after birth that weight was measured. The remainder of the form was left for the physician to fill out after the examination of the newborn and the mother.

If an infant had to be weighed in the clinic or hospital, a CRSP project scale was used. The enumerator then notified the physician, cognitive supervisor, field director, data manager, and anthropometry supervisor. On receipt of confirmation, the Data Manager documented the delivery and informed all appropriate cluster enumeration teams of the presence of a new target individual in the household.

The physician carried out a limited clinical examination of the mother and a full examination on an infant in the home within 72 hours of birth. Potential maternal conditions such as hemorrhage, chills, fever, purulent vaginal discharge, or any other post-partum complications, abnormal findings, or difficulties with lactation were identified. The results were recorded on the Pregnancy Outcome Form and coded with the appropriate ICD codes (1). The gestational age of the infant was determined by Dubowitz examination (2). If the Dubowitz examination was not carried out within the first 72 hours, it was still carried out as late as 5-7 days of life. (Examination at 5-7 days has been documented as valid by Dubowitz and Dubowitz [2]). A complete physical examination of the infant was performed and results coded with the appropriate ICD codes (1).

Enumerators returned to visit the infant and mother at 7 to 9 days post-partum to take full anthropometric measurements. Measurements on the infant included: weight, length, arm and head circumferences, and triceps, biceps, and subscapular fatfolds. Measurements on the mother include: weight, length, and arm circumference, and triceps, biceps, and subscapular, supra-iliac, abdomen, and thigh fatfolds. Thereafter, measurements were repeated on the infant at one month of life (± 1 week) and every subsequent month until he/she reached six months of age. Anthropometric measurements including all six fatfolds were carried out on the mother one month post-partum and at monthly intervals through the first six post-partum months.

Lactation Questionnaire (Form 421)

The Lactation Questionnaire (Form 421; Fig. 10.4) was used in conjunction with the collection of breast milk samples and administered monthly by the Reproduction team to the lead female after delivery. The questionnaire was used to record how the infant was fed, how many infants the mother was nursing at one time, the duration and frequency of feedings (both day and night), whether there were additions of supplementary foods, the weaning practices, and use the of bottle/formula feeding. The data reported by the Reproduction enumerators on supplementary foods were primarily qualitative, with the Food Intake enumerators documenting the exact amounts of the supplemental feedings.

Other Relevant Studies

In addition to administering the above questionnaires, a Brazelton test was carried out on each infant between one and seven days after birth (see Chapter 11) by a trained nurse and/or by the psychologist. Finally, the resting metabolic rate (RMR) of the pregnant/lactating females was carried out at 5 and 8 months of pregnancy, and 1, 3, and 6 months during lactation. See Chapter 23.

NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU **CONFIDENTIAL**

PREGNANCY OUTCOME

FORM NO 4 1 3 VISIT NO 0 1 COUNTRY CODE 2 HOUSEHOLD NO TI NO DATE DY MO 8 YR ENUMERATOR NO STATUS PHYSICIAN NO

RESPONDENT'S NAME TI'S NAME ENUMERATOR'S NAME

COMMENTS:

Missing data, use, 8, − 8, − 88 etc. Not applicable, use 9, − 9, − 99 etc

BIRTH DATE (DY, MO, 8 YR)

OUTCOME OF DELIVERY: 1. Livebirth 3. Stillbirth (> 28 wks) 2. Abortion/miscarriage (< 28 wks)

TYPE OF DELIVERY: 1. SVD 2. Breech 3. Vaccum 4. Caesarian 5. Forceps

PLURALITY: 1. Single 2. Twins 3. Triplets 4. Quadruplets

(APGAR) (1 min)

APGAR (5 min)

WHERE DELIVERED: 1. Home 2. Karurumo HC 3. Embu Hos 4. Kyeni Hos 5. Runyenje HC 6. Other (specify in comments)

WHO DELIVERED: 1. Relative 2. Trad midwife 3. Enrolled midwife 4. Clinical officer 5. Physician 6. Other (specify in comments)

WEIGHT (Kg)

HOURS AFTER BIRTH (FOR WT)

GESTATIONAL AGE (WEEKS) BY: a) MENSES b) DUBOWITZ

HOURS AFTER BIRTH (FOR DUBOWITZ)

INFANT PHYSICAL CONDITION: 1. AGA 2. SGA 3. LGA

ABNORMAL FINDINGS (ICD NAME & CODE) 1. 2. 3.

TIME OF DELIVERY (24 hr)

MATERN PP CONDITION: 1. NORMAL 2. ABNORMAL

ABNORMAL FINDINGS (ICD NAME & CODE) 1. 2. 3.

FIG. 10.3. Pregnancy outcome form 413.

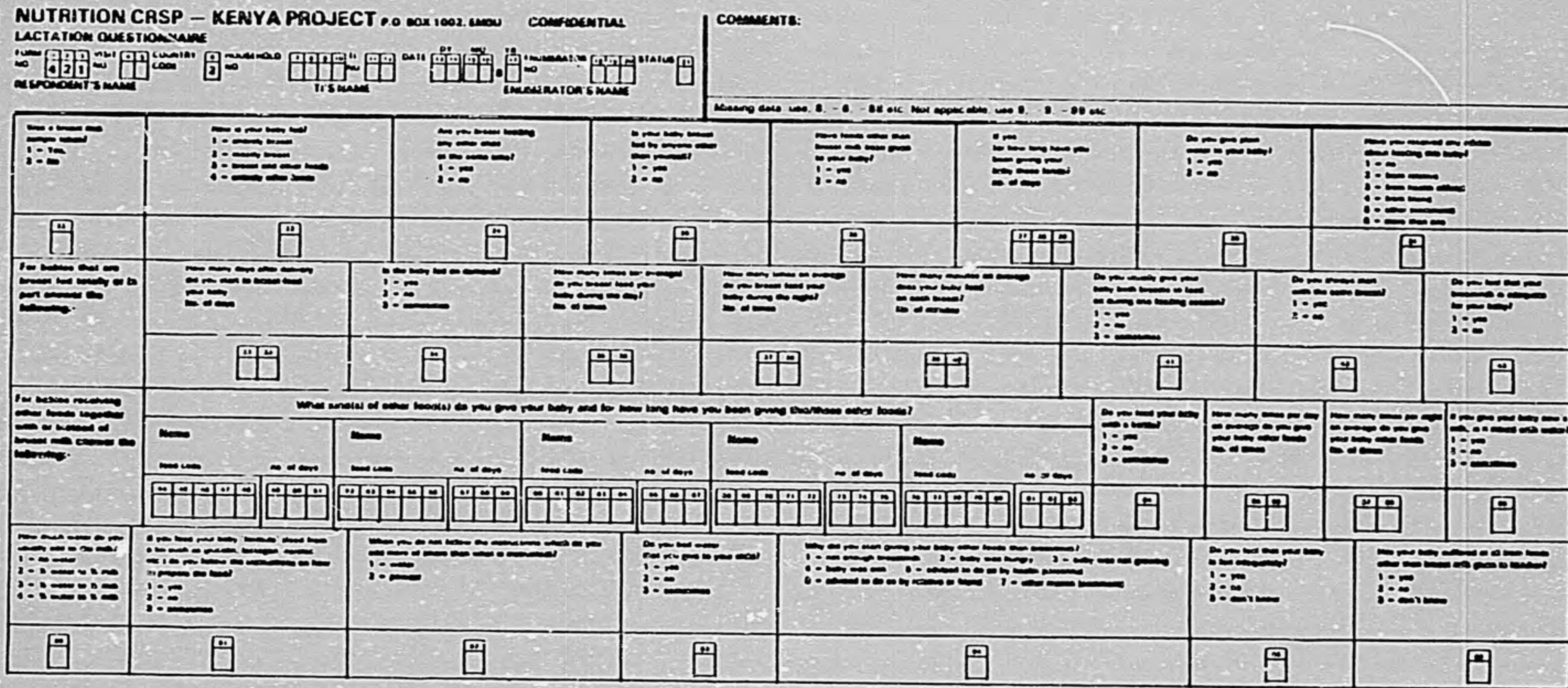


FIG. 10.4. Lactation questionnaire form 421.

QUALITY CONTROL MEASURES

Numerous safeguards were built into the data collection and data handling procedure, to ensure that high quality data were collected. Quality control measures included direct field supervision of data collection, data form checks, scale calibration, re-interviews, and repeat measures.

Supervisors observed the administration of the Reproductive History, Pregnancy Survey, and Lactation forms daily. Independent reinterviews were carried out within one week on a 5% subsample by the supervisors. For the Pregnancy Outcome form, repeat measures on birthweight, maternal weight, and an independent Dubowitz examination were carried out on a 5% subsample.

Quality control measures taken during collection of the anthropometric measurements and cognitive tests are reported in the respective chapters.

PREPARATION OF DATA FOR ANALYSIS

Many derived variables were compiled for the pregnancy analysis section. The variables were constructed to accurately reflect biologic events as well as to maximize the sample size. The following definitions are in analyses:

Gestational Age (GA): GA is the basis for the fixing the "day of conception". The GA utilized in analysis was based on the Dubowitz examination (2) of the newborn in 79% of the cases. GA based on menses (LMP) were generally unreliable as the LF rarely have regular menses because of continuous cycles of pregnancy and lactation. When Dubowitz testing was not possible, the Lubchenco Intrauterine Growth Curves were used by selecting the 50th percentile gestation age for the infant's weight, length, and head circumference values (3). See Fig. 10.5. These curves were constructed at an altitude similar to the study area. Newborn infants weighing 2800 gm or more were assumed to have a GA of at least 37 weeks. The date of conception was determined by subtracting the gestational age from the date of birth.

Trimesters: Pregnancy trimesters were used to describe maternal anthropometry, food intake, morbidity, etc. Day 0 is considered the day of conception and trimesters are counted from the day of conception.

1st:: 0-90 days
2nd: 92-180 days
3rd: 181 days until delivery

An alternate definition of trimesters is as follows:

1st:: Beginning of 1st trimester or day of conception to 75-105 days
2nd: Beginning of 2nd trimester, 75-105 days, to 195-205 days
3rd: Beginning of 3rd trimester 95-205 days to last measurement prior to delivery:
- i) within 15 days prior to deliver (LSWT 15)
- ii) within 30 days prior to delivery (LSWT 30)

Pre-pregnancy Values:

1. Closest values within 90 days prior to conception; up to 60 days post-conception.
2. Mean values within 90 days prior to and up to conception.
3. Mean of all values from 90 days prior to conception and up to 60 days post conception.
4. Mean of values between birthdate minus 205 days to birthdate minus 175 days.

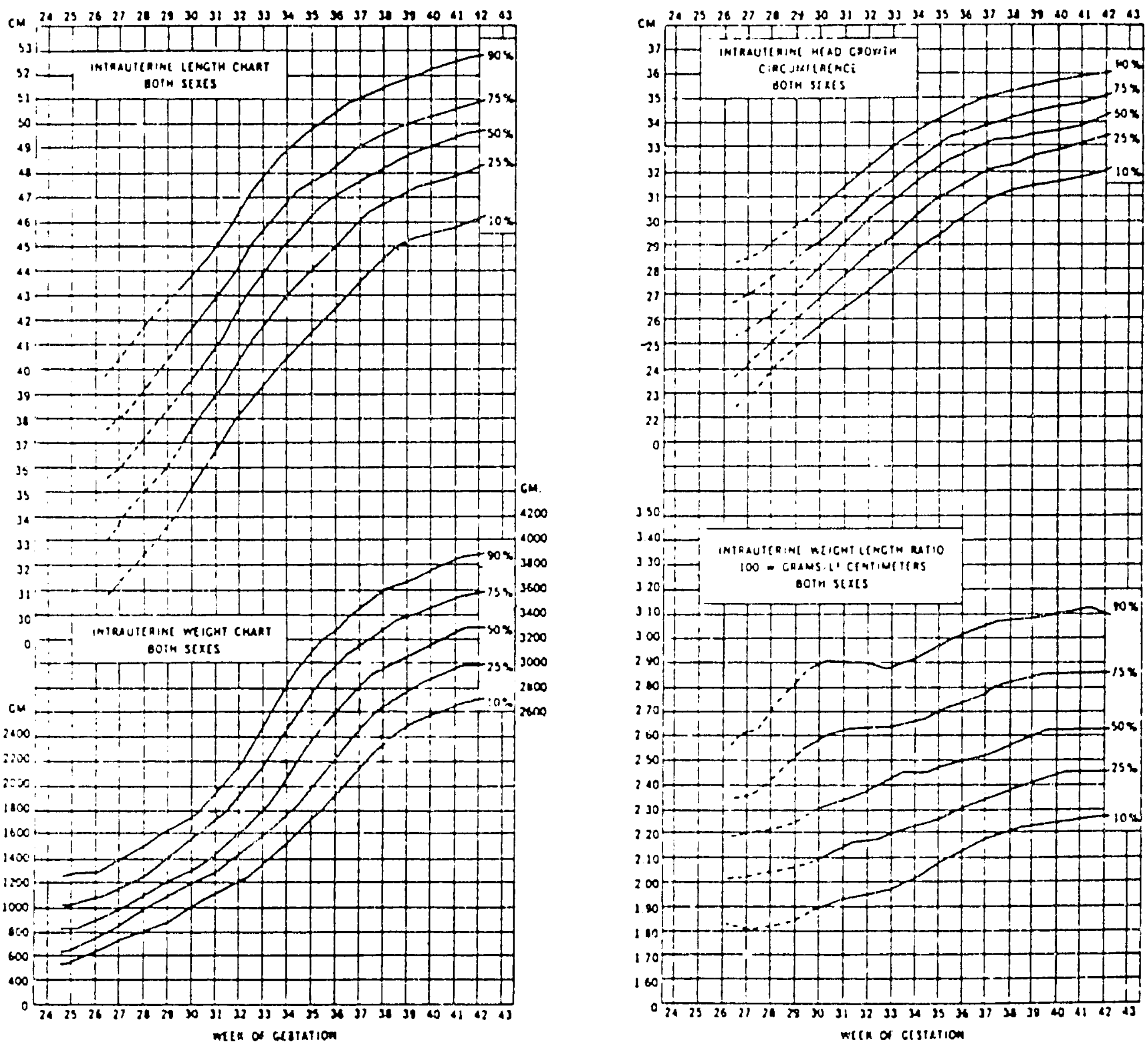
Colorado Intrauterine Growth Charts

Name ______________________

Birth date ______________________

Hospital number ______________________

Date ______________________



From Lubchenco, L.O., et al., Pediatrics 37:403, 1966.
Additional copies available from Ross Laboratories, Columbus, Ohio 43216

FIG. 10.5. The Lubchenco intrauterine growth curves used to estimate gestational age.

Pregnancy Weight Gain:

Pre-pregnancy (PR) value until 15 days prior to birthdate	PR 15
Pre-pregnancy (PR) values until 30 days prior to birthdate	PR 30
Last 2 trimesters to within 15 days prior to birth	PE 15
Last 2 trimesters to within 30 days prior to birth	PE 30

(175 days to within 15 days of birthdate or 30 days of birthdate)

Post Partum (PP) Values:
Within 3 days (72 hrs.) of birth - pp1
Within 7 days to 9 days of birth - pp2

Birth Weight (on CRSP scales):

Within 72 hrs. of birth	BW
Within 7-9 days	BW2

Lactation:
Period 1: 0 to 45 days
Period 2: 46-135 days
Period 3: 136-180 days
(or by 30 day periods: 1 to 6)

Net Post-partum Wt. Gain: post-partum wt 2 minus pre-pregnant wt.

Total kcal Pregnancy Intake:
Trim. 1: Sum of daily mean kcal intake x 30 for each of the 3 mos.
Trim. 2: Sum of daily mean kcal intake x 30 for each of the 3 mos.
Trim. 3: Sum of daily mean kcal intake x exact number of days in 3rd trimester.

Total kcal for 2nd & 3rd Trimesters: Same as above minus Trim. 1.

Net Wt. Gain: post-partum wt 2 minus PR wt.

Available Energy (AE): kcal intake minus RMR for same defined time period.

Net Available Energy in Lactation (NAEL): (Net post-partum wt gain) x 6500 kcal plus available energy in lactation (mean kcal intake - mean RMR measured concurrently for a deferred period).

Miscarriage/Abortion: A loss of the products of conception from the uterus before the fetus is viable, prior to 28 weeks of gestational age.

Stillbirth: The delivery of a fetus of at least 28 weeks of gestational age, which never breathed or displayed other signs of life.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Reproductive History

The reproductive history (Form 411) of 288 lead females was obtained at the onset of the study to serve as a background for the study of pregnancy outcome. The findings are summarized in Table 10.1.

TABLE 10.1
Selected data on the reproductive history of lead females.

	Mean ± S.D	Range	%	First Quartile	Third Quartile
Age at 1st pregnancy, yr.	19.0 ± 2.7	12-29		17	20
Total No. of pregnancies	5.8 ± 2.9	0-15		4	8
Never pregnant			0.3%		
No. of live births	5.2 ± 2.5	0-15		3	7
No. of stillbirths	0.3 ± 0.5	0-4			
		0	77.8%		
		1	19.4%		
		2	2.4%		
		4	0.3%		
No. of abortions/ miscarriages	0.4 ± 0.8	0-7			
		0	70.5%		
		1	21.5%		
		2	5.9%		
		5	1.4%		
		7	0.3%		

The age at first marriage ranged from 13 years to 34 years, with mean age of 19.7 (SD = 3.0) years. Three of the women (1.0%), were not currently married, twelve women (4.2%) had been married twice, and the remainder had married only once. The reported duration of the current marriage ranged from one to 31 years, with a mean of 12.0 (SD = 6.6) years.

Pregnancy

The age at first pregnancy ranged from twelve to 29 years, with a mean of 19.0 (SD = 2.7) years. Women reported 0-15 pregnancies, averaging nearly six pregnancies each. One woman had never been pregnant. The total number of live births per women also ranged from 0-15; the average was five live births. While the majority of woman had never experienced a stillbirth, abortion or miscarriage, several reported multiple stillbirths, and a greater number reported multiple abortions and miscarriages. Approximately 20% of the women stated that they were currently pregnant, and 42% were currently lactating.

Menstrual History and Date of Last Delivery

The age of menarche ranged from ten to 20 years, with most women reporting the onset of menstruation at 15 years. In early 1984, 3% of women reported their last menses to have been at some time between 1976 and 1981; 3% had their last menses in 1982; 59% in 1983; and 36% in 1984.

The majority of women, 57%, had last delivered in 1982 as this was one of the criteria for selection. Six percent delivered an infant in 1983, and less than 1% had delivered in 1984. The remainder, 36%, last delivered in 1981 or earlier. The average birth interval was about two and a half years.

The number and type of abnormal deliveries were reported as follows. Nine percent of women reported one caesarian, 2% reported two caesarians, 5% reported three, and 1% reported four and five, respectively. One percent of the women had each experienced two deliveries requiring the use of forceps. Three percent of the women reported one breech delivery, 1% reported two breech deliveries, and another 1% reported four breech deliveries.

Conditions experienced by the women in past pregnancies included oedema (23%), high blood pressure (22%), anemia (15%), vaginal bleeding (5%), and a history of sugar in their urine (less than 1%).

Family Planning

Forty-seven percent of the women reported that they were not currently using any method of family planning. Among those claiming to use family planning, natural methods were the most popular, followed by the pill, IUD, traditional methods, tubal ligation, and other methods (see Table 10.2).

Summary

In summary, this group of women married young and started childbearing early, at around 19 years of age. The women reported an average of five livebirths each, which is quite high considering the women as a group were relatively young, averaging around 32 years of age at the time of the survey. This is not surprising, given that Kenya is recognized as having the highest population growth rate in the world. While the majority of women had never experienced a stillbirth, abortion, or miscarriage, quite a few did report multiple abortions and miscarriages. The rate of abnormal delivery, particularly multiple ceasarians was also high. This may reflect, in part, the prevalence of cephalo-pelvic disproportion among women due to early PEM and low stature. No rickets or osteomalaria was seen in the study population or reported by the local hospitals. The mean age of menarche reported by the women, 15 years, is relatively delayed in contrast to urban populations. The low reported rates of utilization of family planning, particularly of the more effective methods is also notable.

Pregnancy Survey

The pregnancy survey (Form 412) was used to identify pregnancy in the early stages, to monitor women's signs and symptoms of pregnancy, and to investigate women's plans for prenatal care and delivery.

A total of 3,036 responses were collected from 247 women monthly over a period averaging twelve months. Each woman was initially asked whether or not she was pregnant. If she responded positively or indicated she was not sure, the remainder of the questionnaire was administered. In any given month, approximately 30% of women indicated that they thought they were pregnant, and about 2% were not sure.

TABLE 10.2
Current use of family planning methods.

Method	N	%
No method	134	46.9
Natural Methods	82	28.7
Pill	29	10.1
IUD (loop)	18	6.3
Traditional	4	1.4
Tubal Ligation	2	0.7
Other methods	17	5.9
Total:	286	100.0

Common Signs and Symptoms of Pregnancy

Signs and symptoms associated with pregnancy were reported by the majority of the women suspecting pregnancy. Heaviness of body was reported by 88% of the women, and 80% reported heaviness of breasts. Cravings were reported by 52% of women, morning sickness by 61%, quickening by 99%, enlarged nipples by 71%, and oedema by 17%.

A preliminary look at the reported distribution of symptoms revealed the following. Heaviness of body and breast was reported by women early in pregnancy and was experienced increasingly through the final trimester. Cravings were experienced by women throughout pregnancy, with 30% to 50% of the respondents reporting cravings in any given month and over 50% of the respondents reporting cravings during their third, sixth, and eighth month of pregnancy.

Morning sickness was reported by 45% to 60% of the respondents in any given month of pregnancy. Morning sickness apparently peaked during the third and eighth month of pregnancy. Quickening usually commenced in the second trimester, and was reported by over 98% of the respondents throughout the last trimester. Enlarged nipples were reported beginning in the first month of pregnancy, and were increasingly reported through the ninth month. Oedema was reported primarily during the seventh month.

Prenatal Care

Among those women confirming or suspecting pregnancy, nearly all planned to seek or were currently receiving some form of pre-natal care. Sixty percent planned to go to Karurumo Health Center at the lower end of the study area and 32% to Kyeni hospital, a mission hospital which charged a delivery fee. Four percent planned to go to one of the other health centers or hospitals in the area, 4% had other sources of care, and less than 1% of the women said they would not seek any pre-natal care. None of the woman admitted to seeking or using traditional care. As was reported, nearly all women received antenatal care but the actual number of visits is not known.

Site of Delivery

The site of delivery was reported for 132 births. The majority of infants were delivered by trained qualified personnel in a hospital or health center. Approximately one third of women delivered at home or enroute to a center or hospital. Transportation may have been a problem because of long distances to these facilities (in some cases as much as a 40 minute walk). The provisions for home deliveries are uncertain. Actual site of delivery is shown in Table 10.3.

Use of Medication

The majority of pregnant women, on average 84% per month, were not taking any medication or vitamin and/or mineral supplements. Six percent were taking vitamins, 3% were taking iron, 2% were taking anti-malarials, 2% were taking other medications, and 3% were not able to identify the type of medication they were taking.

TABLE 10.3
Actual site of delivery (n=247).

Location	Actual (%)
Kyeni Hospital	34.8
Karurumo Health Center	28.8
Home	22.0
Embu Hospital	9.1
Runyenje Health Center	1.5
Other Locations	3.8
Total:	100.0

Lactation During Pregnancy

Among those women reporting or suspecting pregnancy, only 4% were currently lactating. Very few women continued to lactate beyond their second month of pregnancy.

Pregnancy Tests

Urine tests were administered to approximately one third of the women that claimed or suspected pregnancy. Of the tests administered, 41% yielded positive results.

Summary

Overall women were well aware of the signs and symptoms of pregnancy. Over 50% of women suspecting pregnancy, however, received negative results upon urine testing. There is a strong desire to have children. The vast majority were not taking any medication or vitamin supplements, and nearly all women planned to seek prenatal care. Reported morning sickness was high throughout pregnancy and, strikingly, the peak occurred during the eighth month. The timing of this corresponds to the late third trimester weight loss and decreased food intake.

Pregnancy Outcome

The pregnancy outcome form (Form 412) was used to document the specifics of the delivery and health of the post partum mother and newborn infant. Among the 138 pregnancies reported during the main study, 94 infants were born in 1984, and 43 in 1985 (one was not specified).

Also, 95% of the 138 pregnancies resulted in live births, 4% in abortions/miscarriages (occurring at less than 28 weeks gestational age), and 1% in stillbirths (greater than 28 weeks of gestational age) (Table 10.4). This translates into a fetal death rate of 36 per 1000, and a perinatal death rate of 30 per 1000. There were no maternal deaths.

Among the 131 documented deliveries, 98% were single deliveries, and 2% were twins. Ninety-one percent were normal-spontaneous vertex deliveries. Six percent of the deliveries were by ceaserian section, two percent were breech deliveries, and 1% were vacuum extractions.

The neonates were usually in excellent condition at birth. Apgar scores were recorded at one and five minutes after delivery for 72 infants. The one minute scores ranged from one to nine, with a mean and SD of 9.0 ± 1.5. The five-minute Apgar scores ranged from four to ten, with a mean and SE of 9.8 ± 0.9.

Sixty-five percent of the infants were delivered by trained midwives, 13% by relatives, 6% by traditional midwives, 4% by clinical officers, 3% by physician, and 9% by other unspecified persons.

Birthweight

Of 130 infants weighed at birth, the weights ranged from 1.6 to 4.0 kg, with a mean of 3.1 ± .5kg. For the full range of values, see Table 10.5. Approximately 11% (10.8) of the infants were low birthweight (2500 g). Fig. 10.6 presents the complete distribution of infant birthweights. The number of hours after the delivery birth weight was measured ranged from one to 96, with a mean of 24 ± 23 hours.

Gestational Age

The gestational age, calculated by date of the last menstrual period (LMP) was reported for 117 infants. The range was from twelve weeks to 51 weeks, with a mean of 36.4 ± 4.6 weeks. Gestational age was determined by Dubowitz examination for 103 infants, which yielded a range of 31 to 42 weeks and a mean of 39.1 ± 2.2 weeks. A comparison of the gestational age calculated by LMP with the gestational age as determined by Dubowitz examination is presented in Table 10.6 and Fig. 10.7. The preterm rate (37 weeks gestation using Dubowitz data) was 10.7%. The exact age of the newborn at the time of the Dubowitz examination ranged form three hours to eight days. Ninety percent of the infants were examined within the first 72 hours. The Dubowitz score was used for dating conception in 79% of the cases. For methods used when Dubowitz was not available see "Preparation of Data for Analysis" in this chapter.

TABLE 10.4
Pregnancy outcome, type of delivery, and type of birth attendant.

	n	%
Outcome		
Livebirth	131	94.9
Abortion/Miscarriage (<28 weeks)	5	3.6
Stillbirth	2	1.4
Total	138	100.0
Type		
Spontaneous Vortex Delivery	119	90.8
Ceaserian	8	6.1
Breech	3	2.3
Vacuum	1	0.8
Forceps	0	0.0
Total	131	100.0
Birth Attendant		
Enrolled Midwife	85	64.9
Relative	17	13.0
Traditional Midwife	8	6.1
Clinical Officer	5	3.8
Physician	4	3.1
Other	12	9.2
Total	131	100.0

Newborn and Maternal Post-Partum Examinations

The physical condition of the infant was assessed by the physician as soon after birth as possible but no later than 72 hours.

Eighty percent of the newborns were determined to be normal and 20% were diagnosed as having a wide range of conditions. The diagnoses included Herpes Simplex, Gonococcal omphthalmitis (two newborns), bronchial cleft cyst, ventricular septal defect, other anomalies of upper limb, anomalies of the ear, disorders relating to short gestation, low birthweight, and being born small for dates. Also, omphalitis, tongue tie, "other infections specific to the perinatal period" and neonatal jaundice were found. Pelvic inflammatory disease and gonococcal infections, based on hospital and clinic data, are relatively common though underreported.

Eighty-two percent were determined to have an appropriate weight for gestational age, 16% were small for gestational age, and 2% were large for gestational age using the Dubowitz score and the Intrauterine Growth Reference Curves of Lubchenco constructed on Denver Colorado infants born at about 5200 feet (3; and see Fig. 10.5). Most of the Nutrition CRSP study area is at 4000-4500 feet.

TABLE 10.5.
The distribution of infant birthweights: sexes combined.

Birthweight (kg)	Frequency	%	Cumulative %
1.6	1	0.8	0.8
1.8	1	0.8	1.5
2.1	1	0.8	2.3
2.2	1	0.8	3.1
2.3	2	1.5	4.6
2.4	3	2.3	6.9
2.5	5	3.8	10.8
2.6	7	5.4	16.2
2.7	7	5.4	21.5
2.8	13	10.0	31.5
2.9	5	3.8	35.4
3.0	11	8.5	43.8
3.1	9	6.9	50.8
3.2	15	11.5	62.3
3.3	6	4.6	66.9
3.4	8	6.2	73.1
3.5	10	7.7	80.8
3.6	8	6.2	86.9
3.7	5	3.8	90.8
3.8	7	5.4	96.2
3.9	1	0.8	96.9
4.0	4	3.1	100.0

n = 130 Mean = 3.11 kg Std. Dev. = 0.47

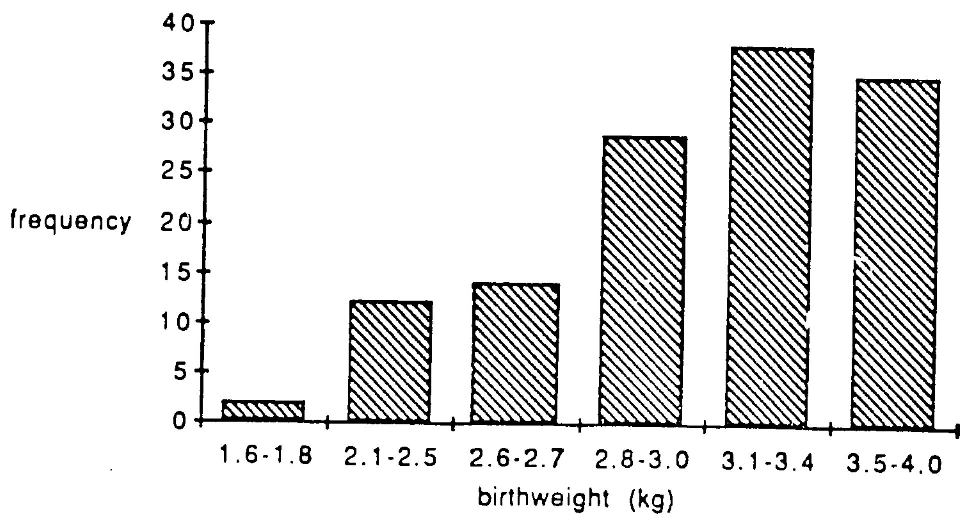


FIG. 10.6. The distribution of infant birthweights, sexes combined.

TABLE 10. 6.
Gestational age of infants at delivery as determined by reported date of last menstrual period (LMP) and the Dubowitz examination.

Age in weeks	Frequency (LMP)	Cumulative %	Frequency (Dubowitz)	Cumulative %
12	1	0.9	0	0.0
15	1	1.7	0	0.0
20	1	2.6	0	0.0
28	1	3.4	0	0.0
29	2	5.1	0	0.0
31	0	5.1	1	1.0
32	6	10.3	1	1.9
33	3	12.8	0	1.9
34	8	19.7	4	5.8
35	11	29.1	0	5.8
36	16	42.7	5	10.7
37	20	59.8	7	17.5
38	21	77.8	13	30.1
39	8	84.6	25	54.4
40	8	91.5	15	68.9
41	4	94.9	23	91.3
42	3	97.4	9	100.0
43	2	99.1	0	100.0
51	1	100.0	0	100.0
totals	117	100.0	103	100.0

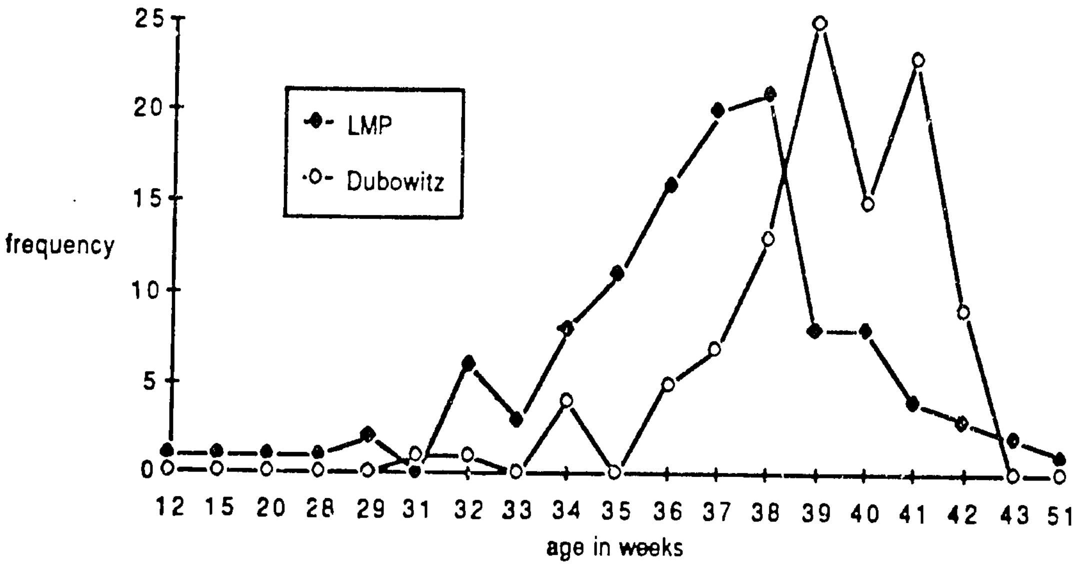


FIG. 10.7. Gestational age of infants at delivery as determined by date of last menstrual period (LMP) and the Dubowitz examination. (LMP sample size = 117 and Dubowitz sample size = 103)

Abnormal findings identified by the physician during the postpartum examination of mothers included the following conditions, each diagnosed in different women: sprains and strains of shoulder, upperarm, and sacroilliac region (probably associated with labor and delivery), toxic effect of solvents (skin reaction-dermatitis), and anemia.

Summary

Most women received appropriate care at delivery. The majority of women were assisted at delivery by trained mid-wives, with very few utilizing traditional birth attendants. It was observed that more women delivered at home than planned, possibly due to the labor starting unexpectedly or progressing very rapidly, and the distance and difficulty involved in reaching the Karurumo Health Center. Neonates were generally found to be in excellent condition at birth. The incidence of maternal and neonatal complications was relatively low. The rate of ceasarian delivery was unexpectedly high, as mentioned earlier in part due to the cephalo-pelvic disproportion. The gestational ages of the infants as determined by Dubowitz examination were consistently about two weeks older than the age calculated from the reported date of the last menstrual period. The women menstruate irregularly and some not at all because of frequent pregnancies and prolonged breast feeding. LMP proved to be unreliable in determining gestational age.

Lactation Survey

The lactation questionnaire (Form 421) was administered monthly to all of the women that delivered live births during the main study to investigate breastfeeding and food supplementation practices during infants' first six months of life.

Breastfeeding Practices

All mothers breastfed their infants. Most mothers began breastfeeding within two days of delivery;approximately 38% began on the day of delivery, 50% began on the day after delivery, and 12% began on the second day after delivery.

Most mothers had never received advice from any source on how to feed their infant during the first six months of life. Less than 8% reported receiving advice during the first six months, with up to 3% receiving advice from a relative, up to 7% receiving advice from a health official, and less than 1% receiving advice from a friend.

During the first six months of life, 70-88% of mothers reported feeding their infants primarily on demand. Frequency and total time spent breastfeeding daily are represented in Fig. 10.8.

During infants' first month of life, the mean reported frequency of nursing episodes during the day was 6.5 times, at night 4.2 times with an average duration of 5.8 minutes per feeding. The total time spent breastfeeding in a 24 hour period (frequency times duration) was calculated to be 60 minutes. In the second month of life there was a slight increase in the daytime frequency of breastfeeding (7.4 times) and the duration (6.2 minutes). The frequency of feedings as well as the duration then gradually decreased through the sixth month when there was an average of 5.5 daytime feedings, and 3.5 nighttime feedings, with an average duration of 6.1 minutes per nursing episode. Total time spent breastfeeding per 24 hours fluctuated throughout the six months, and was calculated to be approximately 63 minutes per day during the sixth month (Fig. 10.8).

Slightly over one-third of the mothers reported giving infants both breasts to nurse from during a single feeding session during the first month of life. This practice gradually increased, with 50% of mothers offering both breasts by the sixth month. Twelve to 34% of the women always started with the same breast over the first six months.

In the mother's estimation (not anthropometric evidence) during the infants' first month, 72% of the mothers felt that their breastmilk was adequate for their baby, but in the second month this dropped to only 48%. In the third month, 39% of the mothers felt that their breastmilk was adequate, in the fourth month, 35% felt it was adequate, and finally, in the sixth month, 31% felt their breastmilk was adequate.

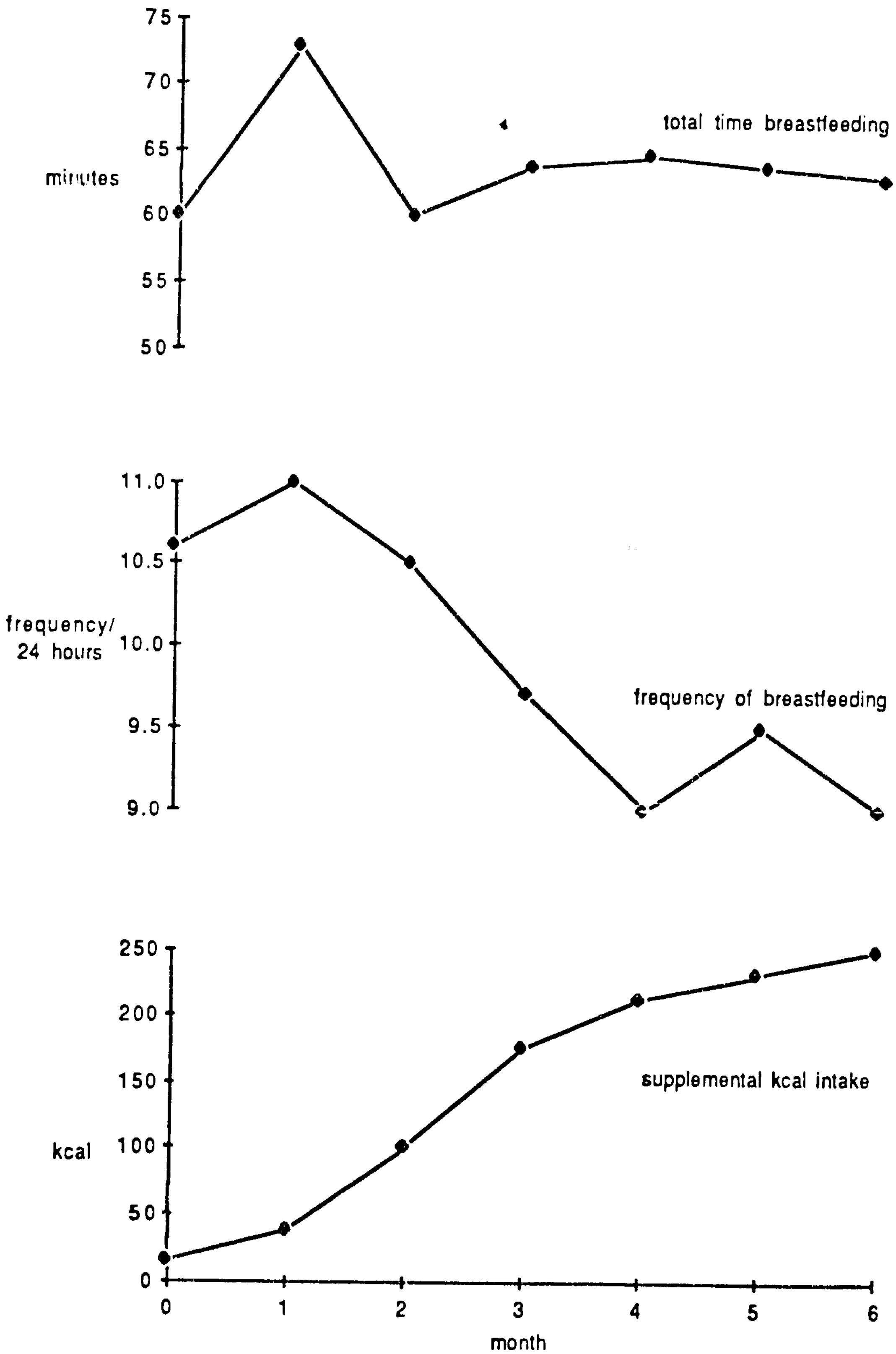


FIG. 10.8. Frequency, time breastfeeding and supplemental daily kcal intake (all infants) during first six months post-partum.

Supplemental Feeding Practices

Mothers began giving foods other than breastmilk to their babies early in life, with approximately 40% of mothers giving formula, cow milk, or other foods during the first month (Table 10.7). Over 50% of mothers offered supplemental fluids and foods during the second month, and 90% during the third month. Nearly all mothers (over 97%) were giving their babies food during the fourth through sixth months. Most supplemental foods were fed during the day rather than at night. Only one woman indicated that she had breastfed more than one infant at a time, and no mothers utilized wetnurses to feed their infants.

Foods that mothers commonly reported giving to their infants included sugar water (during the first several months), gitwero (a local staple, often made from potatoes, bananas and vegetables), porridge (sorghum or maize, sometimes with milk), water with glucolin (a glucose sweetener), tea with milk, Cerelac (a sweetened cereal), Lactogen (a whole milk formula), eggs (rarely), and fruits (including papaya, bananas, and passion fruit).

Eight percent of the mothers reported giving their infants cow milk during their first month of life; 17%, 28%, 35%, 39% and 43% of mothers reported feeding cow milk to infants during the second through sixth months, respectively. Of these women, only 18% reported diluting cow milk with water during the first month. Sixty-three percent of mothers diluted the milk during during the second month, 78% during the third month, and 59-80% during the fourth through the sixth months. Milk was normally diluted with either one fourth parts' water or equal parts' water. Ninety-five to 100% of the women who reported giving their infants water said that they always boiled it.

In the preparation of commercial formula, the majority of women (70-90%) used more water than instructed by the package's label. Only 25-31% of mothers claimed to have followed the instructions.

When mothers were asked why they started giving their babies foods other than breastmilk, the most frequent response during infants' second through sixth months was that "the baby was hungry." In the first month, a variety of other reasons were commonly stated but these, too, were inevitably followed by a statement that "the infant was hungry." The next most frequent response was that the breast milk was not sufficient in quantity. This was stated by 7% during the first month, 19-20% during the second and third months, and 12-14% during the fourth through sixth months of infancy.

When mothers were asked if they felt that their baby was fed adequately, 85% responded affirmatively during the first month. This increased to 98% by the sixth month. Only 3-11% percent of women felt that their infants had suffered by eating foods other then breastmilk. Supplemental feeding early in infancy, according to the community nutrition officer, is common in this area. It will be interesting to relate the above findings to the drought period.

TABLE 10.7
Lactation practices by month during the infants first six months of life.

Month	N	Entirely Breast	Breastmilk, Cow Milk & Formula	Breastmilk & Other Foods	Entirely Other Foods	Total
1	136	57.4	39.7	2.9	0.0	100
2	111	47.7	29.7	21.6	0.9	100
3	119	10.9	44.5	43.7	0.8	100
4	122	1.6	44.3	52.5	1.6	100
5	117	1.7	41.9	53.8	2.6	100
6	125	1.6	32.0	62.4	4.0	100

Summary

Nearly all mothers in the sample initiated breastfeeding during infants' first days of life. While women reportedly began breastfeeding within two days of delivery, only about one-fourth began on the day of delivery. The question arises as to whether the routine established in the health center and maternity units delayed initiation of nursing. The dominant practice was to breastfeed only one infant at a time.

Embu mothers introduced supplemental milks, formula, and weaning foods surprisingly early, starting in the infants' first month of life. Interestly, most mothers reported that they had never received any advice on feeding their infants. The overall quantity of supplemental calories fed to infants was considerable. Supplemental food intake (kcals) was found to be positively correlated with infant weight, and negatively correlated with frequency of breastfeeding over the first six months of infancy (Fig. 10.8).

Of interest, the Central Bureau of Statistics (CBS) found in 1982 that the highest use of infant formula was in Eastern Province (Nairobi excluded), particularly in Embu District where 29.6% of women reporting feeding formula to zero to twelve-month-old infants (5). Also for Embu District, CBS reports that the majority of infants receive cow milk as their first supplement. For Eastern Province the types of porridge reported as given young infants are: maize only, millet only, maize and millet, and, unique to Embu District, banana. Embu town, as the provincial capital, has attracted people from Nairobi who may have introduced or increased the use of formula into Embu District. The use of formula in the study area was considerably below 29.6%.

The relationships between maternal and infant food intake, nutritional status, morbidity, and other variables are discussed more fully in other chapters, and particularly in Chapter 23.

REFERENCES

1. International Classification of Diseases, 9th Revision, Clinical Modification, Volume II, Diseases, Alphabetic Index, Second Edition - September 1980, DHHS Publication No. (PHS) 80-1260, U.S. Govt. Printing Office, Washington, D.C.

2. Dubowitz L.M.S., Dubowitz V. Gestational age of the newborn. Menlo Park:Addison-Wesley, 1977:1-16.

3. Lubchenco L.O., Searls D.T., Brazie J.V. Neonatal mortality rate; Relationship to birthweight and gestational age. J Pediatr 1972;77:814.

4. Manning-Dalton V.C., Allen L.H. The effects of lactation on energy and protein consumption, post partum weight change and body composition of well-nourished North American Women.Nutrition Research 1983;3:293-308.

5. Republic of Kenya. Third rural child nutrition survey. Ministry of Finance and Planning, Central Bureau of Statistics, Nairobi, Kenya, 1983.

Chapter 11

COGNITION AND PSYCHOLOGY

The Nutrition CRSP project conducted a series of cognitive and behavioral assessments to examine the psychological and cognitive functioning of the target individuals at different age levels. Techniques included the administration of standardized and widely-used test instruments that were adapted by the project for use in East Africa. Unstructured observations of behavioral activities were also conducted. Target adults, schoolers, toddlers, and infants from nearly all of the households in the main study were tested.

RESEARCH OBJECTIVES

Structured Assessments of Cognitive and Behavioral Functioning

Structured assessments were used to examine the cognitive and behavioral functioning of the target individuals at several different age levels. The primary objectives of the assessments were to investigate 1) the relationship between energy intake and cognitive, motor, and behavioral development and performance among infants, toddlers, and schoolers, and 2) the relationship between adult nutrition and cognitive functioning as it related to children's cognitive capabilities. A variety of tests were administered, appropriate to the specific cognitive skills assessed at each age level.

Among children, behavioral integration, state control, and reflex response of newborn infants were measured. At six months of age, the motor and visual information processing skills were assessed, along with behavioral characteristics. The assessments administered to toddlers focussed on cognitive, verbal and attentional skills. Structured assessments evaluated verbal and motor abilities, and object play. Observations were also made on behavioral characteristics including attentiveness and persistence.

Among school age children, structured assessments of cognitive skills were conducted, and the behavior of the children was assessed in terms of cooperativeness, goal directedness, and attention span. School attendance and performance data were obtained from the schools. The psychological and cognitive functioning of school attenders will be compared to that of the children that did not attend school.

Adult cognitive functioning was studied in order to provide a measurement of the cognitive abilities of the parents. The influence of parental cognitive status on their children's abilities was considered important in weighing other influences in addition to food intake. Adult cognition was measured with several different instruments; goal directedness, attention span, and cooperativeness were also rated.

Unstructured Assessments of Behavioral Functioning

Observational studies were carried out for two different purposes. Home and school observations were designed to assess child behavior in ways that could not be accomplished by structured assessments. For example, toddlers were very shy about playing in front of an unfamiliar adult, so object play skills could not be measured by the structured assessments. However, naturally occurring play which occurred within or near the household compound could be observed and recorded. The observations focussed on social and emotional responsiveness in the infants and toddlers, and on attentiveness and social interactions for the school age children.

The second purpose of the observations was to assess the child-rearing environment, especially the interactions between children and other household members. In addition to the observational studies described in this chapter, caregiving activities were also closely observed. The techniques utilized are presented in Appendix E. A thorough understanding of the home environment is critical in identifying determinants of child and adult functioning.

THE SAMPLE

Cognitive and behavioral data were collected through the administration of a variety of tests, structured assessments, and unstructured observations. This section describes the specific tests administered to each age group and the number of individuals who were tested by each test.

Structured Assessments

The behavioral integration, state control and reflex response of newborns was measured with the Brazelton Newborn Neurological Examination (1). A total of 97 newborns were tested between birth and five days of age.

At six months of age the motor and visual information processing skills of the infants were assessed with the Bayley Motor Scale and a Visual Recognition Memory paradigm (Fagan Test) (2). The Bayley Behavior Record (3) was used to rate behavioral characteristics. These tests were administered to 112 infants (between 180 and 190 days of age).

The structured assessments administered to toddlers focused on cognitive and verbal skills. Several Uzgiris-Hunt scales (4) were administered to toddlers at 18, 24, and 30 month of age. The verbal items of the Bayley Mental Scale were tested at each age group, and the performance items were applied to 24- and 30-month-olds; the U.C. Berkeley Preferential Looking Test (5) for screening visual acuity was administered at 18 months; and motor abilities (evaluated with the Bayley Motor Scale) and play with objects were assessed at 30 months. The 18-month cognitive test was administered to 110 toddlers (52 males and 58 females). Two females were never tested again, one male and one female were not tested at 24 months but were tested at 30 months, and three males were seen again at 24 months but not tested at 30 months. All the 24 to 30 month testing was carried out within two weeks of the correct age; the age of testing of the 18 month-olds varied slightly more.

Measures administered to school age children included: Draw-a-Person (scored with the Goodenough-Harris method) (6); Raven's Progressive Matrices (7); Arithmetic, Block Design, and Digit Span Subscales of the Wechsler Intelligence Scale for Children - Revised (WISC-R) (8); and a word recognition test using pictures designed in East Africa (9). A total of 141 school age children were tested; almost all were tested three times, and some were tested four times. The ages of testing varied from 85 to 110 months of age. School attendance and performance data were collected on 131 schoolers.

Adult cognitive abilities were measured with Raven's Progressive Matrices, the word recognition test, and four subsets of the Wechsler Adult Intelligence Scale (digit span, similarities, block design, and arithmetic) (10). Approximately 270 adult females and 260 males were tested. (This exceeds the total number of adults participating in the main study; some adults studied during the early phases of the main study continued to participate in the cognition study, although their household did not complete the main study). The age distribution of the adults was as follows: 100 females and 36 males at 20 to 29 years of age; 155 females and 138 males 30 to 39 years of age; 14 females and 75 males at 40 to 49 years of age; and 2 females and 10 males at 50 years and over.

Unstructured Assessments

Unstructured observations of interaction and care-giving activities were conducted on 115 to 120 infants every other month from birth to six months. Observations were made during daylight hours, six days per week, and alternated between mornings and afternoons. Similarly, unstructured observations were conducted on 111 toddlers. The majority of these were seen every other month from 18 to 30 months.

Unstructured observations were made on approximately 120 school children on two separate occasions. On each occasion, each child was observed in a classroom for three 25-minute periods, and on the playground until at least 40 minutes of data per child were collected.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Structured Assessments

A modified form of the Bayley Scale was a major assessment tool for the infant and toddler testing. This scale was selected for toddler testing since it measures abilities, such as word and form recognition, that appear to develop in all cultures in the early years of life although the particular language, perceptual, and motor usages may differ (11). Furthermore, the Bayley Scale has been used successfully by previous investigators in rural Kenya (12), and alternative measures have not been designed for infants or toddlers in this area. Several subtests of the Uzgiris-Hunt Scale were also administered at 18 and 24 months. Sensorimotor scales have been used widely in Africa and sensorimotor development follows the same pattern across cultures (13).

The design and pilot testing of cognitive measures for the toddler group began in September 1983. The Uzgiris-Hunt and Bayley verbal measures were piloted first with a group of about 25 children (average age 20 months) in the pilot testing area. Modifications were made in the Bayley items so that the scale was more appropriate for the culture and testing conditions. The objects discriminated were changed to objects more familiar to Kenyan children (cup, bowl and can instead of cup, plate and box), and the pictures used for word recognition and naming were selected by Kenyans from Kenyan children's picture books. A set of dolls were made locally by some rural Embu women since the children were reluctant to touch or look at the plastic dolls from the Bayley Kit. The local dolls did not have ears or very clear facial features and so the body parts of the doll that the child was to name were changed as well. Due to the extreme shyness of 18 month-olds, as well as the fact that the Bayley Kit was unavailable when training began, the 18-month assessments were limited to the verbal items from the Bayley and the Uzgiris-Hunt scales.

At 18, 24, and 30 months, all the Bayley Mental Items from #116 to the end of the test were assessed with the exception of the items requiring recognition of a watch from ambiguous drawings (#145 and #150), because there are few watches and clocks visible in the environment. One additional item (#113, "says two words") was included at all ages. A computer form was designed which listed every item administered to the 18- and 24-month-olds.

The Uzgiris-Hunt scales used consisted of the Object Permanence Scale, the Means-Ends Scale, and the Vocal Imitation Scale. A modification of the Schemes Scale was used because the children were reluctant to use play objects in the presence of the examiner. For this reason, at the end of the Bayley testing, a number of toys were placed in front of the child and the following items were scored: puts one object in another, number of play activities, some doll play, shows toy to another person, and names objects. At 30 months, only the three most advanced items on the Object Permanence and Means-Ends Scales were administered and the Vocal Imitation and Schemes Scales were omitted. The Bayley Motor Scale was also administered at this age. All items from the 57th to the end of the test were given except the nine items requiring a walking board or stairs (there are no stairs and few single steps in the environment of these children).

Training and pilot testing of cognitive testing measures for school age children began in September 1983. Two enumerators were trained in the administration of several subtests of the WISC-R and Raven's Progressive Matrices, and scoring sheets were constructed for these subtests. Assessment of the inter-enumerator reliability on the toddler assessments in February 1984 for 14 children tested showed high agreement (see "Quality Control"). Changes and clarifications in scoring were made based on this pilot study.

The verbal recognition task was derived from a test developed by a group of investigators with small samples of urban children in Kenya, Tanzania, and Uganda. This test was obtained from Dr. Nunshka Muinde, a Nairobi psychologist. Four enumerators, working in pairs, administered a large number of pilot assessments to children. A revised version of the arithmetic scale of the WISC-R was included among the measures after it was pilot tested on several children. Revisions were necessary because the American items were confusing to the Kenyan children. The enumerators were taught the Bayley Motor Scale and pilot tested it with children four to eight and 28-34 months old. Items were omitted from the six month protocol if considered too easy or too difficult for the age group, or if an item was found too difficult to rate. Items 13 to 46 were used on all infants. The infant visual processing measure was designed to be carried out with stop watches; it was tested with a variety of visual stimuli and testing apparatuses on a large number of infants. A team of field psychologists administered the Brazelton to several newborns in the Embu nursery as a pilot study in March-June, 1984. The 30-month assessment was designed to include most of the 24-month assessment, with some of the easier items from the Uzgiris-Hunt Scale omitted, and with the entire Bayley Behavior Record rated at the end of testing. An observation of object play was also designed and pilot tested.

The cognitive tests for adults were pilot tested on twelve adults. The Porteus Mazes were not used after the piloting phase, since enumerators found them difficult to administer and respondents disliked and often refused to complete them. Many of the items from the WAIS were altered to make them more appropriate for the life experiences of Kenyan adults. On the arithmetic section, unfamiliar items were removed from the questions. The similarities subtest also required revision, replacing unfamiliar items and concepts with locally familiar items.

The structured cognitive assessments were carried out by four enumerators, each of whom was responsible for one cluster. These were mature local woman who had taught pre-school children and/or were mothers themselves. Techniques of administration were rehearsed during training, and further practice and training took place during the pilot testing phases. The enumerators usually worked in pairs, with or alongside the Kenyan field psychologist who was able to offer further supervision and training.

Unstructured Assessments

The observational procedures took nearly 18 months to design and implement. In the first 6-9 months of the project, the aim was to measure all activities of all individuals being studied in each household. Later the focus changed to the rearing of the toddler, and observations were restricted to those concerned with the toddler. The initial training of the observers was carried out by a University of California Senior Investigator who formulated a coding system for activity measurement, utilizing continuous recording. The observers felt that their observations were inaccurate, which led to the development of two different observational systems.

The first observational system measured child caretaking and protective behaviors, with a focus on such activities as feeding, cleaning, teaching, and safety. A continuous recording system was used and the child's location, the individual involved, and the physical proximity of caregiver and child were noted. The second observational system used time sampling, with observations carried out for 30 seconds followed by recording for 30 seconds (this was a modification of the initial 20 second on, 40 second off system). A restricted group of variables was selected from the list of observed behaviors, focussing on behaviors that had been observed in previous Western and African studies. Both of these observational systems were pilot tested and revisions were made. A reliability study carried out in February 1984 yielded a high inter-observer correlation with the 30-30 time sampling, so this system was adopted.

Obtaining sufficient data on the young infants proved to be a major source of difficulty. Observers often had to return several times to collect data for 120 minutes while an infant was awake. This became less of a problem as infants matured, and was not a problem with toddlers.

The observations of school children were pilot tested in February 1984. The procedures were taught to the enumerators who then carried out reliability studies. For classroom observations, 18 children were observed and inter-observer agreement was fairly high. Playground observations were carried out on twelve school children for ten minutes each. Most of these ratings were reliably coded (with the exception of "initiates interaction" and "negative response to bid"). The coding system was altered somewhat to simplify the form. It was clear that only a single child could be observed at a time since the playgrounds were too large and the children too active for an enumerator to locate a second child during the observational period.

A group of 16 enumerators were trained to conduct all unstructured observations in the home, classroom, and playground. Observation and recording techniques were rehearsed during training and pilot testing phases

TECHNIQUES OF DATA COLLECTION

Structured Assessments

The structured cognitive assessments were administered beginning in January 1984. All assessments were administered by the cognition enumerators, the field psychologist, or the field nurse. A description of the data collection techniques for each age group and measure follows.

The Brazelton Newborn Assessment

The Brazelton examination was administered as soon after an infant's birth as possible. Most examinations were carried out in the infant's home and all were done by either the field psychologist or senior nurse who had newborn/nursery experience. The Brazelton examination consists of 48 separate items that include assessment of the newborn's reflexes, movements, reactions to light, sound, and tactile stimulation as well as a few items that record the tes' administrator's global assessment of alertness, tone, and maturity.

The coding system used in this study (described in Brazelton manual) produces seven subscales: 1) Habituation, 2) Orientation, 3) Motor Development, 4) Range of States, 5) Regulation of States, 6) Autonomic Stability, and 7) Reflexes. Infants were scored on each of these subscales.

The Bayley Motor Scale

The Bayley Motor Scale was administered to six-month olds in their home in the mother's presence. Almost all testing was done by the cognitive enumerators working in pairs. The Bayley Motor Scale is designed to provide a measure of the degree of control of the body, coordination of the large muscles and finer manipulatory skills of the hands and fingers. Items of the motor scale are structured in increasing order of difficulty, based on developmental norms established with large American samples. The full battery, applicable from birth to 30 months, consists of 81 items. Inappropriate items were deleted during the pilot testing phase. Items 13 to 46 of the standardized examination were used on all infants.

The Visual Processing Measure (Fagan Test)[1]

The visual processing measure was done in the home with the mother holding the infant in front of the board on which the visual stimuli were placed. Most of the testing was done by a pair of enumerators with the field nurse. This measure reflects an infant's capacity to take in visual information and to then discriminate between the visual stimulus seen previously and a new stimulus. For the purposes of this study, four different tasks were used, two featuring geometric patterns and two featuring photographs or drawings of faces. An infant's attention to the familiar stimulus and differentiation between paired stimuli was observed through a small hole in the center of the board holding the visual stimuli. The length of fixations was measured with a stopwatch and recorded following each trial by the individual responsible for changing the stimuli. The preference for novel stimuli shown by each infant on each of the four tasks has been calculated. This test also serves as an infant vision test.

The Infant Behavior Record

The Infant Behavior Record was completed by an examiner after a testing session to provide an assessment of "the nature of the child's social and objective orientations toward his environment as expressed in attitudes, interests, emotions, energy, activity, and tendencies to approach and withdraw from stimulation." Five-point and eight-point scales were used for this measure. All items were used at six months.

Toddler Cognitive Testing

Toddlers were tested in the home, usually held by or sitting next to their mother or older sister. Testing was usually done outside the house with an enumerator sitting opposite the child at a table. Testing was not carried out if a toddler was ill; an enumerator returned if a child was unable to complete the testing in one session.

Uzgiris-Hunt and Bayley Scales

Four subscales of the Uzgiris-Hunt and the Bayley Mental and Motor items were administered to toddlers. The specific items used are listed on Forms 521 (Fig. 11.1) and 522 (Fig. 11.2). Twelve ratings from the Bayley Behavior Record were made after each testing session. These consisted of the following: responsiveness to examiner, cooperativeness, fearfulness, general emotional tone, responsiveness to objects, imaginative play, attachment to objects, goal directedness, attention span, endurance, judgment of the test, and unusual or deviant behavior.

U.C. Berkeley Preferential Looking Test

The U.C. Berkeley Preferential Looking Test was administered to 18-month-olds in order to screen visual acuity. The test materials consisted of six large rectangular cards, each with two squares (one grey, the other with black and white stripes) of photographic paper. The brightness of the striped square was about equal. The grey square and the striped square appear identical when the stripes cannot be distinguished. An enumerator began with the presentation of the coarsest stripes at a distance of about six feet from the child. Upon attracting the child's attention, eye movements were observed, and the enumerator judged whether the child preferred to look towards the stripes. If no preference was apparent, the enumerator slowly walked closer, moving the card from side to side to attract the child's attention. The distance at which the child first exhibited the preference was recorded, along with the size rating of the stripes. The enumerator then selected the card with the finer stripes, and repeated the procedure, starting at the recognition distance recorded for the coarser stripes. The distance at which the correct preference was shown and the size of the stripes were recorded; the card was changed and the procedure repeated once more.

1 The final version of the visual processing measure currently being presented by Fagan includes stimuli that are not identical to those used in Kenya.

NUTRITION CRSP — KENYA PROJECT P.O. BOX 1032, EMBU **CONFIDENTIAL**

COGNITIVE TODDLER—SUMMARY

FORM NO 5 2 1 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TT NO DATE DY MO YR 8 ENUMERATOR NO STATUS

RESPONDENT'S NAME NOT APPLICABLE — TT'S NAME — ENUMERATOR'S NAME

COMMENTS:

Missing data, use: 8, −8, −88 etc. Not applicable use 9, −9, −99 etc.

UZGIRIS HUNT (1 = Pass, 2 = Fail)

I **Object Permanence (Pass = 2 trials)**
1. One screen
2. Three screens
3. In cup-under 1 screen
4. In cup-alternate screens
5. In hand-displace under last of 3 screens
6. In hand-displace under first screen (one trial)

II **Means — Ends (Pass = 2 trials)**
1. Uses string horizontally
   - without demonstration
   - with demonstration
2. Uses string vertically
   - without demonstration
   - with demonstration
3. Uses stick
   - without demonstration
   - with demonstration
4. Bunches necklace
5. Avoids blue ring

III **Vocal Imitation**
1. Imitates Unfamiliar sounds
2. Imitates Familiar words
3. Imitates Unfamiliar words

IV **Play**
1. Puts one object in another
2. Number of play activities (None = 1, One = 2, Two = 3, Three = 4, Four = 5)
3. Some doll play
4. Shows toy to another person
5. Names objects

BAYLEY ITEMS (1. Pass, 2 Fail)

117 Shows own clothing (UL 1)
124 Names 1 object (UL 2)
138 Names 2 objects (UL 2)
146 Names 3 objects (UL 2)
126 Follow 2 directions, doll (UL 3)
128 Points to 3 parts of doll (UL 4)
144 Discriminates 2: cup, bowl, can (UL 5)
152 Discriminates 3: cup, bowl, can (UL 5)
158 Understands 2 prepositions (UL 6)
163 Understands 3 prepositions (UL 6)
162 Concept of one (UL 7)
130 Names 1 picture (UL 8)
141 Names 3 pictures (UL 8)
132 Points to 3 pictures (UL 8)
149 Names 5 pictures (UL 8)
139 Points to 5 pictures (UL 8)
148 Points to 7 pictures (UL 8)
116 Uses gestures to make wants known (UL 9) observed
Mother reports
127 Uses words to make wants known (UL 9) observed
Mother reports
113 Says 2 words (UL 9) observed
Mother reports
136 Sentence of 2 words (UL 9) observed
Mother reports

BAYLEY ITEMS (24-36 mos) (1. Pass, 2. Fail)

118 Pegs placed in 70 seconds
123 Pegs placed in 42 seconds
134 Pegs placed in 30 seconds
156 Pegs placed in 22 seconds
121 Blue board: places 2 round blocks
129 Blue board: places 2 round and 2 square blocks
142 Blue board: places 6 blocks
155 Blue board: completes in 150 seconds

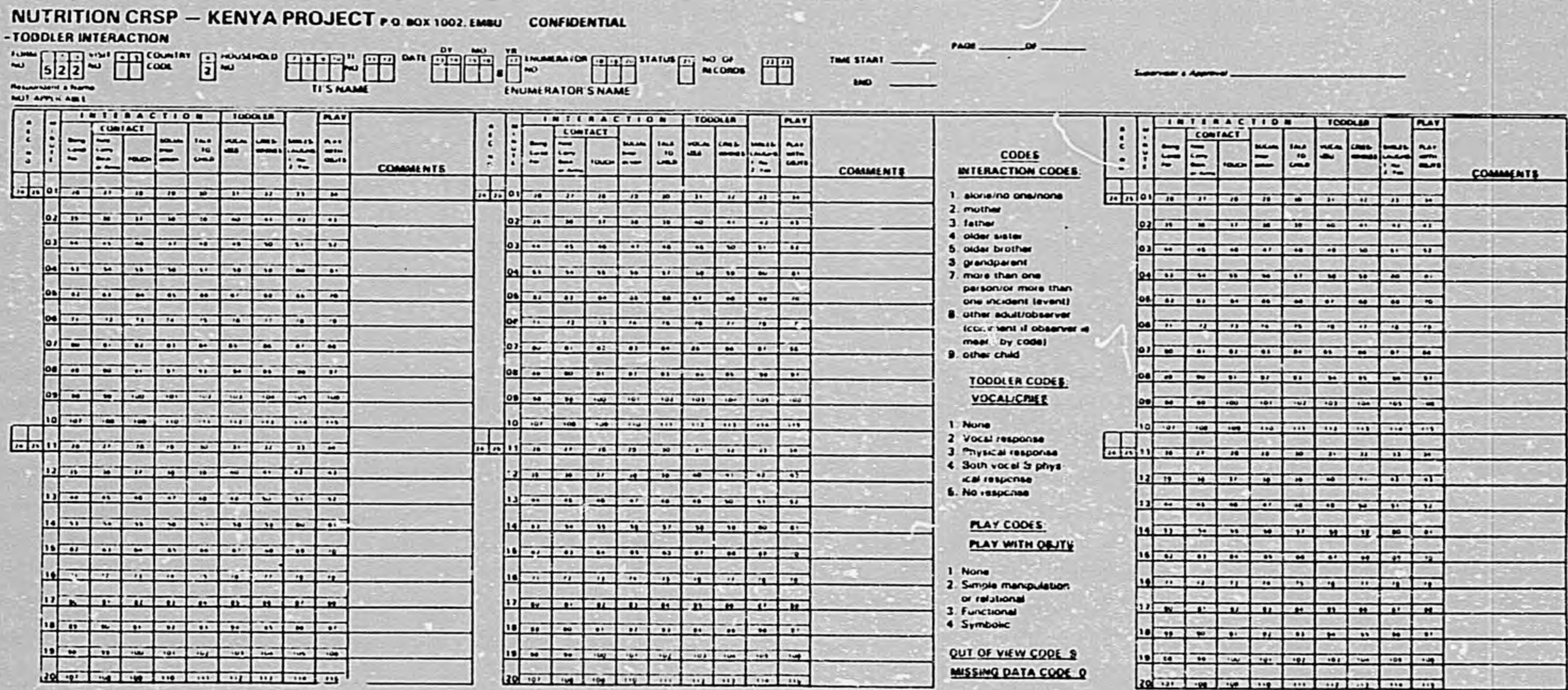
BAYLEY ITEMS (continued)

159 Blue board: completes in 90 seconds
160 Blue board: completes in 60 seconds
119 Builds tower of 3 cubes
143 Builds tower of 6 cubes
15* Builds tower of 8 cubes
154 Car of cubes
120 Pink board: places round block
137 Pink board: completes
151 Pink board: reversed
125 Imitates crayon stroke
135 Differentiates scribble from stroke
147 Imitates strokes: vertical and horizontal
133 Broken doll: mends marginally
140 Broken doll: mends approximately
153 Broken doll: mends exactly
157 Folds paper
122 Attains toy with stick
131 Finds 2 objects

BAYLEY BEHAVIOUR RECORD

1) Responsiveness to Examiner (1-5)
2) Cooperativeness (1-9)
3) Fearfulness (1-9)
4) General Emotional Tone (1-9)
5) Responsiveness to objects (1-9)
6) Imaginative play (1-2)
7) Attachment to object (1-2)
8) Goal Directedness (1-9)
9) Attention span (1-9)
10) Endurance (1-9)
11) Judgement of the Test (1-5)
12) Unusual or Deviant Behavior (1-2)

FIG. 11.1. The toddler cognitive summary form 521.



NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002, EMBU CONFIDENTIAL

-TODDLER INTERACTION

FORM NO 5 2 2 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TI'S NAME TI NO DATE DY MO YR 8 ENUMERATOR NO ENUMERATOR'S NAME STATUS NO OF RECORDS TIME START END PAGE ___ OF ___ Supervisor's Approval

Respondent's Name NOT APPLICABLE

INTERACTION — CONTACT — TODDLER — PLAY — COMMENTS

Records 01–20

CODES

INTERACTION CODES:

1. alone/no one/none
2. mother
3. father
4. older sister
5. older brother
3. grandparent
7. more than one person/or more than one incident (event)
8. other adult/observer (comment if observer is meant by code)
9. other child

TODDLER CODES:

VOCAL/CRIES

1. None
2. Vocal response
3. Physical response
4. Both vocal & physical response
6. No response

PLAY CODES:

PLAY WITH OBJTS

1. None
2. Simple manipulation or relational
3. Functional
4. Symbolic

OUT OF VIEW CODE 9

MISSING DATA CODE 0

FIG. 11.2. Toddler interaction form 522.

School Age Children

All testing of school age children was done by enumerators in their homes, usually in the afternoons after school. An enumerator selected a quiet place, either inside or outside the home where there were few distractions, and sat down at a table facing the child. The children were all tested in June-July and September-October 1984, and a large number were retested in the spring of 1985.

Assessments were administered in the following order: Picture drawing, Digit span (forward and backward), Raven's Matrices (sets A, Ab, and B), the Verbal Meaning Task, Block Design, and Arithmetic. The picture drawings were scored by the field nurse, after establishing inter-enumerator agreement on a set of drawings from pilot subjects. Scores were tabulated by the enumerator and checked by the field psychologist.

School attendance and performance data were also collected from the headmasters and school teachers at eight different schools by the project's social scientist and cognition enumerators. Attendance and performance data cover two full years, from January 1984 through December 1985, (three academic quarters per year). Aggregated test scores from all subject areas and class rankings were collected for each student.

Adult Cognitive Testing

Adults were tested in their homes at a time which they had determined as convenient. They were given the choice of being tested in Kiembu or English; all chose Kiembu. The enumerator sat opposite the adult across a table, located in a quiet area. The subtests administered mirrored those given to the school age children. The following tests were used: Digit Span (Forward and Backward), Raven's Progressive Matrices, Similarities (some of the items were changed), Block Design, Arithmetic, and Verbal Meaning. The enumerators tabulated scores and these tabulations were checked by the field psychologist.

Unstructured Observations

Infant and Toddler Social Interaction Observations

Observations were carried out every other month for infants and toddlers at their homes. Observations were done for periods of 120 minutes, six days a week. If an infant or a toddler was taken out of sight away from the home, the time period was coded "out of view." The enumerator stopped recording after a child had been out of vision for ten minutes, and returned for another visit if the subject stayed away longer or fell asleep. Enumerators were instructed not to observe a child who was seriously ill.

Behaviors and interactions observed and coded for infants (and their caretakers) included: physical care, holding or carrying, touching, face to face contact, talking to infant. In addition, infant vocalizations and cries were recorded along with whether there was a physical response, vocal response, both physical and vocal, or no response. Infant smiles were also noted. The individual involved in the interaction was identified as: mother, father, older sister, older brother, grandparent, more than one person or incident, other adult, and other child. The data were then summed over the observational period.

The same system was used to record toddler behavior and interaction except that social interaction replaced face to face contact and the child's object play was classified into simple manipulation, functional, or symbolic. None of the behaviors were mutually exclusive so that any number could be coded in one time frame.

Infant and Toddler Caregiving Activities

The following areas of infant and toddler caregiving activities were observed and recorded: safety, general care, eating and food-related, personal care, supervising/training, and other. The time the activity started and ended, the location and both positive and negative aspects of the activity were reported. The physical proximity of the individuals interacting was recorded (whether the child was carried close to or far from the care-giver), and the interaction was characterized as physical or verbal. The same differentiation between individuals interacting with the infant or toddler was made as in the social interaction system. Identical procedures were carried out with both social and caregiving interaction systems.

School Observations

School observations included both classroom and playground observations. In the classroom, two children were observed during each class period. The time sampling interval was ten seconds of observation followed by 20 seconds of recording. The following behaviors were coded: talking (non-permitted vocalizations), play, off-task (for the full ten seconds), out of the room, and none of the above. Each child was observed in three classes, each lasting 25 minutes. If the classes did not last this long, the observer continued into a new class period or returned on a different day. The enumerators then summed the data on the forms, which were checked and signed by supervisors.

Playground observation of each school child was carried out until at least 40 minutes of data had been collected over the course of a few days. The aim was to have at least 80 minutes of playground observation per child per term. Each child was observed individually, rather than alternating between children as in the classroom, because the playgrounds were too big to follow more than one child at a time. A time sampling procedure was used with an interval of 30 seconds to observe, 30 seconds to record. The following behaviors were observed and recorded: initiates interaction, positive response to bid, negative response to bid, seeks help, caretaking/helping behavior, aggression, involved in ongoing activity, solitary behavior, leadership/organizing behavior, and no behavior. The predominant emotion shown by a child in the 30-second interval and the predominant level of activity was also recorded. The frequency of each of these codes was then summed over an entire record.

QUALITY CONTROL MEASURES

Quality control measures undertaken during the behavioral observations included direct field supervision of data collection, concurrent inter-observer and repeated intra-observer reliability studies on a 10% subsample, supervision during training and pretesting, data form checks, and equipment maintenance.

Simultaneous scoring by two testers was utilized as a quality control measure on several of the structured behavioral observations. The Brazelton Newborn Assessment was tested on ten newborns by the field psychologist and nurse, and scored simultaneously. With the Bayley Motor Scale ten infants were observed simultaneously by two testers, including the nurse. With the six-month visual processing measure ten infants were observed simultaneously (a second peephole was placed in the board for this purpose) to assess inter-observer agreement. Quality control on the Bayley Behavior Record was achieved by training and pre-testing with a large number of subjects. The structured examinations of the school children were scored simultaneously by the field nurse and enumerators for 40 children (ten per enumerator); a subsample of 40 adults were scored independently by the enumerator and field nurse.

The toddler reliability studies yielded the following results. There was good agreement on interrater scoring on the total Bayley Scale. For the 24-month Bayley score, the two observers agreed perfectly on 16 of the 26 cases, disagreed by one point on six cases, and disagreed by two points on four cases. There was complete agreement between observers on the scores on the Object Permanence Scale and Vocal Imitation Scale, and one point disagreement on two of the 26 Means-Ends and Play Scale Scores. At 30 months, there was perfect agreement on 15 of the 16 cases and a two point disagreement on one case using the Bayley Scale. Of the 16 toddlers jointly scored on the Uzigiris-Hunt Scale at 30 months, there was perfect agreement on the Means-Ends Scale and one disagreement on the Object Permanence Scale. On the Bayley Motor Scale, the two observers differed by only one point on two of the 16 toddlers assessed jointly. Inter-observer agreement was somewhat lower at 18 months on the Bayley Verbal Scale but still adequate with a correlation between observers of $r = .88$, with a sample of 32 toddlers. Pearson product movement reliability coefficients on the same Bayley Verbal items were $r = .93$ at 24 months and $r = .99$ at 30 months. Test-retest reliability was also calculated with testing carried out by the same tester over a two-week period. The correlation in Bayley Verbal scores over this period was r = .70 for 59 toddlers at 18 months, r = .95 for twelve toddlers at 24 months of age, and r = .82 for nine 30-month-olds.

In the unstructured assessments, quality control was maintained by simultaneous independent coding of social interaction and care-giving observations by supervisor and enumerator. A number of reliability studies were carried out during the pilot testing period and main study to validate the scoring system. A reliability study was carried out in February 1984 with groups of toddlers and infants in the study area. Seventeen toddlers and 14 infants were observed by 15 observers working in pairs. Comparison of scores showed high inter-observer correlation. For the toddler data, interrater agreements were calculated with Pearson correlation coefficients and were uniformly high. On the interaction variables, the correlations were as follows: Physical Care (r = .98); Carry (r = .98); Touch (r = .85); Talks to Child (r = .90); and Social Interaction (r = .93). On the responsiveness measures, the correlations were somewhat lower: any response to Toddler Vocalizes (r = .94); verbal response to Toddler Vocalizes (r = .94); any response to Toddler Cries (r = .69); verbal response to Toddler Cries (r = .80). For toddler behaviors, the observers agreed to a remarkable degree: Vocalizes (r = .89); Cries (r = .96); Smiles and Laughs (r = .[illegible]); and Plays with objects (r = .93).

For the classroom and playground observations of schoolchildren, supervisors carried out simultaneous observations and monitored the observational procedures of the enumerators.

PREPARATION OF DATA FOR ANALYSIS

Structured Observations

Bayley Motor Scale

For analysis purposes, total number of items passed was calculated for each toddler. Scores were not converted into developmental quotients because the standardization did not seem appropriate for this sample. The total number of items passed was used rather than the highest item passed, as the linear ordering of items was not the same for the Kenyan toddlers as for Western toddlers.

Bayley Behavior Record

Two forms of data reduction were used. Factor analysis was carried out to determine which factors are found to be significant in this sample. In addition, the two categories of cognitive behavior rating and extroversion behavior rating were used to group scores on the appropriate items. Results are reported in the following section (Descriptive Statistics and Summary of Findings).

U.C. Berkeley Preferential Looking Test

The visual activity scores were recorded as "Snellen fractions," the enumerators indicating the observation distance, the denominator indicating the size rating. The size rating is the distance at which the critical detail subtends one minute of arc. The activity scores are then converted to more familiar fractions by multiplying the fraction such that the numerator becomes 20 (six if metric notation is used).

School Children

No data reduction was necessary for the standardized cognitive measures as each child obtained only eight scores on the various subtests and three behavior ratings. School attendance and performance data (class rankings obtained by aggregating student test scores in each subject area) are currently being compiled, and will be analyzed to determine the relationship between the two variables.

Adults

No data reduction was necessary for the standardized cognitive measures as each adult obtained only eight scores on the various subtests and three behavior ratings.

Unstructured Observations

Observations of social interaction and caregiving activities require extensive data reduction. Only those records for which at least 90 minutes of data are available were used in analysis. Each observation period was limited to 120 minutes. Percentage scores have been used throughout because of variations in the length of individual observations. Each toddler was observed six to eight times, over a 12-16 month period. The data have been analyzed in two ways, either as means over all observations or as means within age periods. In the latter case, the data collected when the toddlers were 15 to 30 months of age have been grouped into five age periods, each period covering a three-month span.

Classroom observation data are expressed as percentage scores of observation periods for the three variables of talking during class, playing during class, and off-task behavior. These variables provide an indication of the extent to which a school child maintained attention in the classroom. For playground observation, percentage scores were used to reflect the extent of a child's social behavior, activity level, and predominant emotions.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Toddlers

Bayley Mental Scales

The composite verbal and performance scores achieved by each of the toddler age groups on the Bayley Mental Scales are presented in Table 11.1.

Two-Factor (Age x Sex) Repeated Measures ANOVAs were calculated on the Bayley Verbal Score and Bayley Performance Score. As expected, there were significant age effects on both measures. There were no significant sex differences nor significant interactions of age and sex, therefore all subsequent analyses were carried out with the data from male and female subjects combined.

TABLE 11.1
Bayley verbal and performance scores achieved by toddlers.

Age	N	Mean	± SD
18 months			
Verbal Scale (21 items)	101	5.2	3.07
24 months			
Verbal (21 items)	102	11.4	3.9
Performance (22 items)	101	10.8	3.6
Total Score	99	22.2	7.5
30 months			
Verbal (21 items)	105	17.2	3.4
Performance (22 items)	105	15.1	3.9
Total score	105	32.3	6.0

Scores for the 18-month and 24-month toddlers on selected items of the Bayley Mental Scale are presented in Table 11.2.

The percentage of the 102 toddlers who passed each Bayley item at 18 and 24 months was calculated. The progression is clearest when the expressive language, receptive language, and performance items are illustrated separately (see Table 11.3). The linear ordering of the original scale can be inferred from the Bayley numbers. It is clear that these items represent a variation in task difficulty which is similar during both ages. Pilot testing of the scale in Kenya revealed that the difficulty of items did not seem to follow the same linear pattern as shown by American infants, and this pattern remained during the main study. For example the Kenyan toddlers found it relatively easy to discriminate 2-3 objects (a cup, can, and bowl), but more difficult to point to pictures correctly which, for American children, is the simpler task. The expressive language items were passed by fewer children than the receptive language items, although many American children would have passed expressive items than receptive language items. In order to show the irregularity of the Kenyan toddler's performance on the American linear arrangement, the items in Table 11.4 are ordered according to Bayley numbers. The percentage of passes clearly does not follow the pattern shown by American children. Despite the differences in linear ordering, the total number of items passed at each age group are used in analysis.

TABLE 11.2
Scores of 18-month and 24-month toddlers on selected Bayley items.*

Age	Mean	± SD
<u>18 Months</u> (n = 110)		
Bayley Receptive Language	2.9	2.2
Bayley Expressive Language (Observed)	1.2	1.4
Bayley Expressive Language (Reported)†	3.0	2.1
Bayley Performance (Visit 2)	0.0	0.3
All Bayley Items (Visit 2)	5.8	3.4
<u>24 Months</u> (n = 94)		
Bayley Receptive Language	6.2	2.8
Bayley Expressive Language (Observed)	4.4	3.2
Bayley Expressive Language (Reported)†	7.2	4.1
Bayley Performance Items (Visit 2)	11.1	3.9
All Bayley Items (Visit 2)	23.3	8.5

* Scores are drawn from preliminary analysis.

† Based on mothers' reports.

TABLE 11.3
Percentage of toddlers (n = 102) who passed each of the Bayley receptive language and expressive language items.

Bayley No.	Item	% Passed Item: 18 Month Toddlers	% Passed Item: 24 Month Toddlers
Receptive Language			
144	Discriminates 2	59	88
152	Discriminates 3	42	81
117	Shows clothes	43	79
132	Points to 3 pictures	39	73
126	Follows 2 directions	37	67
128	Points to 3 parts of doll	31	69
158	Understands 2 prepositions	25	63
139	Points to 5 pictures	12	51
148	Points to 7 pictures	5	32
162	Concept of one	3	24
163	Understands 3 prepositions	1	23
Expressive Language			
116	Uses gestures	51	71
127	Uses words	18	62
124	Names 1 object	14	60
113	Says 2 words	11	44
130	Names 1 picture	9	41
136	Sentence of 2 words	8	32
138	Names 2 objects	7	55
146	Names 3 objects	4	44
141	Names 3 pictures	3	25
149	Names 5 pictures	1	8

The percentage of 24-month-old toddlers who passed the performance items is shown in Table 11.5. These items follow the American pattern more closely, but differences still exist. The Kenyan toddlers found the peg board relatively easier than the other items, in contrast to American children who pass the pegboard items at later ages.

TABLE 11.4
Percentage of toddlers (n = 102) who passed each of the Bayley receptive and expressive language items (ordered by Bayley number).

Bayley No.	Item	% Passed Item: 18 Month Toddlers	% Passed Item: 24 Month Toddlers
113	Says 2 Words	11	44
116	Uses gestures	51	71
117	Shows clothes	43	79
124	Names 1 object	14	60
126	Follows 2 directions	37	67
127	Uses words	18	62
128	Points to 3 parts of doll	31	69
130	Names 1 picture	9	41
132	Points to 3 picture	39	73
136	Sentence of 2 words	8	32
138	Names 2 objects	7	55
139	Points to 5 pictures	12	51
141	Names 3 pictures	3	25
144	Discriminates 2	59	88
146	Names 3 objects	4	44
148	Points to 7 pictures	5	32
149	Names 5 pictures	1	8
152	Discriminates 3	42	81
158	Understands 2 prepositions	25	63
162	Concept of one	3	24
163	Understands 3 prepositions	1	

Uzgiris-Hunt Scales

Scores received by the 18-month and 24-month Toddlers on selected items of the Uzgiris Hunt Scales are presented in Table 11.6.

The toddlers passed the Uzgiris-Hunt items in much the same way as American toddlers (see Table 11.7) The Kenyan 18-month-olds are relatively more aware that a circular piece without an opening cannot be placed on a stick. They also tend to imitate familiar words more than unfamiliar sounds; the order is reversed for American children. Also notable is the infrequency of doll play in the schemes scale. Kenyan toddlers were reluctant to play with objects spontaneously in the presence of the tester; spontaneous play was observed, however, during the unstructured activity observations.

TABLE 11.5
Percentage of toddlers (n = 102) who passed each Bayley Performance item.

Bayley No	Item	% of Passed Toddlers
118	Pegs placed in 70 seconds	97
119	Builds tower of 3 cubes	92
123	Pegs placed in 42 seconds	90
122	Attains toy with stick	82
132	Pegs placed in 30 seconds	71
121	Blue board: places 2 round blocks	70
131	Finds 2 objects	66
120	Pink board: places round block	62
129	Blue board: places 2 round & 2 square blocks	60
120	Pink board: places round block	62
143	Builds tower of 6 cubes	53
135	Differentiates scribble from stroke	52
137	Pink board: completes	38
133	Broken doll: mends marginally	35
156	Pegs placed in 22 seconds	33
142	Blue board: places 6 blocks	28
140	Broken doll: mends approximately	24
154	Care of cubes	22
153	Broken doll: mends exactly	7
155	Blue board: completes in 150 seconds	2
159	Blue board: completes in 90 seconds	2
160	Blue board: completes in 60 seconds	2

Visual and Auditory Acuity

The U.C. Berkeley Preferential Looking Test was administered to all 18-month- old toddlers to test visual acuity, and hearing tests were administered with the use of tuning forks and bells. Results showed that none of the toddlers had impaired vision or hearing.

Rearing Conditions

In order to understand the children's development, patterns of care and changes over time are described. The rearing variables selected for description consist of the following: physical care, holding, touching, talking to, and social interaction. These were used for infants as well as toddlers. The following description refers to the toddlers.

The rearing variables were analyzed with 2 (Sex) x 8 (Caregiver) ANOVAs to determine whether males and females were treated differently and whether there were significant differences among caregivers. The only significant effect of sex was that male toddlers were slightly more involved in sustained social interaction (xx = 0.8%) than female toddlers (x = 0.6%). There were no significant interaction effects.

TABLE 11.6
Scores of 18-month and 24-month toddlers on selected Uzgiris Hunt Scale items.*

Age	Mean	± SD
<u>18 months</u> (n = 110)		
Object Permanence - No. correct	2.1	1.7
Object Permanence - Highest Passed	2.6	2.0
Means - End No. Correct (w/Demo)	2.1	1.2
Means - End No. Correct (w/out Demo)	2.5	1.3
Means - End Highest Passed	3.4	1.8
Vocal Imitation - Number Passed	0.5	0.9
Doll Play	0.2	0.4
Shows Toy	0.4	0.5
Names Object	0.1	0.3
<u>24 month</u> (n = 94)		
Object Permanence - No. Correct	4.5	1.3
Object Permanence Highest-Passed	4.6	1.3
Means - End No. Correct (w/Demo)	3.3	1.1
Means - End No. Correct (w/out Demo)	3.7	1.1
Means - End Highest Passed	4.9	1.3
Vocal Imitation - Number Passed	1.6	1.3
Doll Play	0.4	0.5
Shows Toy	0.7	0.5
Names Object	0.5	0.5

* Scores are drawn from preliminary analysis.

The distribution of caregiving of toddlers by different caregivers during the observation periods is presented in Table 11.8. The means for father, grandparent, and other adults are combined since the individual means were so small. As indicated in the table, the mother and older sister were the predominant caregivers; they carried, provided physical care, and talked to toddlers more than did any other individuals. The only exception to this pattern was in sustained social interaction, which almost always occured between toddlers and other children. The toddlers were talked to for fully 35 - 40% of the observed time, with about half of this conversation coming from mother and older sister.

TABLE 11.7
Percentage of toddlers (n = 102) who passed each item on selected Uzgiris-Hunt Scales.

Tests	% Passed Item	
	18 Month Toddler	24 Month Toddler
Object Permanence		
1 Screen	64.5	95.0%
3 Screens	34.5	95.0
Visible - 1 Screen	40.9	92.2
Visible - 2 Screen	40.0	89.2
Invisible - 3	16.4	45.1
Invisible - Countertest	9.1	27.5
Means - Ends		
Uses string horizontally	80.0	96.0
Uses string vertically	64.8	95.0
Uses stick with demo	51.5*	80.9*
Uses stick without demo	17.0	50.0
Bunches necklace	15.5	47.1
Avoids ring	29.1	46.1
Vocal Imitation		
Imitates familiar words	27.3	63.7
Imitates unfamiliar sounds	15.0	50.0
Imitates unfamiliar words	11.8	50.0
Play (Schemes)		
Puts one object in another	47.3	80.4
Number of play activities	0-2	0-2
Shows toy	44.5	71.0
Names	10.0	52.0
Doll play	16.4	34.0

* Approximate.

TABLE 11.8
Distribution of time spent caring for toddlers by various caregivers, expressed as percentage of total observation period of toddlers.

Caregivers	Physical Care	Hold or Carry	Touch	Social Interaction	Talk
Mother	5.2	7.3	3.0	<1	10.8
Other Adults	1.1	1.1	1.2	<1	5.7
Older Sister	1.8	3.4	3.5	1.6	9.7
Older Brother	<1	<1	2.0	1.3	5.5
Other Child	<1	<1	<1	1.9	2.7
More than one individual	<1	<1	1.0	<1	2.6

To evaluate changes in rearing patterns related to child age, regressions were calculated for the durations of the rearing variables over the 15 month period of observation. The only significant changes with age were declines in the percentages of physical care (r(494) = -.38, p < .001) and carrying (r(494) = -.43, p < .001). Thus, mothers provided physical care during 10% of observed time for the toddlers 15-18 months old, 6% of the time for the 18-24 month-olds, and 4% of the time for the 24-30 month-olds. The decline in carrying and holding the toddlers was even sharper. Mothers and older sisters carried the 15-18 month-olds for 23% of the time, the next age group for 12% of the time, and the oldest group for 6% of the time, with mothers carrying the toddlers about twice as much as the older sisters at every age. There were no significant changes with age in the extent to which children were touched, talked to, or involved in social interactions.

Toddler Behavior and Caregiver Responsiveness

Observations of toddler behavior are presented in Table 11.9. Each of the scores represents the percentage of the observation period that the behavior was reported.

Toddlers played with objects for about 35% of the observation time, and the total amount of time engaged in play (as reflected by the group mean) remained relatively constant over the year. Like other individuals in the compound, young toddlers talked a fair amount -- about 22% of the time -- and this increased significantly with age (r (797) = .17, p < .001). They cried only 7% of the time and this decreased with age (r (797) = -.27, p < .001). They smiled 17% of the time and this increased as they matured (r (797) = 22, p <.001). There were no sex differences in these behaviors and males and females changed with age in the same way. Responsiveness to the vocalizations and cries of toddlers were analyzed with 2 x 3 (Sex x Type of Response) ANOVAs and there were significant effects in type of response but no sex differences. The majority of caregiver responses to toddler vocalizations and cries were vocal responses rather than physical or combined vocal-physical responses. Responsiveness to toddler vocalization increased slightly and responsiveness to toddler crying decreased slightly as toddlers matured.

TABLE 11.9
Percentage of observation time toddlers (n=109) engaged in selected behaviors.

Observation	Mean %
Plays with Objects	35
Simple Play	27
Functional Play	4
Symbolic Play	3
Total Vocalizations	22
Total Smiles	17
Total Cries	7

Schoolers and Adults

Descriptive data for the tests administered to schoolers and adults are not presented in this report as the data have not yet been analyzed. Data on these target individuals are being compiled for the following tests:

Schoolers (n = 131)

1) Draw-a-person Test
2) Raven's Progressive Matrices
3) Word Recognition Test
4) The Block Design Test (WISC-R)
5) Digit Span Test (WISC-R)
6) The Arithmetic Test (WISC-R)
7) Behavior Rating
8) School Attendence and Performance Data

Schoolers were tested on three occasions over a two year period.

Adults (n = adult males - 260, adults females = 270)

1) Digit Span (WAIS)
2) Similarities (WAIS)
3) Block Design (WAIS)
4) Arithmetic (WAIS)
5) Raven's Progressive Matrices
6) Word Recognition Test

Adults were tested at least once; a subsample had repeat testing in late 1985, near the end of the study.

REFERENCES

1. Brazelton T.B. Neonatal Behavioral Assessment Scale. Philadelphia: J.B. Lippincott Co., 1973.

2. Fagan J.F., McGrath S.K. Infant Recognition Memory and Later Intelligence. Intelligence, 1981; 5:121-130.

3. Bayley N. Bayley Scales of Infant Development. New York: The Psychological Corporation, 1969.

4. Uzgiris I.C., Hunt J. McV. Assessment in Infancy; Ordinal Scales of Psychological Development. Urbana, Illinois: University of Illinois Press, 1975.

5. Center for the Study of Visual Impairment, University of California at Berkeley. The U.C. Berkeley Preferential Looking Test For Screening Visual Acuity in Infants. Berkeley, California.

6. Goodenough F.L. Draw-A-Person Test (DAP). In Measurement of Intelligence by Drawings. Yonkers, New York: World Book Company, 1926.

7. Raven T.C. Ravens Progressive Matrices. In: Guide to Standard Progressive Matrices. New York: Psychological Corporation, 1960.

8. Weschler D. Weschler Intelligence Scale for Children - Revised. New York: Psychological Corporation, 1974.

9. Muinde N. Word Recognition Test -- East Africa Personal Communication. 1984.

10. Wechsler, D. Wechsler Adult Intelligence Scale (WAIS). New York: Psychological Corporation, 1955.

11. Werner E.E. Cross-Cultural Child Development. Monterey, California: Brooks-Cole, 1979.

12. Leiderman P.H., Leiderman G.F. Affective and Cognitive Consequences of Polymatric Infant Care in the East African Highlands. In: A.D. Pick, ed., Minnesota Symposia on Child Psychology.Minneapolis: University of Minnesota Press 1974; 8:81-110.

13. Berry J.W., Dasen P.R., Witkin H.A. Developmental Theories in Cross-cultural Perspective. In: L.L. Adler, ed., Cross Cultural Research at Issue. New York: Academic Press. 1982: 13-22.

Chapter 12

RESTING METABOLIC RATE

A core research component of the Nutrition CRSP Kenya Project is the investigation of the resting metabolic rate for lead males, lead females and school-age children between the ages of seven and eight years. The Project used a Beckman Metabolic Measuring Cart to measure the caloric expenditure of these individuals while at rest.

RESEARCH OBJECTIVES

The goal of the investigation was to determine the energy available for activity (food intake minus resting metabolic rate) and whether a lowering of the resting metabolic rate (RMR), a surrogate for basal metabolic rate (BMR), was adaptive in helping to restore energy equilibrium. A lowering of the resting metabolic rate for target individuals was hypothesized as a physiological adaptation to lower levels of food intake and, in the case of women, increased energy demands due to pregnancy and lactation.

THE SAMPLE

The Kenya Project's Resting Metabolic Rate database consists of 2,102 energy (kcal) expenditure measurements for post-absorptive, resting individuals. The target individuals are the lead male (01), lead female (02), male schooler (27) and female schooler (37). With the exception of a few preliminary RMR tests during January, the data were collected from February 1984 through December 1985. Table 12.1 summarizes the RMR data per respondent category.

TABLE 12.1
Number of RMR measurements per respondent category.

Target Individual	No. of Respondents Participating	No. of Measurements	Mean No. Measurements per Respondent
01 (Lead Males)	241	761	3.2
02 (Lead Females)	247	973	3.9
27 and 37 (Schoolers)	151	368	2.4
	639	2102	

DEVELOPMENT OF DATA COLLECTION TECHNIQUES, AND STAFF TRAINING

The collection of RMR data began in February 1984. This section briefly discusses the preparatory work completed by Project staff during the year prior to this beginning date.

The protocol for the RMR study was developed in conjunction with researchers from the other Nutrition CRSP Projects. In January 1983, UCLA investigators met jointly with University of Nairobi researchers and Project field staff to plan the RMR study. These initial meetings focused on such topics as equipment requirements, staffing needs, and measurement strategies. Additionally, the study area was visited in order to determine the feasibility of establishing a RMR test laboratory at the Karurumo Health Centre.

A major decision during this period was to purchase Beckman Metabolic Measuring Carts (MMC), one to be used for each Nutrition CRSP Project. The MMC is an automated and mobile system for assessing metabolic, respiratory, and ventilatory variables. The unit contains a series of analyzers for measuring CO_2, O_2, expired volume, temperature, barometric pressure and time. The MMC uses magnetic cards to program a processor which controls the timing and sequence of measurements. A more detailed description of the MMC's specifications is available elsewhere (1).

The completion of the RMR study depended on the successful operation of the MMC. Support equipment such as external barometer, thermometer, calibration gases, generator, hoses, mouthpieces, printout paper, etc.) were secured and staff (a Kenyan graduate student and laboratory technician) were hired and trained. In September 1983 one senior investigator of the UCLA Department of Kinesiology returned to Kenya to supervise the set-up of the Karurumo RMR laboratory, and to begin testing of the RMR protocol. The MMC arrived and was installed in the laboratory. The operating of the machine was reviewed in detail, with strong emphasis placed on providing "hands-on" experience for the lab staff. Various test situations were created to provide the MMC operators with experience in interpreting and reacting to different instrument measurement situations, and to test the operating capabilities of the MMC. At this time it was discovered that the MMC required a larger, more powerful generator than had originally been planned (Karurumo has no other source of electricity), and that the nose clips needed to be replaced by masks.

In September 1983, the basics for the data-collecting protocol were established. A preliminary form was generated, which field staff piloted during late 1983 and early 1984. The piloting was very useful in helping to identify logistical problems and in providing information on how respondents reacted to the test situation.

TECHNIQUES OF DATA COLLECTION

Resting metabolic rate data were collected for a two year period starting in February 1984. This section discusses the method used during fieldwork, beginning with a summary of the overall research protocol and concluding with a detailed examination of the actual 30-minute RMR test situation. The RMR data form (711) is reviewed in the context of the laboratory test.

The goal of the Kenya Project's RMR study was to obtain four 30-minute tests of resting metabolic rate for each enrolled household's lead male (01), lead female (02), male schooler (27) and female schooler (37). On an average, each study household was scheduled for RMR every three months. In most cases, the test was completed at the scheduled time, although on occasion a household requested rescheduling for a variety of reasons. The RMR examinations were scheduled for Monday through Friday, with an attempt made to complete six to eight tests per day.

The RMR test procedure was as follows. On the day prior to the examination, the household was alerted that a test had been scheduled for the following morning. If the household agreed to the test date, they were reminded that a vehicle would come between 0700 and 0900 hours to transport them to the Karurumo laboratory. The target respondents were asked to refrain from eating a morning meal on the day of the RMR test, although they were allowed to take tea without sugar. Additionally, they were asked to refrain from smoking during the same pretest time period.

On the morning of the examination day, a project vehicle transported respondents to the Karurumo Health Center. Upon arrival height, weight and age were recorded by a project nurse. Because the RMR laboratory was small and contained only two beds (respondent RMR was measured while in a supine position), respondents waited in a quiet area near the clinical laboratory. As space became available, the respondents were escorted to the RMR laboratory. Upon arrival at the RMR laboratory, respondents were asked to lie down and rest for 30 minutes. After the necessary rest period, a respondent was fitted with a face mask and connected to the Beckman MMC. For the next 30 minutes, respiratory and metabolic measurements were made on a minute by minute basis. Upon completion of the test, a project vehicle transported respondents back to their households.

The most critical component of the RMR protocol is the 30-minute MMC test period. Before each test, the technician recorded on the RMR data form the visit number, the number of the household and target individual, the date, the technician's number and the respondent's status. In addition to the above identification information, the technician recorded the time, oral temperature, body surface area (m^2) (calculated by the MMC), resting heart rate pre-test (beats/minute), resting heart rate post-test, room temperature, barometric pressure (mmHg), and humidity (%) (see Figure 12.1).

After completing the above, the technician recalibrated the MMC's O_2 and CO_2 sensors and conducted a quick status check of the machine's operating parameters. Once the technician was assured that the machine was operating correctly, the respondent was fitted with a mask connected by tubing to the MMC. When the respondent was comfortable, the technician entered into the MMC's processor the subject's age, sex, height and weight, all information that the MMC's Nutritional Program requires to perform the metabolic and respiratory calculations.

The Nutritional Program performs a range of calculations automatically and also allows for technician intervention to modify the automated format. The Kenya Project's technicians operated the MMC according to protocols established by the UCLA Senior Investigator. These guidelines instructed the technician to collect minute by minute respiratory/metabolic data, with summary calculations performed at 20 and 30 minutes. The following minute by minute information is produced by the Nutritional Program:

- V: The total volume of expired gas in L/minute (BTPS)
- FR: Rate, the number of breaths/minute
- VT: Tidal volume of each breath in mL/minute (BTPS)
- VO_2: Volume of expired oxygen in mL/minute (STPD)
- A: Volume of expired oxygen in mL/minute (STPD) per body weight (kg)
- VCO_2: Volume of expired carbon dioxide in mL/minute (STPD)
- RQ: Respiratory Quotient = VCO_2/VO_2
- T: Elapsed time (min-sec)

The above minute by minute information was collected for a total of 30 minutes. As stated above, at minutes 20 and 30 the technician switched the MMC from the automatic to the calculation mode. For the two years of data collection, field staff consistently followed the 20/30 minute protocol. The only major modification of the protocol occurred during the first three months of data collection. Due to an initial reluctance by respondents to remain supine for 30 minutes, combined with the technicians' inexperience with the MMC, test time was reduced to a maximum of 20 minutes. If the test lasted 20 minutes, the calculation was done at minute 20.

Additionally, a minor change to the 20/30 minute calculation procedure was implemented from April 1985 until the end of the study. This modification involved the addition of a calculation at 10 minutes to provide more flexibility in recording the lowest three minute segment (see below).

Regardless of when calculations were done, the Nutrition Program uses one of two calculation procedures depending on whether or not the respondent achieves steady-state rest conditions during the test. The Program recognizes steady-state as minute by minute changes in VE and VO_2 of less than 10% and in RQ of less than 5%. Specifically, the VE,

VO_2 and RQ data obtained at the conclusion of each minute calculation is compared with similar data from the two previous measurement intervals (minutes).

If a steady state is reached, the computed values for VE, VO_2, and VCO_2 are averaged from the data of the three measurement intervals. If no steady state is reached during the 10-minute test period, the summary calculations are performed based on the last data set (e.g. minute 10). In addition to the computed values for V, VO_2, VCO_2, RQ, the respondent's resting energy expenditure (REE) (kcal/day), REE/body weight (kcal/kg), REE/body surface (kcal/m^2), and REE/PRE (Predicted REE) are also calculated. One other value appearing during calculation, and at the beginning of each-10 minute test segment, is the fraction of inspired oxygen (FIO_2). The FiO_2 is a measure of the percentage of O2 in ambient air and is used in all metabolic calculations performed by the Nutrition Program. Due to ambient conditions, particularly humidity, the FIO_2 can vary from the expected 20.9%.

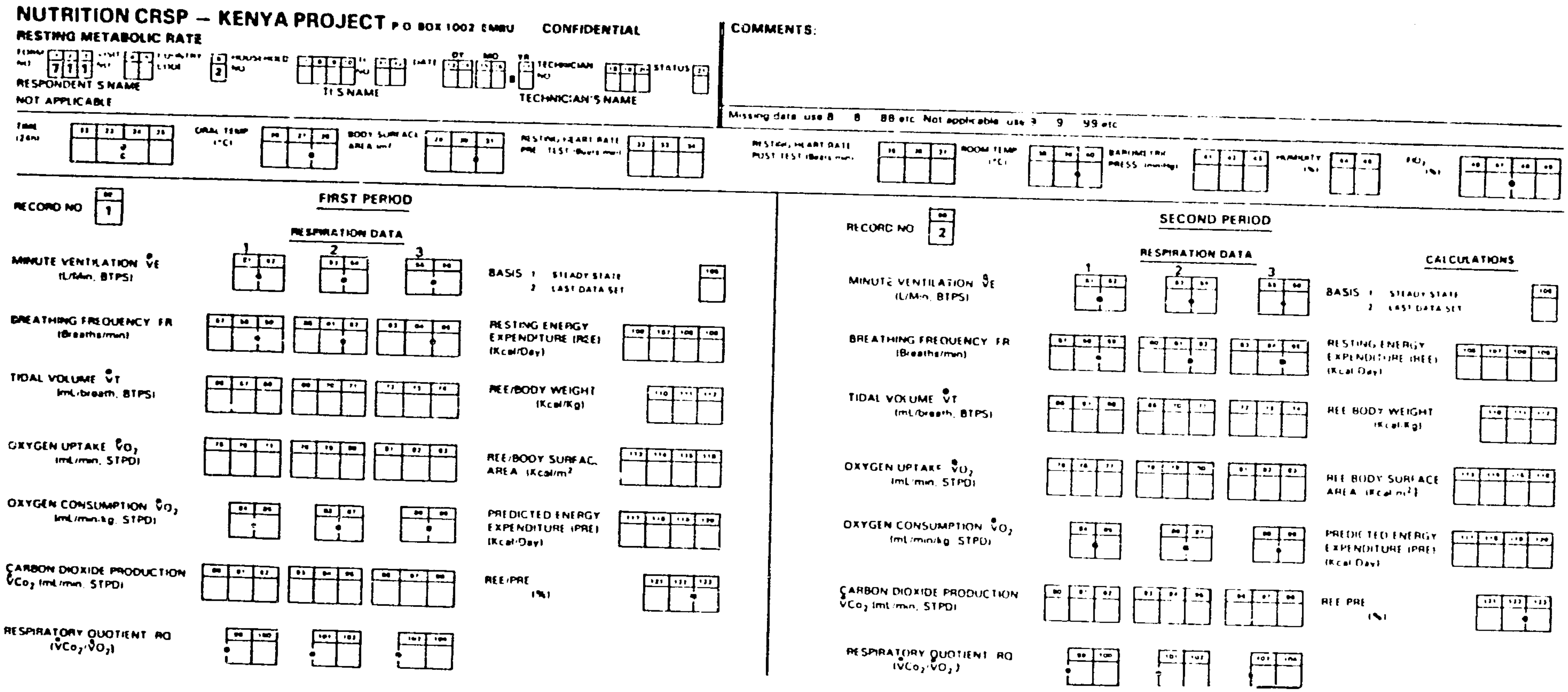
The final stage in the RMR protocol involves the transfer of selected MMC calculations to the data forms for eventual computer entry. The choice of which minutes should be transferred was based on the researchers' review of previous studies of RMR and on a preliminary analysis of the Project's pilot RMR study. Originally, it appeared in these studies and during the pilot research that the minute by minute respiratory/metabolic values stabilized after the first 10 minutes of testing. Therefore, it was decided that three representative minutes from the second and third 10-minute test segments would be recorded for computer analysis. Restated, minutes 18, 19, and 20 for the second 10-minute test period, and minutes 28, 29, and 30 for the third 10-minute test period were selected. With the exception of elapsed time, all the minute values recorded by the Nutrition Program were transferred to columns 50-104 on the RMR form (see Figure 12.1). Minutes 18, 19, and 20 comprised the First Period, while 28, 29, and 30 constituted the Second Period. A printed 1 or 2 in column 50 identified the data as belonging to either the first or second period.

During 1985 the data transfer protocol was twice modified. First, rather than test for 20 minutes before calculating, a calculation was made after 10 minutes of testing, followed by ones at 20 and 30 minutes respectively. This change was instituted after a preliminary review of the data suggested that during the last 10 minutes of the test, respondents were becoming restless, resulting in higher respiratory values. As a result of this change, the technician had an additional 10-minute period from which to select the two lowest three-minute datasets, following the same guidelines utilized during the first year of data collection. The protocol change separated the data into finer groups; the method of selecting within the groups remained unchanged.

The second change in the data transfer protocol involves not which minutes would be used for summary calculations but rather a correction in the specific metabolic/respiratory values produced by the MMC. Due to a faulty CO_2 analyzer, both the VCO_2 and the RQ values produced by the MMC during this period were spurious. To correct these values the Project employed a default RQ value of .85 to correct VCO_2. Both the RQ value of .85 and the corrected VCO_2 values were computer-entered. The default value of .85 was based on the average of previously obtained RQ's.

In addition to the values transferred from the selected minutes and the summary calculations following each three-minute block were also recorded. Columns 105-123 for both periods on form 711 were used to record these data (see Figure 12.1). The relationship between the minute calculations and the summary data depend on whether the calculations were based on a steady state or the last data set (column 105). The summary calculations are based on either an average of three very stable minutes within the 10-minute test segment, which may or may not be recorded on the data form, or on the last minute in each period.

Form 711 contains the RMR study data that was computer-entered. It is these data that form the basis of the Project's RMR database.


NUTRITION CRSP — KENYA PROJECT P.O. BOX 1002 EMBU CONFIDENTIAL
RESTING METABOLIC RATE
FORM NO. 7 1 1
RESPONDENT'S NAME
NOT APPLICABLE
HOUSEHOLD NO. 2
TT'S NAME
DATE DY MO YR
TECHNICIAN NO.
TECHNICIAN'S NAME
STATUS
COMMENTS:
Missing data use 8 8 88 etc. Not applicable use 9 9 99 etc.
TIME (24H)
ORAL TEMP (°C)
BODY SURFACE AREA (m²)
RESTING HEART RATE PRE TEST (Beats/min)
RESTING HEART RATE POST TEST (Beats/min)
ROOM TEMP (°C)
BAROMETRIC PRESS (mmHg)
HUMIDITY (%)

RECORD NO 1
FIRST PERIOD
RESPIRATION DATA
1 2 3
MINUTE VENTILATION $\dot{V}_E$ (L/Min, BTPS)
BREATHING FREQUENCY FR (Breaths/min)
TIDAL VOLUME $\dot{V}_T$ (mL/breath, BTPS)
OXYGEN UPTAKE $\dot{V}O_2$ (mL/min, STPD)
OXYGEN CONSUMPTION $\dot{V}O_2$ (mL/min/kg, STPD)
CARBON DIOXIDE PRODUCTION $\dot{V}CO_2$ (mL/min, STPD)
RESPIRATORY QUOTIENT RQ ($\dot{V}CO_2/\dot{V}O_2$)
BASIS 1 STEADY STATE 2 LAST DATA SET
RESTING ENERGY EXPENDITURE (REE) (Kcal/Day)
REE/BODY WEIGHT (Kcal/Kg)
REE/BODY SURFACE AREA (Kcal/m²)
PREDICTED ENERGY EXPENDITURE (PRE) (Kcal/Day)
REE/PRE (%)

RECORD NO 2
SECOND PERIOD
RESPIRATION DATA
CALCULATIONS
1 2 3
MINUTE VENTILATION $\dot{V}_E$ (L/Min, BTPS)
BREATHING FREQUENCY FR (Breaths/min)
TIDAL VOLUME $\dot{V}_T$ (mL/breath, BTPS)
OXYGEN UPTAKE $\dot{V}O_2$ (mL/min, STPD)
OXYGEN CONSUMPTION $\dot{V}O_2$ (mL/min/kg, STPD)
CARBON DIOXIDE PRODUCTION $\dot{V}CO_2$ (mL/min, STPD)
RESPIRATORY QUOTIENT RQ ($\dot{V}CO_2/\dot{V}O_2$)
BASIS 1 STEADY STATE 2 LAST DATA SET
RESTING ENERGY EXPENDITURE (REE) (Kcal/Day)
REE/BODY WEIGHT (Kcal/Kg)
REE/BODY SURFACE AREA (Kcal/m²)
PREDICTED ENERGY EXPENDITURE (PRE) (Kcal/Day)
REE/PRE (%)

FIG. 12.1. Resting metabolic rate form 711.

QUALITY CONTROL MEASURES

The progress and quality of the RMR measurements was supervised by the senior investigator from UCLA and by senior field staff. The laboratory was visited regularly, forms were reviewed for completeness and tests were observed to ensure adherence to protocol, with particular emphasis given to verifying that masks were regularly checked for leakage. Also, log books were maintained to record MMC calibration levels (the quality of the calibration gases purchased locally was monitored throughout the study by comparing them with known percentages of gas in cylinders provided by Beckman) and servicing dates.

To check for MMC reliability, selected Project field staff were tested on a regular basis. From June until November, 1985, four senior staff members were tested for RMR on two consecutive days per month. The RMR quality control tests on staff followed the identical protocol used during respondent testing. For REE/day the comparison yields a correlation coefficient of .736 and for REE kg/day the coefficient is .837.

As a further check on methodology, a comparison was made of RMRs on 13 adults by the MMC and the Max Plank Respirometer. There was good correlation between the two sets of data (r = 0.843), but values were higher by about 200 kcals/day using the Max Plank (see Appendix F).

Variation in RMR Across Time

A crude estimation of the partitioning of variance in RMR was made by the Management Entity scientists. Only subjects with 3 or more replicated RMR estimations were included. Data were first examined by subject to obtain estimates of the subject's mean SD. The mean and SD of the means of the subjects were then obtained to provide a crude estimate of the between subject SD. The mean of the subject SDs was taken as an estimate of the within person SD. Outliers were first removed. The data suggests that within person variability across time is of similar magnitude to between person variability (see Table 12.2). These have implications for the interpretation of RMR and RMR related analyses.

TABLE 12.2
Variation in RMR measurements.

	n	Mean REE	Between Person SD	Within Person SD
Adult Males	137	1312.2	158.3	145.9

A more detailed description of the evaluation of the RMR data set can be found in the Management Entity Final Report, Part IV-E..

PREPARATION OF DATA FOR ANALYSIS

The Kenya Project's RMR database is large both in number of minute measurements and number of respondents tested. The data recorded on the 711 form was computer entered in Nairobi and a tape copy was forwarded to UCLA.

The initial computer generated descriptions of the complete RMR dataset revealed two unexpected and disturbing findings. First, a very large number of the respiratory quotients (VCO_2/VO_2) were greater than 1.0. The normal range of RQ is between .70 and 1.0, depending on substrate metabolism. Respiratory quotients greater than 1.0 are artifactual.

Second, the respondents' resting energy expenditure (REE) values were consistently 20-30% lower than what the MMC predicted, suggesting that the MMC predictions, based on studies of Western populations, were too high for non-Western populations. However, because the low REEs occurred along with high RQs, staff researchers were once again suspicious of the O_2 and CO_2 measurements (2).

The first step in the investigation of high RQs and low REEs was the plotting of RQ against numerous other respiratory variables. Of obvious immediate interest was the relationship between RQ and both VO_2 and VCO_2. Scatterplots and correlation analyses revealed a stronger relationship between VO_2 and RQ than between VCO_2 and RQ: a strong fall in RQ with increasing VO_2 and only a small rise in RQ with increasing VCO_2. Analyses also indicated a moderately strong relationship between FIO_2, humidity and RQ: a decrease in FIO_2 and a rise in humidity correlated with a rise in RQ. Scatterplots of other RQ and respiratory frequency (hyperventilation), temperature, barometric pressure, cluster location of household, body weight and change in body weight did not produce any significant correlations.

Project staff focused their efforts on explaining the relationship between RQ and FIO_2, humidity and VO_2. The re-analysis of these data began with a review of the field protocol. The MMC's maintenance log and the service reports filed by Beckman/SensorMedics repair technicians were reviewed to determine whether the high RQs occurred during periods when either the MMC's oxygen sensor required frequent recalibrations or when we were suspect of the quality of the calibration gases. No systematic relationship was found between calibration procedures or frequency and the high RQs. The maintenance log revealed that the technician properly calibrated the MMC and, with the exception of a few short periods, calibration gases with an acceptable CO_2 and O_2 mix were available.

The MMC's service records were also checked. RMR test results from the period just prior to repairs were compared with the results from the period immediately following servicing. This comparison revealed no significant differences between the two periods: the distribution of RQ, FIO_2 and VO_2 values were similar in periods before and after servicing.

The investigation shifted efforts to an investigation of the MMC, with an emphasis on the technical parameters of the instrument and the formulas used by the Nutrition Program, which are derived from the Exercise Program algorithms. In particular we were interested in the operating characteristics of the O_2 sensor and the formula for deriving VO2. The formula used in the Exercise Program for calculating VO_2 is presented below:

$$VO_2\,(STPD) = \left[\left(\frac{1 - FEO_2 - FECO_2}{1 - FIO_2} \times FIO_2\right) - FEO_2\right] \times VE(STPD) \times 10^3$$

Since preliminary analyses had indicated that VO_2 appeared to be driving RQ, we experimented with various combinations of acceptable FIO_2, FEO_2 and $FECO_2$ values in the above equation. The intent was to determine the sensitivity of VO_2 to changes in each of these variables. Initially, it appeared that an error in measuring $FECO_2$ could account for some overestimates of RQ; however, the magnitude of the error was too small to explain the high RQs. Moreover, the small errors in $FECO_2$ did not explain the low resting energy expenditure (REE) values which also characterize the Kenya data.

Our attention shifted to the FIO_2 variable. The Kenya data base contains FIO_2 values ranging from 0.2093 to as low as 0.20. Under normal conditions at sea level the percentage of O_2 in the ambient air should approximate 0.2093. In our experimentation with the VO_2 formula, we employed a range of FIO_2 values. We found that FIO_2 and VO_2 were strongly positively related: as FIO_2 decreased, VO_2 also decreased. The decrease in VO_2 drove RQ up and REE down. The consequences of a decreasing FIO_2 for VO_2 and RQ are presented in Table 12.3.

Table 12.3
Results of decreasing FIO_2 on VO_2 and RQ.*

FIO_2	Resulting VO_2 (ml)	Resulting RQ
0.209	513	0.85
0.206	475	0.96
0.203	437	0.99
0.201	412	1.05
0.199	387	1.12

* The calculations employ the following parameters: $FEO_2 = 0.16$; $FECO_2 = 0.04$; VE = 10 lts.

The analysis presented in Table 12.3 raised the possibility that a MMC underestimation of FIO_2 explains the high RQs and, indirectly, the low REEs in the data base. However, before this assertion could be accepted additional information was required. First, the calculations in Table 12.3 assume that the measurement of FIO_2 is independent of FEO_2. A major question that confronted project staff was whether a decrease in FIO_2 was accompanied by a proportional decrease in FEO_2. If so, the absolute difference between FIO_2 and FEO_2 would be maintained and any effect on VO_2 would be negated. Secondly, if in fact FIO_2 is experimentally independent of FEO_2, the source of the varying FIO_2 values would still have to be determined. To answer these questions more technical information was obtained from the Beckman manual(1).

The Beckman manual provides diagrammatic descriptions of gas flow through the MMC. In the case of FIO_2 and FEO_2, both gases are measured by the OM-11 sensor after calibration. The manual clearly states that the VO_2 equation requires these gases dry. To achieve this, the Beckman provides a drying tube to remove moisture. The MMC, however, provides three options for imputing the FIO_2 value: measured FIO_2 moist, measured FIO_2 dry and default FIO_2 of 0.209. The Kenya project employed the first option: the concentration of O_2 in ambient air was collected moist. Only one option is provided for FEO_2. The expired gas is passed through a drying tube and the O_2 concentration is measured.

According to the MMC operating instructions, the CRSP projects employed an acceptable protocol that imputed FIO_2 moist. Because the FIO_2 value contained moisture and the FEO_2 was measured dry, questions were raised about the interdependence and comparability of the two variables. Although each is measured by the same O_2 sensor, the presence of moisture in the FIO_2 sample would reduce the partial pressure of O_2, thus resulting in a lower O_2 reading at the OM-11. This would be reversed for FEO_2, since the removal of moisture would raise the partial pressure of expired oxygen. It thus appeared possible that due to moisture the FIO_2 was experimentally independent of FEO_2. Restated, decreases in the FIO_2 could occur without linear adjustments in FEO_2. This is exactly the situation modeled in Table 12.3.

If the FIO_2 value can fluctuate independent of FEO_2 due to moisture, strong support is given to the preliminary analyses that linked increases in humidity and RQ. Given these parallels between the patterns in the data and the results of the review of the MMC operating procedures, a working hypothesis was generated to verify the effects of humidity on FIO_2.

The MMC VO_2 equations require dry FIO_2 and FEO_2 values. The moist FIO_2 hypothesis states that moisture in the inspired air sample lowers the partial pressure of oxygen, resulting in lower FIO_2s, VO_2s, and higher RQs. Because the Beckman MMC provides the option to measure FI02 moist, yet the manual provides no text or diagrammatic explanation on how that sample is dried, the only default assumption remaining is that adjustments for moisture in ambient FIO_2 are written into the MMCs operating programs. To confirm this hypothesis, it had to be shown that the Beckman MMC program does not make adjustments for a moist FIO_2.

Neither the MMC's flow diagram nor the Exercise Program description mention any moist-to-dry adjustment for FIO_2. In a follow-up to the manual's lack of information, project staff contacted engineers familiar with the Beckman MMC model used by CRSP. The problem of high RQs was explained and also our suspicion that a depressed FIO_2 was the source of error. The engineers confirmed through experimentation the hypothesis that the MMC is not compensating for moisture in the FIO_2 sample. Using an MMC identical to the one used in Kenya, laboratory ambient FIO_2 was measured using two protocols. In the first, the FIO_2 value was recorded from the calculator printout while the programming mode was set to automatic. In the second, the FIO_2 value was read directly from the meter on the OM-11 while the programming mode was set to manual. In the first case, an FIO_2 of 0.208 was recorded. The FIO_2 manually recorded at the OM-11 indicated the same value. The agreement between the two FIO_2 values was unexpected, since the MMC software was designed to correct for moisture at the point of measurement. If this in fact is happening, the FIO_2 value at the OM-11 should have been lower, due to the effect of moisture on the partial pressure of O_2, than the 0.208 value generated by the MMC program. The MMC operating programs do not correct for moisture in the inspired air. It is now clear why, during periods of high humidity, FIO_2 decreased while RQ increased. We clearly see this during the peak of the rainy period for 1984. In October the mean adult male RQ was 1.06. The converse relationship holds true for dry periods. The first few months of fieldwork coincided with the 1984 drought. During this period, the as the male adult mean RQ was 0.85.

The moist FIO_2 hypothesis was strongly supported by the technical analyses performed by the engineers. Project staff recalculated respiratory parameters using the conventionally assumed FIO_2 value of 0.2093 for the 10% sample of RMR observations. This analysis has several important findings:

1) The distribution of RQ values became much more acceptable. In the original data approximately 30% of the RQ values exceeded 1.0. The corrected set showed only a small fraction of the RQs outside the acceptable range of 0.7-1.0. In the corrected set, there were approximately equal numbers of under- and over-estimates of RQ.

2) The seasonal time-course in RQ was dampened and brought back into the acceptable range, but there may still be some real seasonal variation in respiratory exchange.

3) The correlation between FIO_2 and RQ observed in the original data disappears in the corrected sample data.

4) Resting Energy Expenditure values increased, coming closer to predictions based on anthropometry. The original and revised data indicated possible seasonal variation (2).

The overall conclusion from the data test of the moist FIO_2 hypothesis is that the anomalously high RQ values and low REE values are due to methodological errors in the measurement of FIO_2. Accordingly, respiratory parameters were recalculated using a more correct assumed FIO_2 value of 0.2093. These corrections were made according to the following procedures:

Required parameters

Pb	Barometric pressure (mmHg)
FIO_2%	Inspired oxygen percentage
VO_2	Calculated oxygen uptake (ml/min, stpd)
VCO_2	Calculated carbon dioxide production (ml/min,stpd)
VEbtps	Minute ventilation (l/min, btps)

Intermediate calculations

1) Convert inspired oxygen % to fraction

$FIO_2 = FIO_2\% / 100$

2) Determine uncorrected VEstpd

$$VEstpd = VEbtps * ((Pb-47)/863) 1000$$

3) Determine expired carbon dioxide proportion

$$FECO_2 = (VCO_2 / VEstpd) + 0.0003$$

4) Determine expired oxygen proportion

$$FEO_2 = (((FIO_2 * (1-FECO_2))/(1-FIO_2)) - (VO_2/VEstpd)) * (1-FIO_2)$$

Corrected values

5) Correct VEbtps to Pb = 660 mmHg

$$VEbtpscorr = (VEbtps/((Pb-29)/(Pb-47))) \quad 1.02936$$

6) Determine corrected VEstpd

$$Vestpdcorr = VEbtpscorr * 710.31$$

7) Determine corrected oxygen uptake

$$VO_2corr = ((((1-FEO_2-FECO_2)/0.7907) * 0.2093) - FEO_2) * VEstpdcorr$$

8) Determine corrected carbon dioxide production

$$VCO_2corr = (FECO_2 - 0.0003) * VEstpdcorr$$

9) Determine corrected respiratory quotient

$$RQcorr = VCO_2corr / VO_2corr$$

10) Determine corrected resting energy expenditure

$$REEcorr = ((3.796 * VO_2corr) + (1.214 * VCO_2corr)) * 1.44$$

DESCRIPTIVE STATISTICS AND SUMMARY FINDINGS

Data on RMR are presented by target individuals and by season. The data for the lead females are separated into non-pregnant non-lactating (NPNL) and pregnant and lactating groups. RMR in pregnancy and lactation is more fully discussed in the section on pregnancy outcome.

In general, RMR values are approximately 90 to 95% of predicted values for sex and age using the MMC and FAO/WHO/UNU algorithms. There are body composition differences between the Embu study population and the population from which the constants were derived both for the MMC algorithm for predicted REE and the FAO/WHO/UNU algorithm for BMR (3). Studies by Mason et al (4) have pointed out that energy allowances derived from European and American Standards are not universally applicable even if adjusted for body weight. In contrast to the reference population, the Embu are leaner and have a lower fat diet than the reference population. (About 10 to 15% of total calories are derived from fat; please see Chapter 6).

The occurrence of severe drought in late 1984 presented an opportunity to examine the relationship between an acute decline in energy intake and RMR. In this report only simple correlational analyses are undertaken, examining the relationship of RMR to kcal intake, body fat, arm muscle area (to represent lean body mass) and changes in body weight and thyroid enlargement.

RMR by Target Individual

Resting energy expenditure (REE) per day and REE per kg per day are presented by target individual in figures 12.2 and 12.3. On a per kg basis, REE values of NPNL women are only 2.5% lower than for men. Daily REE for men exceed that for NPNL women by a mean value of 142 kcal per day (see Table 12.4). Schoolers have a higher daily per kg REE compared to adults. The schoolers are 83% of predicted REE using the FAO/WHO/UNU algorithms (1).

TABLE 12.4
Resting energy expenditure in lead males, non-pregnant and non lactating females, and schoolers (mean ± SD and range), seasons combined.

Target Individual	n*	REE/24hrs Kcal	REE/kg Kcal	REE/min Kcal
Lead Male	683	1321 ± 213 (860 - 2123)	24.1 ± 3.7 (14.8 - 39.7)	.90 ± .15 (.60 - 1.46)
NPNL	240	1179 ± 200 (725 - 1860)	23.5 ± 3.7 (15.4 - 36.2)	.82 ± .14 (.50 - 1.29)
Schoolers (Male & Female)	368	740 ± 155 (401 - 1187)	36.8 ± 7.3 (18.8 - 59.1)	.51 ± .11 (.28 - .82)

* Total number of measurements taken over two year period.

Season Effect

Of nutritional significance is the fact that a severe drought affected the study population from August through November 1984 with a marked food shortage particularly affecting a third of the households. The "long rains" in April and May is normally a period of reduced food supplies. Disease is also seasonal. Respiratory disease increases from June through September and more diarrheal disease is present in January through March, the warm dry season.

In examining RMR on a seasonal basis, one sees a decline in values for adult NPNL females from July through December 1984 both in REE/day and REE/kg/day. A slight gradual increase is seen but values do not return to the original levels of January to March 1984 until some six months later. For lead males one sees a slight decline in RMR from April 1984 through March 1985 and then a return to the original values. Schoolers fluctuate slightly and show a mild overall decline from October 1984 through April 1985 and then a gradual increase. The effects of season must be controlled in attempting to identify the effects of pregnancy and lactation per se in RMR (see Tables 12.5 and 12.6).

Relationship of RMR to Energy Intake and Body Weight and Composition

A number of pair wise correlations were run between RMR and energy intake, body weight, sum of fat folds, arm muscle circumference (AMC) and arm muscle area (AMA).

RMR and Weight Lead Males

Concurrently measured body weight and REE per day, quarter by quarter, show statistically significant correlations of medium strength, ($r = .34$ to $.60$, $p < .001 - .0005$). The strongest correlations are seen in April through June, July through September, and October through December, 1985 ($r = .55$ to $.60$, $p < .0005$) (see Table 12.7). REE from one quarter to another is highly correlated as are weights from one quarter to another. Weight correlates with REE for anygiven quarter. In trying to predict body weight, positive correlations are also seen but at a low level ($r = .20$ to $.30$, $p < .02 - .01$).

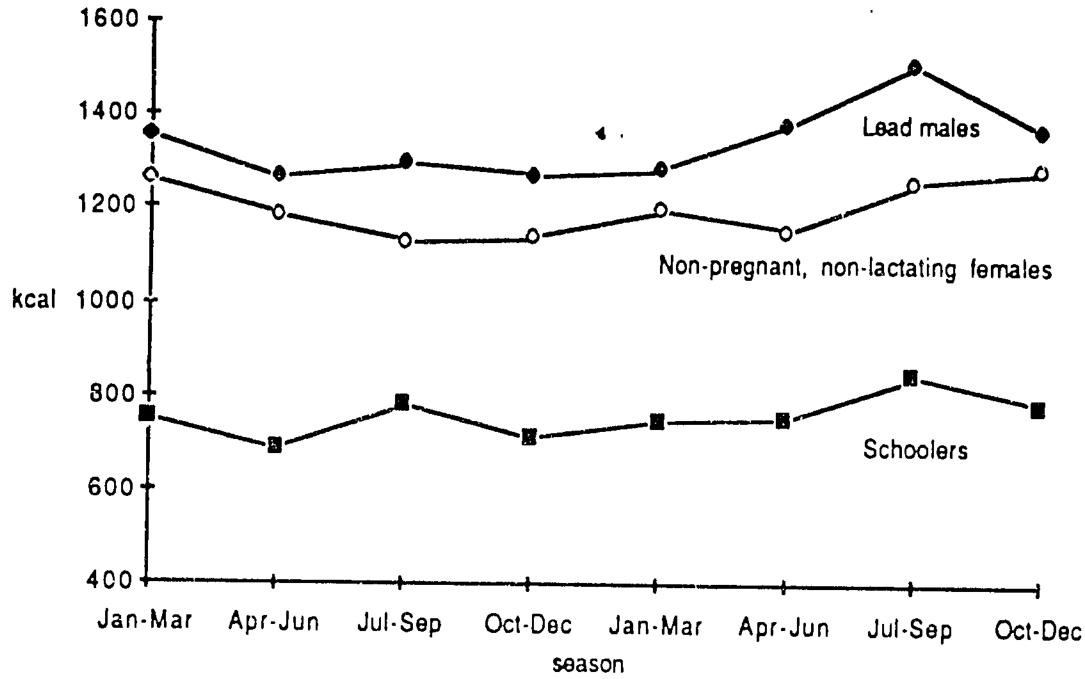


FIG. 12.2. Resting energy expenditure (REE) per day by target individual.

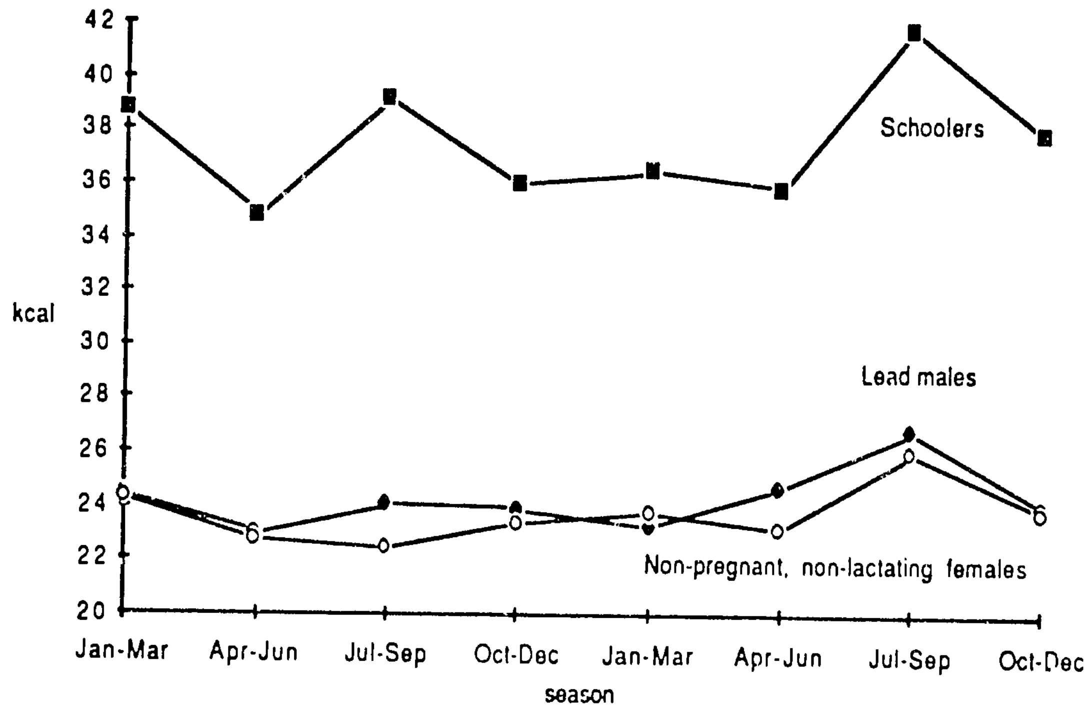


FIG. 12.3. Resting energy expenditure per kilogram of body weight for target individuals.

RMR and Protein Stores of Non-pregnant, Non-lactating women

As a surrogate for lean body mass, arm muscle circumference and arm muscle area are used. With values for all quarters combined, in NPNL women, correlations between REE and AMC and REE and AMA are both .33 (p<.0005).

RMR and Energy Intake of Lead Males

In examining the relationship between REE and energy intake, low correlations are seen through 1984 and 1985 with the exception of the October to December quarter of 1985 which yielded a correlation of .39. In examining food intake and subsequent REE (food intake lagged behind REE by one quarter) no significant correlations are seen with the exception of the April to June quarter of 1984 (r=.36). In the reverse situation (lagging REE behind food intake) there are a few low but significant correlations. Further analyses should be carried out using smaller time periods for lagging (see Table 12.8).

TABLE 12.5
Resting energy expenditure for lead males, non-pregnant and non-lactating females and schoolers by seasons in 1984 (kcal, mean ± SD, range).

	Jan.- Mar.	Apr.- Jun.	Jul.- Sept*	Oct. - Dec.*
NPNL Females	N=26	N=41	N=17	N=53
REE/d	1259 ± 227 (725 - 1678)	1184 ± 182 (786 - 1596)	1127 ± 201 (752 - 1474)	1137 ± 171 (765 - 1627)
REE/kg	24.3 ± 4.9 (15.6 - 36.2)	22.7 ± 3.5 (15.4 - 29.7)	22.4 ± 3.1 (16.9 - 28.7)	23.4 ± 3.7 (15.5 - 31.7)
Lead Males	N=63	N=86	N=36	N=144
REE/d	1349 ± 221 (949 - 1949)	1263 ± 194 (912 - 2124)	1289 ± 172 (908 - 1674)	1281 ± 173 (876 - 1758)
REE/kg	24.3 ± 4.1 (16.9 - 36.4)	23.0 ± 3.5 (15.6 - 39.8)	23.7 ± 3.8 (15.5 - 35.2)	24.2 ± 2.9 (17.0 - 34.1)
Schoolers	N=38	N=62	N=16	N=75
REE/d	751 ± 166 (470 - 1111)	686 ± 138 (401 - 997)	779 ± 139 (522 - 1019)	709 ± 136 (423 - 1057)
REE/kg	38.8 ± 7.0 (28.0 - 54.8)	34.8 ± 5.9 (22.3 - 49.1)	39.2 ± 6.4 (25.1 - 48.0)	36.0 ± 6.7 (19.8 - 54.3)

* The period of the famine was from August through November 1984.

TABLE 12.6
Resting energy expenditure for lead males, non-pregnant and non-lactating females and schoolers by seasons in 1985 (kcal, mean ± SD, range).

	Jan.- Mar	Apr.- Jun.*	Jul.- Sept.†	Oct.- Dec
NPNL Female	N=52	N=37	N=9	N=3
REE/d	1194 ± 231 (809 - 1860)	1151 ± 180 (823 - 1499)	1252 ± 191 (938 - 1487)	1281 ± 124 (1207 - 1423)
REE/kg	23.8 ± 3.8 (15.9 - 32.3)	23.1 ± 3.0 (17.9 - 28.8)	26.0 ± 3.7 (20.5 - 30.2)	23.7 ± 2.3 (22.2 - 26.4)
Lead Male	N=149	N=120	N=51	N=28
REE/d	1280 ± 226 (860 - 1960)	1373 ± 222 (969 - 1888)	1505 ± 197 (1031 - 1978)	1362 ± 188 (1056 - 1713)
REE/kg	23.2 ± 4.0 (14.8 - 35.1)	24.6 ± 3.5 (16.1 - 34.7)	26.9 ± 3.5 (21.3 - 35.7)	23.9 ± 2.9 (19.0 - 30.8)
Schoolers	N=80	N=55	N=25	N=17
REE/d	744 ± 183 (409 - 1187)	753 ± 144 (466 - 1116)	844 ± 119 (669 - 1068)	784 ± 129 (502 - 952)
REE/kg	36.5 ± 8.8 (19.2 - 59.1)	35.8 ± 6.5 (18.8 - 52.1)	41.9 ± 6.0 (27.0 - 51.2)	37.9 ± 8.8 (26.0 - 53.0)

* Period of the long rains.
† Period of the short rains.

TABLE 12.7
Correlations of resting energy expenditure (REE) with body weight for lead males.

	Year	Quarter	r value	p value
Weight vs REE/24 hr (concurrent values)				
	1984	Jan-Mar	.35	.01
		Apr-Jun	.49	<.0005
		Jul-Sep	.36	.025
		Oct-Dec	.50	<.0005
	1985	Jan-Mar	.39	<.0005
		Apr-Jun	.59	<.0005
		Jul-Sep	.55	<.0005
		Oct-Dec	.60	.005
Weight vs REE/24 hr (wt lagged behind REE by one quarter)				
	1984	Jan-Mar	.49	<.0005
		Apr-Jun	.28	NS
		Jul-Sep	.46	<.0005
		Oct-Dec	.41	<.0005
	1985	Jan-Mar	.57	<.0005
		Apr-Jun	.53	<.0005
		Jul-Sep	.62	.0005
		Oct-Dec	----	----

TABLE 12.8
Correlations between resting energy expenditure (REE) and energy intake (kcal) for lead males.

	Year	Quarter	r value	p value
Kcal vs REE/24 hr (concurrent values)				
	1984	Jan-Mar	.13	NS
		Apr-Jun	.13	NS
		Jul-Sep	.18	NS
		Oct-Dec	.19	<.05
	1985	Jan-Mar	.12	NS
		Apr-Jun	.01	NS
		Jul-Sep	.12	NS
		Oct-Dec	.39	<.05
Kcal vs REE/24 hr (kcal lagged behing REE by one quarter)				
	1984	Jan-Mar	.06	NS
		Apr-Jun	.36	<.025
		Jul-Sep	.09	NS
		Oct-Dec	.04	NS
	1985	Jan-Mar	.00	NS
		Apr-Jun	.13	NS
		Jul-Sep	-.14	NS
		Oct-Dec	---	---
Kcal vs REE/kg (concurrent values)				
	1984	Jan-Mar	-.03	NS
		Apr-Jun	.10	NS
		Jul-Sep	-.05	NS
		Oct-Dec	-.08	NS
	1984	Jan-Mar	-.01	NS
		Apr-Jun	.03	NS
		Jul-Sep	.03	NS
		Oct-Dec	.13	NS
Kcal vs REE/24hr (REE lagged behind food intake by one quarter)				
	1984	Jan-Mar	---	---
		Apr-Jun	.04	NS
		Jul-Sep	.33	<.005
		Oct-Dec	.30	<.05
	1985	Jan-Mar	.03	NS
		Apr-Jun	.08	NS
		Jul-Sep	-.04	NS
		Oct-Dec	.40	<.005

RMR and Fat Stores

The correlations between REE and body fat are generally inconsistent, however, in the quarter of July to September, 1984 during the early months of the famine, a weak and negative correlation is seen between REE and the sum of fat-folds (r = -.12). RMR values were starting to decrease at that time (see Table 12.9).

In pregnant, lactating, and post-partum women (7-9 days) correlations between REE values and AMC and AMA are positive and low but still statistically significant (see Table 12.10). Only weak correlations are seen with lactation through 6 months.

Relationship of RMR to Goiter

Goiter was found to be present in 25.9% of NPNL women (18.9% were 1+, 7.1% were 2+ in size) (see Table 12.11). Using analysis of variance, there is a near statistically significant difference among the groups with the 1+ and 2+ goiters with reference to REE per day. There are no significant differences with REE/kg and presence or absence of goiter.

TABLE 12.9
Correlations between resting energy expenditure (REE) and body fat for lead males.

	Year	Quarter	r value	p value
Sum FF vs REE/24 hr (concurrent values)				
	1984	Jan-Mar	-.20	NS
		Apr-Jun	.19	NS
		Jul-Sep	-.12	NS
		Oct-Dec	.17	<.05
	1985	Jan-Mar	.06	NS
		Apr-Jun	.16	<.05
		Jul-Sep	.07	NS
		Oct-Dec	.07	NS
Sum FF vs REE/24 hr (Sum FF lagged behind REE by one quarter)				
	1984	Jan-Mar.	.15	NS
		Apr-Jun	-.12	NS
		Jul-Sep	.18	<.05
		Oct-Dec	.05	NS
	1985	Jan-Mar	.21	<.025
		Apr-Jun	.09	NS
		Jul-Sep	.16	NS
		Oct-Dec	---	---

TABLE 12.10
Correlations of resting energy expenditure (REE) with arm muscle circumference (AMC) and arm muscle area (AMA) for pregnant, lactating, and post-partum females.

	AMC		AMA	
	r value	p value	r value	p value
Pre pregnancy	.01	NS	.02	NS
Pregnancy (trimester)				
1	.09	NS	.09	NS
2	.31	<.01	.30	<.01
3	.25	<.01	.25	<.01
Lactation				
0-45 days	.08	NS	.08	NS
46-135 days	.19	<.025	.19	<.025
136-180 days	.18	NS	.19	NS

TABLE 12.11
REE and Goiter in NPNL Women.

	N	Mean REE/24 h (kcal)*	REE/kg/24 h†
0 Goiter	82	1157 ± 202* (725 - 1627)	23.4 ± 4.2† (15.4 - 36.2)
1+ Goiter	21	1225 ± 164* (973 - 1474)	23.7 ± 3.7 (18.8 - 32.6)
2+ Goiter	8	1304 ± 238* (1103 - 1678)	22.4 ± 2.5 (18.6 - 26.5)

* ANOVA: $F = 2.7$, $p < .07$; borderline significance.
† No significant differences.

Final Remarks

Simultaneous plots are presented for kcal intake, daily REE, body weight and sum of three fat folds for lead males and NPNL women. In general, these variables change simultaneously and in the same direction (see Fig. 12.4 and Fig. 12.5).

The RMR data collected by the Nutrition CRSP represent a wealth of information. Numerous additional analyses remain to be conducted; several suggestions as to the types of analyses that should be conducted are presented in Chapter 27.

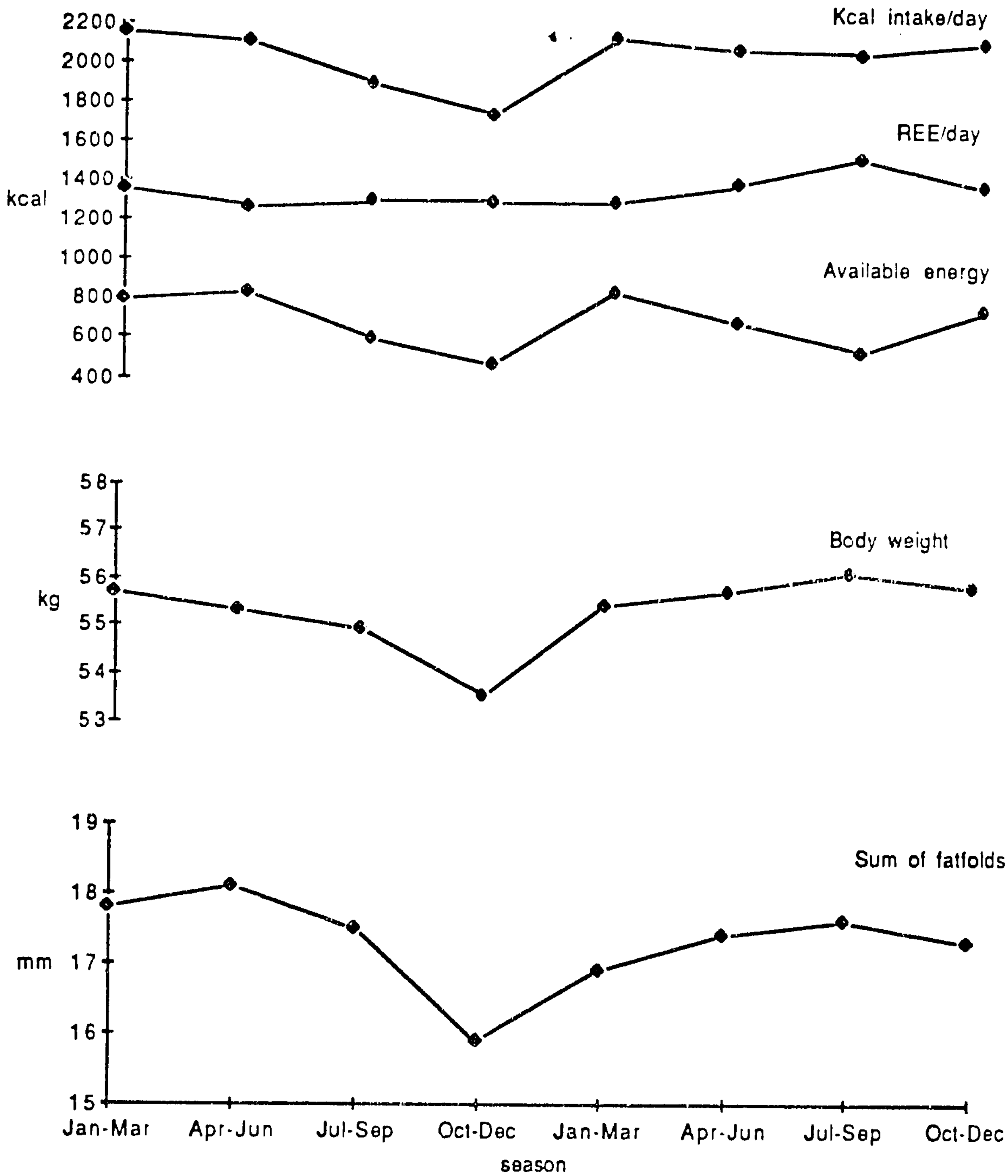


FIG. 12.4. Kcal intake per day, REE per day, available energy, body weight and sum of three fatfolds for lead males.

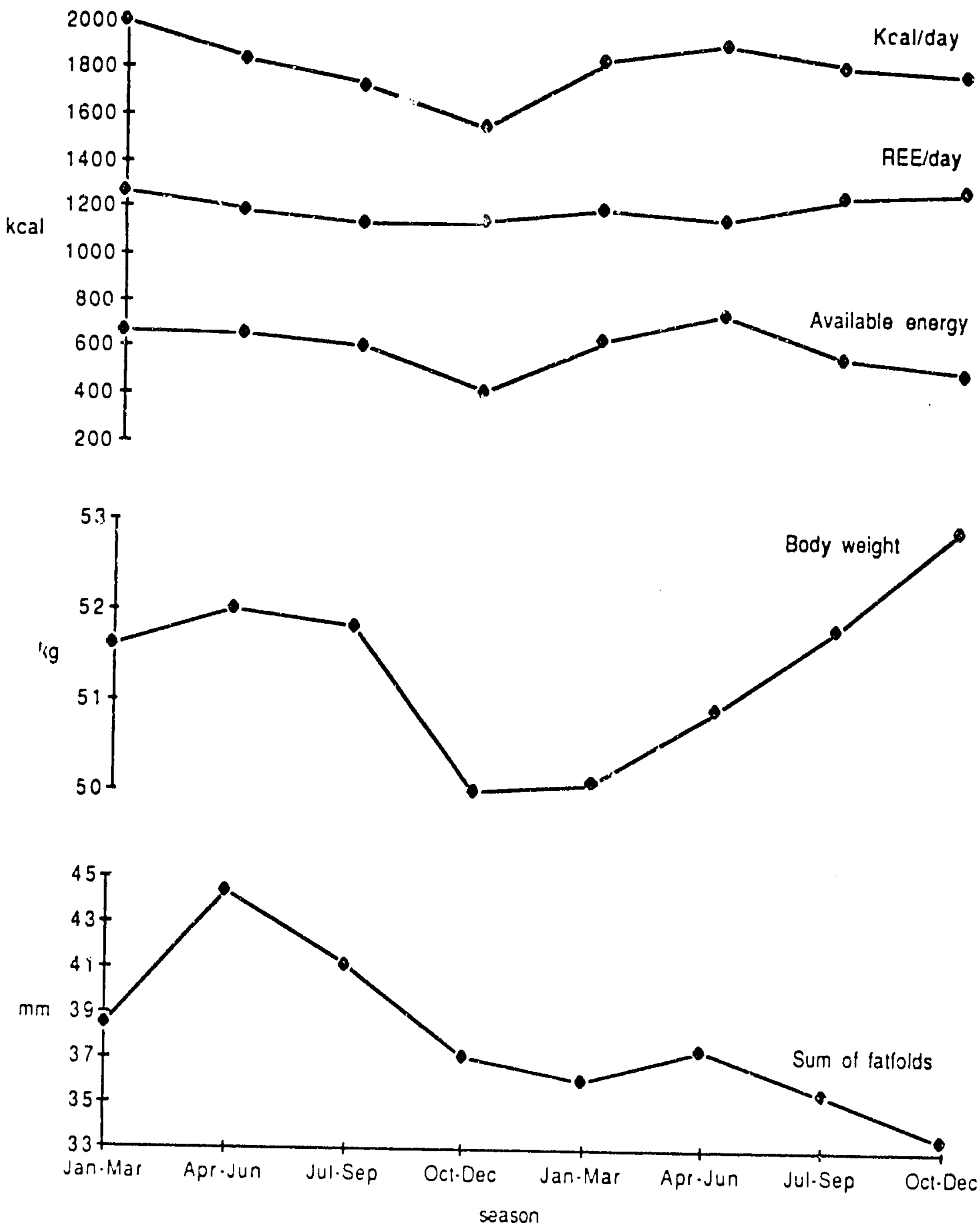


FIG. 12.5. Kcal intake per day, REE per day, available energy, body weight and sum of three fatfolds for non-pregnant, non-lactating females.

REFERENCES

1. SensorMedics. Metabolic Measurement Cart: Operating Instructions. Anaheim, CA: SensorMedics Corporation, 1981.

2. Paolisso M, Gardner G, Sackett R. Analyses of Resting Metabolic Rate Data. Nutrition CRSP Kenya-Project Unpublished Report. Los Angeles, CA: University of California.

3. World Health Organization. Energy and Protein Requirements, Report of a Joint FAO/WHO Ad Hoc Expert Committee, WHO Tech. Rep. Ser., in press, WHO, Geneva, 1986.

4. Mason, E.D., Jacob, M. Racial group differences in the basal metabolism and body composition of Indian and European women in Bombay. Human Biology 1964; 36: 374-396.

Chapter 13

SOCIOECONOMIC STATUS

The Nutrition CRSP Kenya Project investigated a wide range of socioeconomic variables in the effort to determine whether households' social position and economic well-being are related to their nutrition and health. Three complementary test instruments including a comprehensive socioeconomic questionnaire, a social and economic ranking of households by community subchiefs, and a detailed household income and expense questionnaire were administered to obtain data on household socioeconomic status. Preliminary analyses suggest that household socioeconomic status correlates positively with food intake and sanitation and hygiene, and negatively with morbidity.

RESEARCH OBJECTIVES

The objective of collecting comprehensive data on the social position and economic well-being of study households was to determine whether these variables influence or otherwise relate to food intake, morbidity, sanitation and hygiene, cognition, and other "functional outcomes." It was expected that information on households' socioeconomic status (SES) would help in the effort to understand 1) why some households are not as healthy or well-fed as others, and 2) whether household poverty and/or relatively low social esteem are among the major factors that limit the ability of households to increase their overall well-being, such as by obtaining more nutritious food or having more energy to carry out good sanitary practices.

The most comprehensive SES data collection instrument, the Socioeconomic Status Questionnaire (Form 631; Fig. 13.1), was designed to inquire about a broad range of social and economic factors. Economic questions on this form inquire about agricultural topics, farming facilities, income and cash acquisition, household possessions and assets, housing materials, and paid labor. Social questions inquire about the "well-being" of the household, the household head's family leadership role, education, the use of postal, telephone, and bank services, participation in community meetings and local organizations, leadership role in the clan, compound improvements, and other issues.

Although Form 631 collected data on a wide range of social and economic phenomena, which allow for the discrimination of households of high vs. low SES, the data tell us little about how the Embu people view themselves in terms of their socioeconomic situation. Thus, the project developed the "Subchief Household Ranking Study" (no form was used). This emic (indigenous perspective) study first investigated the indigenous criteria used to rank households both socially and economically, and subsequently asked the community subchiefs to rank each study household according to these criteria.

The Household Economic Questionnaire (Form 662; Fig. 13.2) was developed late in the fieldwork to capture important economic information not obtained through the administration of Form 631. This questionnaire investigates in detail the topics of land availability, agricultural commodity production, household school expenses, and the financial contribution of children.

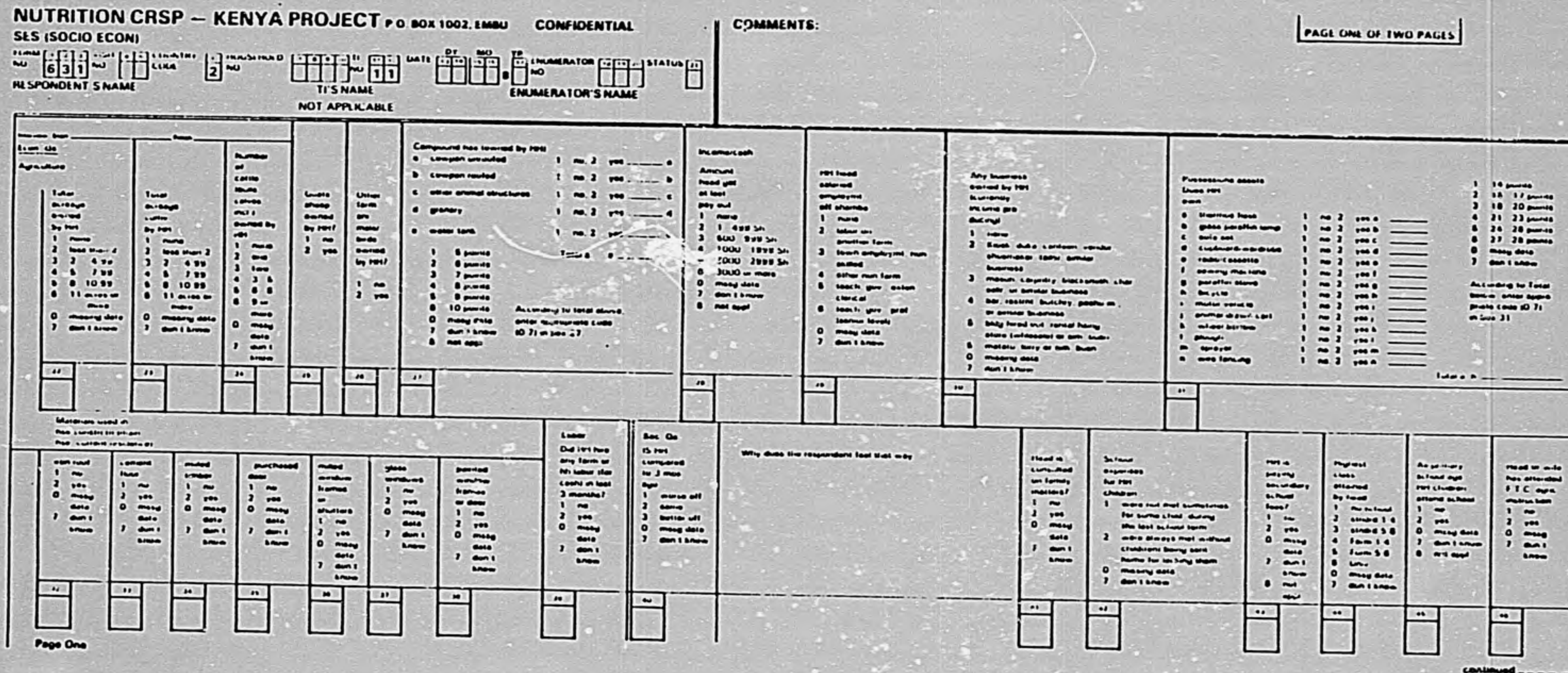


FIG. 13.1. Socio-economic status form 631, page one.

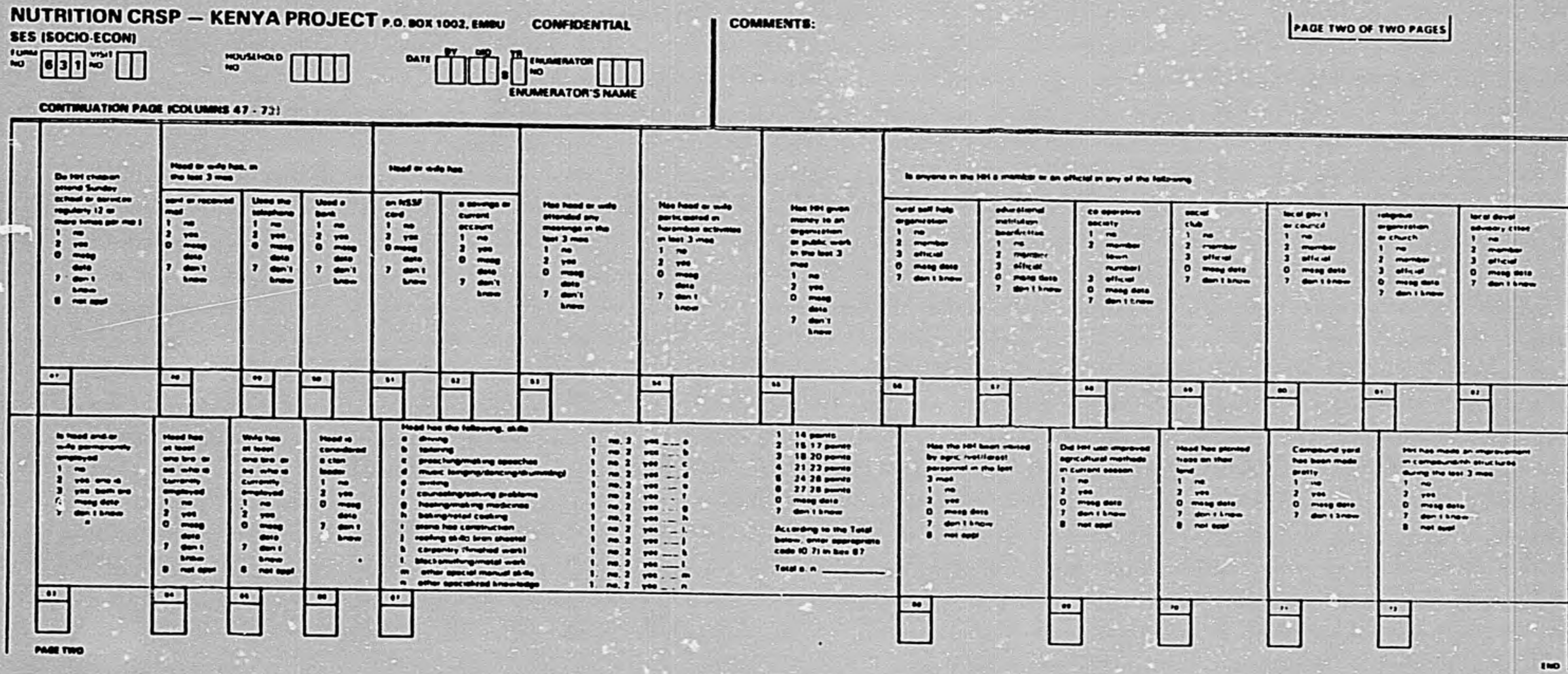


FIG. 13.1. (Continued) Socio-economic status form 631, page two.

The techniques used to collect socioeconomic data and the preliminary findings of the data are discussed below.

THE SAMPLE

The three data collection instruments were applied to slightly different sample populations. The Socioeconomic Status Questionnaire (Form 631) was administered on a quarterly basis to 247 households for at least one year each. Data were collected, therefore, a minimum of four times for each of these households, with few exceptions.

The subchiefs of the study area, who know the households under their political jurisdiction intimately, were asked to rank both the social position and economic well-being of project households. A total of 273 households (including the 247 households for which complete SES data for Form 631 are available) were ranked in late 1985.

The Household Economic Questionnaire (Form 662) was administered once to a sample of 169 households. Complete SES Form 631 data, as well as the subchiefs rankings, are available for these 169 households. These were also the households for which Time Allocation data, and the most extensive Food Intake, Morbidity, and Anthropometry data, are available.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The main socioeconomic status data collection instrument, Form 631, was developed in 1983 prior to commencement of the main study. The questionnaire was developed by Nutrition CRSP Kenya Project senior personnel, principally by the Field Anthropologist, and was based primarily upon preliminary investigations of various social and economic factors. The questions and observations selected for Form 631 were felt to be potentially good indicators of SES. The form was designed in such a manner that a score could be calculated by summing the values of all variables for each household visit.

Six fieldworkers (including one supervisor) were trained to administer the Socioeconomic Status Questionnaire. Staff training was conducted under the supervision of the Field Anthropologist. The questionnaire was translated into Kiembu by well qualified bilingual speakers, and extensively pre-tested in the pilot study area prior to the commencement of the main study. Few problems with the instrument or its administration were uncovered, and those which did arise were easily resolved. Staff training both prior to and throughout fieldwork emphasized standardization in the administration of the questionnaire's observations and queries, and consistency in the assignment of codes and scores. Methodological details for data collection were explained clearly in the SES Manual, which was utilized extensively by fieldworkers throughout the study.

Development of the household ranking study primarily involved learning the criteria that the Embu use to rank households socially and economically. This was accomplished through interviews with the subchiefs themselves. The project's Kenyan social scientist explained the goal of the study to the subchiefs, and over a period of two months met with them to discuss the behaviors and other characteristics that made some households esteemed, successful, and perceived as "doing the right things" (to develop economically), while other households were felt to be poor, deficient, and "going about things wrongly." These concepts of appropriate vs. inappropriate or successful vs. unsuccessful were discussed in Kiembu, and culturally relevant examples were employed. After numerous discussions, the subchiefs agreed upon a list of nine indicators each of household social status and economic status (Table 13.1). It was these criteria which the subchiefs were asked to consider when ranking households.

NUTRITION CRSP - KENYA PROJECT CONFIDENTIAL

..JUSEHOLD ECONOMIC QUESTIONNAIRE

FORM: 6/1 6/2 2/3 HH: __/4 __/5 __/6 __/7 TI: __/8 __/9 DATE: __/10 __/11 0/12 3/13 6/14 ENUM: 0/15 __/16 __/17

---

1. How much land, in acres was available for you to cultivate during 1984 and 1985? (This includes titled, rented, given etc.)

   1984 = __ (18) "Known" or "Estimated"? __ (19)

   1985 = __ (20) "Known" or "Estimated"? __ (21)

   0 = None
   1 = Less than 2
   2 = 2-4.99
   3 = 5-7.99
   4 = 8-10.99
   5 = 11 or more
   6 = Don't know

   1 = "Known"
   2 = "Estimated"
   3 = NA

2. Do you cultivate coffee? (1=Yes; 2=No) __ (22)

3. How many stems of producing coffee do you have in your shamba? __/23 __/24 __/25 __/26

4. How many stems of recently-planted coffee do you have in your shamba? __/27 __/28 __/29 __/30

5. If you cultivate coffee, during the past two seasons (April 1984-March 1985, April 1985-March 1986) how many shillings did you earn from the sale of coffee to the New Kyeni Cooperative Farmer's Society? (-99999 and 9 = NA)

   1984-1985 = __/31 __/32 __/33 __/34 __/35 __/36 Receipt or Recall? __ (37)

   1985-1986 = __/38 __/39 __/40 __/41 __/42 __/43 Receipt or Recall? __ (44)

   (1=Receipt; 2=Recall; 3=Both)

6. Do you sell coffee to individuals outside the Cooperative Society? (1=Yes; 2=No; 9=NA) __ (45)

7. If yes to question #6, what type of coffee did you sell? (1=Yes; 2=No; 9=NA)

   __ (46) Green Beans __ (47) Dried Coffee

   __ (48) Other (describe: ________________)

FIG. 13.2. Household economic questionnaire form 662.

8. Do you cultivate tobacco? (1=Yes; 2=No)

49

9. If yes to question #8, how many shillings did you earn from the BAT during the 1983-1984 and 1084-1985 seasons? (-9999 and 9 = NA)

1983-1984 = ___ ___ ___ ___ ___ (50 51 52 53 54) Receipt or Recall? ___ (55)

1984-1985 = ___ ___ ___ ___ ___ (56 57 58 59 60) Receipt or Recall? ___ (61)

(1=Receipt; 2=Recall; 3=Both)

10. Do you cultivate cotton? (1=Yes; 2=No)

62

11. If yes to question #10, how many shillings did you earn during the 1984 and 1985 growing seasons? (-9999 and 9 = NA)

1984 = ___ ___ ___ ___ ___ (63 64 65 66 67) Receipt or Recall? ___ (68)

1985 = ___ ___ ___ ___ ___ (69 70 71 72 73) Receipt or Recall? ___ (74)

(1=Receipt; 2=Recall; 3=Both)

12. Did you sell cotton to anyone besides representatives of the Cotton and Lint Marketing Board? (1=Yes; 2=No; 9=NA)

75

13. Did you cultivate any other cash crop (non-food) during the 1984 and 1985 growing seasons? (1=Yes; 2=No)

76

14. If yes to question #13, which crops? (1=Yes; 2=No; 9=NA)

___ (77) Sunflowers ___ (78) Castor beans ___ (79) Local Tobacco ___ (80) Other

15. How many shillings did you realize from the combined sale of these crops?

1984 = ___ ___ ___ ___ ___ (81 82 83 84 85) 1985 = ___ ___ ___ ___ ___ (86 87 88 89 90)

16. During the 1984 and 1985 school terms, how much did you pay in "school fees?" (i.e., building fund, tuition, activity fees, supplies, etc.)

1984 = ___ ___ ___ ___ ___ (91 92 93 94 95) 1985 = ___ ___ ___ ___ ___ (96 97 98 99 100)

17. Do any of your children who are employed contribute money to the household on a regular (monthly) basis? (1=Yes; 2=No; 9=NA)

101

FIG. 13.2. (Continued) Household economic questionnaire form 662, page two.

In working with the subchiefs to perfect the ranking scale, fictitious households which fulfilled different criteria were developed, and the subchiefs practiced ranking these. One outcome of these practices sessions was that the final ranking scale was designed to consist of a five point scale ranging from low (1) to high (5). Households who fulfilled many or all of the criteria were to be ranked high, those who fulfilled some were to be ranked medium, and those who fulfilled few or none were to be ranked low.

TABLE 13.1
The emic criteria used to rank the social and economic status of Embu households.

	Social Criteria		Economic Criteria
1.	Riches or wealth	1.	Motor Vehicles
2.	Leadership qualities	2.	Business
3.	Peacefulness	3	Stone house
4.	Self respect (good behavior)	4.	Land size (owned)
5.	Generosity (willingness to help)	5.	Cattle (number/type)
6.	Dispute solving qualities	6.	Money
7.	Dare	7	Amount of coffee
8.	Level of education	8.	Household possessions
9.	Occupation	9.	Occupation/profession

The Household Economic Questionnaire (Form 662) was developed by project's Anthropologist and Field Director in early 1986. This questionnaire originated out of a felt need for more quantitative data on land availability, agricultural commodities (coffee, tobacco, and cotton), school expenditures and the financial contribution of the household's employed older children. Although Form 631 addressed issues of land, cash crops, school fees, and employment of young adults, the level of response was felt to be inadequate for detailed agro-economic analyses, and possibly misleading on the question of land availability. Because of staff limitations, the questionnaire was not designed and implemented until 1986. The fieldworkers who participated in conducting SES interviews throughout the main study contributed significantly to the development of this new, complementary questionnaire. Piloting and revision of the final form was conducted in the first week of March, and the survey was completed by the end of March.

The Household Economic Questionnaire was administered by three male enumerators who had experience with administering Form 631, and who also knew the 169 households to which this new form was to be administered. These enumerators learned the questionnaire in detail and, under supervision by senior staff, determined their interview assignments and conducted the interviews accordingly.

TECHNIQUES OF DATA COLLECTION

The primary SES questionnaire (Form 631) was administered quarterly during the months of March, June, September, and December (1984 and 1985) to all enrolled households. After locating either the lead female or male of a scheduled household and receiving permission to conduct an interview, a fieldworker administered the questions and made the necessary observations.

The first questions dealt with the total acreage owned, the total acreage cultivated, the number of cattle owned, and the number of other farm animals (exluding dogs and cats) and fowl owned by the household. The number and type of structures on the compound in usable condition were then counted. Proceeding to income and cash acquisition, the amount of money received by the household from the last coffee and cotton payout was recorded, as was any type of employment and/or business engaged in by the household head. Possessions owned by the household, such as bicycles, furniture, and paraffin stoves, were recorded, and the fieldworker continued on to describe materials used in the construction of the household's residence (e.g., presence of iron roof, cement floor, glass windows, etc.). The respondent was then questioned as to whether the household had hired any farm or other labor in the last three months, and whether the household was better off, worse off, or the same as three months before, and why. Respondents almost unanimously interpreted this latter question in economic terms, and provided a qualitative response that was recorded in the space provided. The respondent was then asked whether the household male head was consulted on important family matters, and then a series of questions was asked on the ability of the household to pay for school expenses and whether school age children were attending school.

Moving on to the more "social" questions, the highest class completed by the male head was recorded, and the respondent was asked whether either adult head had attended any agricultural training courses. The respondent was then asked whether household children regularly attended Sunday School or church services. The use of national facilities such as sending or receiving mail, using a telephone, or using a bank in the past three months by lead adults was recorded, as was possession of a Social Security card (NSSF) and possession of a bank account. Several questions were asked regarding participation in community activities in the past three months such as attendance at any community meetings, participation in community self-help activities, and contribution to public works. Membership in self-help groups, educational boards, social clubs, and other organizations and committees was recorded. The respondent was also asked whether the household head and/or his wife was permanently employed, and whether at least one brother or sister of either was currently employed. Clan leadership status was determined by asking whether the head was considered a clan leader by others. After documenting specific skills that the household head had (e.g., driving, tailoring), the respondent was asked whether the household had been visited by agricultural/veterinary/ forestry extension workers in the past three months; whether the household had used improved agricultural methods (e.g., hybrid seeds, terracing, etc.) in the current season; and whether the lead male had planted trees of any type. Finally, the fieldworker noted any compound yard beautification efforts (e.g., planted flowers), and determined whether the household had made any compound/structural improvements or repairs during the past three months.

Household revisits were made when the initial visit was not successfully completed. In these instances, fieldworkers made every attempt possible to schedule revisits when the lead female would be present. If the originally scheduled visit and two subsequent revisits failed, an attempt was made to arrange an interview with the lead male since a partially successful visit was considered better than none at all. If a household was missed completely, a copy of the questionnaire was completed with "missing data" for that visit.

The ranking of households by the subchiefs was coordinated by the Kenyan Social Scientist who met with each subchief and discussed the study households within his administrative jurisdiction. Again, it was explained to each subchief that each household should be evaluated based on the presence or absence of the social and economic indicators. The subchiefs successfully completed this task, and the data were computer-entered.

The Household Economic Questionnaire (Form 662) was administered to 169 households by three fieldworkers in March 1986. The objective of this survey was to obtain important information not obtained through the administration of the primary SES tool, Form 631.

The first question on Form 662 asked for the amount of land available to a household, which often differs from the amount of land owned as asked by Form 631. The questionnaire then sought information on the amount and types of household commodity production; respondents were asked whether the household cultivated coffee, tobacco, or any other non-food cash crops, and if so, the amounts produced, who they were sold to, and the amount of cash generated. Respondents were then asked how much they were required to pay in "school fees" (e.g., building fund, tuition, activity fees, supplies, etc.) for 1984 and 1985 school terms. Finally, they were asked whether any household children were employed and contributed money to the household on a monthly basis.

QUALITY CONTROL MEASURES

The quality control measures undertaken for the administration of SES Form 631 included preliminary and ongoing staff training, standardization of the administration of questions and of the assignment of codes to responses and observations, household revisits, and close supervision of fieldworkers by senior staff and the SES supervisor. The duties of the SES supervisor were to 1) schedule household visits, 2) monitor fieldworkers' attendance, 3) maintain records, 4) check forms, and 5) conduct independent interviews.

To ensure that field enumerators interpreted and applied the SES questionnaire (Form 631) consistently, the Field Anthropologist and Social Scientist held review meetings with enumerators and supervisors at the beginning of each quarterly data collection cycle. All data collection and recording procedures were discussed to guarantee conformity with established protocols.

Systematic re-interviews of respondents were undertaken by supervisors under the close supervision of senior staff. The goal of these revisits was to determine the reliability of data collection. A household sample size of at least 3% was randomly selected during each round of data collection for this purpose. Revisits followed within one week of the regularly scheduled visits. A preliminary analysis comparing the "revisit" data with the data obtained during the scheduled visits indicates 84% of the values correspond exactly. Additional work is required for a more precise understanding of the relationship between the two data sets.

Quality control is also provided by the Subchief Household Ranking Study and the Household Economic Questionnaire. The former was conducted by the project's Social Scientist in close collaboration with the Anthropologist and Field Director. The field staff who administered the Household Economic Questionnaire were highly competent. They had worked for CRSP for over two years and were extremely dedicated in all their work. All three had previously been promoted to the highest level of field supervisor, and all required minimal training. They also knew and maintained excellent rapport with all 159 households.

Finally, detailed measurements of land owned and land cultivated by a sample of households were conducted (see Chapter 16).

PREPARATION OF DATA FOR ANALYSIS

Due to time and financial limitations, only the primary SES data set (i.e , the data collected by Form 631) has been anaylyzed to date. This section describes the procedures used to generate a "total score" for each SES household visit.

Because it is not possible to calculate "realistic" total scores simply by summing all values for every variable on Form 631, due to inadequate "weighting" of values for certain variables and other reasons, it has been necessary to develop a system of transformation rules. Thus, some variables, such as those which do not apply to all households, have been deleted from analyses; the indicators of one variable ("Number of Possessions," Variable 20) have been disaggregated to generate yet another ("Value of Possessions," Variable 62), and additional "weight" has been given to certain other variables. The final result of these developments is the compilation of a system of SES indicators that generates a scale of scores capable, we believe, of realistically discriminating actual SES levels. Table 13.2 describes the current disposition of each variable on Form 631 in the calculation of SES scores.

The "Value of Possessions" variable (Variable 62) which has been derived from the "Number of Possessions" variable (Variable 20) requires further explanation. Although Variable 20 is still used in the calculation of total scores, since it discriminates between households that own many purchased items and those that own few, the values assigned to this variable stop short of taking full advantage of the important raw data made available through the administration of the question. Specifically, the values potentially assignable to this variable reflect on the number of items possessed, and

TABLE 13.2
Disposition of values on socioeconomic status Form #631 in the compilation of household visit scores (see Fig. 13.1 for variable names).

Variable	Column	Disposition of Values*	Other Comments
11	22	Let: 1 = 1 2 = 2 3 = 4 4 = 6 5 = 8 6 = 9	
12	23	Same as for Variable 11	
13	24	Same as for Variable 11	
14	25	Used as is	
15	26	Used as is	
16	27	Used as is	
17	28	Used as is	
18	29	Used as is	
19	30	Used as is	
20	31	Same as for Variable 11	Indicators a-n have been disaggregated and assigned values to create new Variable 62
21	32	Let: 1 = 1 2 = 4	
22	33	Same as for Variable 21	
23	34	Used as is	
24	35	Let: 1 = 1	2 = 3
25	36	Same as for Variable 24	
26	37	Same as for Variable 24	
27	38	Used as is	
28	39	Used as is	
29	40	Not used	
30	41	Used as is	
31	42	Used as is	
32	43	Not used	
33	44	Same as for Variable 11	
34	45	Used as is	
35	46	Used as is	
36	47	Not used	
37	48	Used as is	
38	49	Used as is	
39	50	Used as is	
40	51	Used as is	
41	52	Used as is	
42	53	Used as is	
43	54	Used as is	
44	55	Used as is	
45	56	Used as is	
46	57	Used as is	
47	58	Used as is	

TABLE 13.2 continued

Variable	Column	Disposition of Values*	Other Comments
48	59	Used as is	
49	60	Used as is	
50	61	Used as is	
51	62	Used as is	
52	63	Used as is	
53	64	Not used	
54	65	Not used	
55	66	Used as is	
56	67	Used as is	
57	68	Used as is	
58	69	Used as is	
59	70	Used as is	
60	71	Used as is	
61	72	Used as is	
62	73,74	Let shilling value of: 0 Ksh = 00 pts 1-999 = 01 1000-1999 = 02 2000-2999 = 03 3000-3999 = 04 4000-4999 = 05 5000-5999 = 06 6000-6999 = 07 7000-7999 = 08 8000-8999 = 09 9000-9999 = 10 10000-10999 = 11 11000-11999 = 12 12000-12999 = 13 13000-13999 = 14 14000-14999 = 15 15000-15999 = 16 16000-16999 = 17 17000-17999 = 18 18000-18999 = 19 19000-19999 = 20 20000 + = 21	New Variable ("Value of Possessions"), based upon disaggregation of items in Variable 20; see Footnote 2 for value assigned each item.

* In the few instances in which "0" (Missing data), "7" (Don't know), or "8" (Not applicable) was assigned as the value for any variable, such values are now = 1.

not their value. Since several items listed in Variable 20 are extremely costly and therefore indicative of wealth, it was deemed necessary to give credit for the possessions of such items based on their actual value. Another way of stating the problem with Variable 20 is that all possessions are treated as if they are of the same value. Thus, for example, the household with a "thermos flask" and "paraffin stove" receives the same score (2 points) as the household possessing a "bicycle" and an "animal drawn cart," while in actuality the value of items owned by the first household is considerably less than that of the second. The new variable (Variable 62), which reflects the total shilling value of possessed items, is believed to remedy and strengthen the shortcomings of Variable 20.

By adding the values of all variables as described above, a total SES score has been calculated for every household visit. Although these total scores are felt to reflect the actual socio-economic status of households in a highly meaningful way, data from the Subchief Household Ranking Study and the Household Economic Questionnaire would no doubt contribute further to the compilation of total scores that realistically reflect household social status and economic well-being. The Subchief Household Ranking data will be incorporated into the current scores for the 247 households at a later date. Similarly, for analyses limited to the 169 household sample, data from the Household Economic Questionnaire will be factored into the revised scores.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

A total SES score has been calculated for every SES household visit following the procedures outlined above, and it is these total scores which are used for analyses in this report.

One finding is that there is a wide range of socioeconomic status among the study households. The distribution of household SES mean scores (all visits for each household have been averaged to yield a household mean for each) is presented in Table 13.3 and Fig. 13.3. The distribution is not entirely "normal" on the scale being used; there is a tendency for more households to be relatively low in SES.

It is perhaps useful, at this point, to indicate what households of different SES might "look like." Actually, while it is difficult to generalize about specific socioeconomic features for households of "mid-SES", the features of households of low and high SES can be generalized with confidence. Thus, because the lowest score possible on the scale described above is 46 points, those households with the lowest scores (say, less than 70) are without doubt relatively deprived economically and of low social status. More specifically, these households have very little if any land, livestock, regular income, or major assets, and probably do not own a business. Their houses are likely constructed entirely of locally available materials, and likely in need of repair. The adults probably attended school for only a few years, if at all. And the household probably does not use postal, telephone, or bank facilities, nor participate in community meetings or local organizations.

In contrast, households of the highest scores (say 120 points or more; the highest possible score is 182) are, in most ways measured, economically well off and socially influential. More specifically, these households most likely own and cultivate at least several acres of land, own a dozen or more farm animals, own a business or benefit from non-farm employment, and have several purchased assets (possibly including a vehicle). The houses are most likely in good condition, and are constructed with an iron roof, windows, and possibly a cement floor. These households are likely to employ others for farm or house/compound labor. And finally, the adults probably use banking and facilities regularly, and participate heavily in community activities. It is perhaps noteworthy that households with the highest scores (130-139 points, and, to some extent, 120-129 points) include at least one schoolteacher.

The distribution of SES scores by month (Table 13.4) indicates no discernible seasonal variation in socioeconomic status. It is noteworthy that, at least from this preliminary analysis, SES appears not to have been significantly affected by the drought (although the highest score was prior to the drought). A plausible explanation for this observation is that the SES total scores are not sensitive enough, due to their highly comprehensive nature, to reflect significant changes for those limited variables that would be most prone to the onset of a drought (e.g., number of farm animals). Considerable work on this topic must be conducted before any final conclusions can be drawn.

Related to the above findings is the observation that the variance of "within household" scores over time is small (mean score = 87.1; SD = 4.2; CV = 4.82%), and considerably less than the "between household" scores (SD = 16.6; CV = 19.06%).

TABLE 13.3
The distribution of household socioeconomic status mean scores.

Score	Frequency	Percent
130-139	3	1.2
120-129	7	2.8
110-119	14	5.6
100-109	28	11.4
90-99	45	18.2
80-89	54	21.8
70-79	60	24.3
60-69	30	12.2
50-59	6	2.4
total	247	99.9

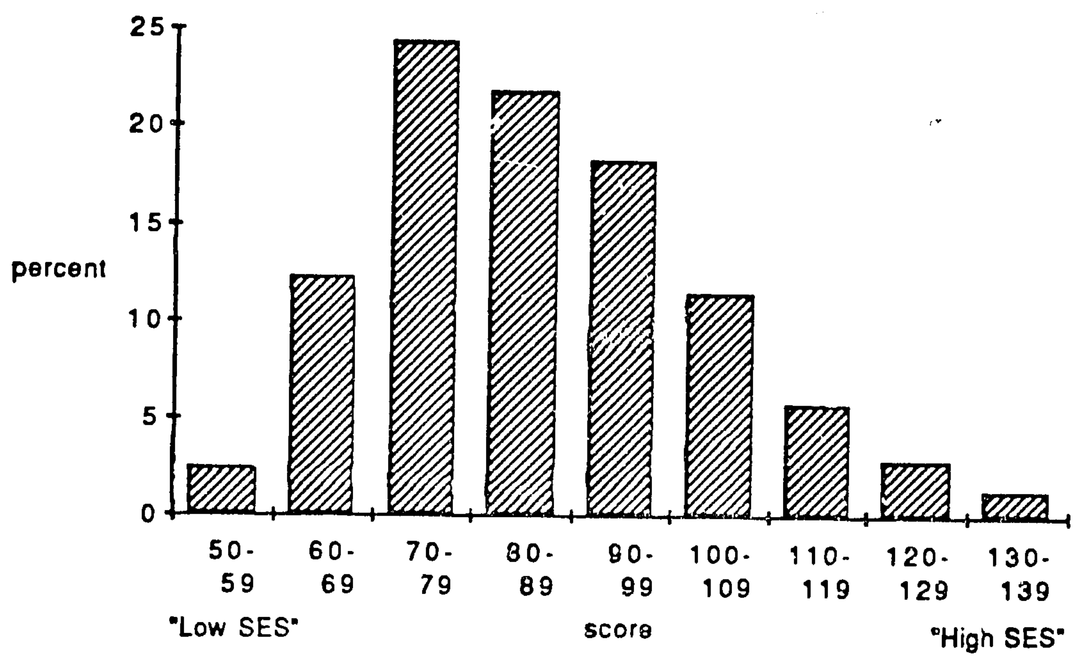


FIG. 13.3. The distribution of household socioeconomic status mean scores.

Limitations of staff and time have not allowed other analyses to be conducted. In particular, work has not progressed to the stage that correlations with other variables have been systematically performed. It is noteworthy, however, that a correlation between SES and Sanitation and Hygiene has been conducted for households with pregnant and lactating lead females (see following chapter), and that the two are highly correlated ($n = 118$, $r = .46$, $p < .0005$). There is every reason to believe that this correlation will remain high among "non-pregnant/non-lactating" households. Based on the strong correlation between SES and SAHY, it is assumed that SES also correlates positively with food intake, anthropometry, and the ability of the lead male to both read and write, and negatively with morbidity. These assumptions remain to be tested, however.

Finally, it is important to note that there is a strong correlation between the SES total mean scores and the Subchiefs' rankings of households ($N = 247$, $r = .48$, $p < .001$). This finding, like numerous other topics related to the data on socioeconomic status, requires additional work for a thorough understanding of the complex relationships between SES and other variables.

TABLE 13.4
Mean socioeconomic status scores (all households combined), by month.

1984	N	Mean Score	1985	N	Mean Score
March	247	84.8	March	166	86.3
June	242	87.4	June	96	84.9
September	241	86.3	September	43	83.3
December	226	86.7	December	12	75.4

Chapter 14

SANITATION AND HYGIENE

The Nutrition CRSP Kenya Project conducted a sanitation and hygiene study to determine the extent to which household sanitary practices and conditions are associated with health, nutrition, socioeconomic status, and other factors. The Sanitation and Hygiene (SAHY) study collected both interview and observational data on personal hygiene, house and compound maintenance, excreta disposal, handling of food and utensils, animal management, and water sources. These data were collected from 247 households on a quarterly basis for a minimum of one year each. Preliminary analyses of households with pregnant lead females indicate that household sanitation and hygiene levels correlate positively with household socioeconomic status and lead male literacy, and negatively with low grade and significant illness of the lead female.

Although numerous studies have been conducted on the sanitary conditions and practices of rural populations in less technically developed countries, most of this research has been quite specialized (such as focussing on the relationship between water use and diarrhea) and cross-sectional. Few studies have conducted comprehensive investigations for a year or more of sanitation practices and how they relate to health, nutrition, and child care over time (1-3); the Nutrition CRSP Kenya Project attempted to contribute to the current state of knowledge about the above topics and their interrelationships by collecting data on them over a period of two years.

RESEARCH OBJECTIVES

The major objective of the sanitation and hygiene study was to conduct a comprehensive investigation of the study households' sanitary conditions and practices in order to rank households according to the quality of these characteristics. It was expected that this information would be useful for explaining the health status of household members, as well as their nutritional well-being, socioeconomic status and other topics. Components of the survey are described in detail below.

THE SAMPLE

The Sanitation and Hygiene Questionnaire was administered to 247 households for one to two years each. The questionnaire was administered on a quarterly basis during the months of January, April, July, and October. Special effort was made to conduct interviews with lead females; interviews were conducted with lead males in only a few instances (after having failed to locate the lead females on three consecutive days).

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Household sanitary conditions and practices were assessed primarily through the administration of the Sanitation and Hygiene Questionnaire (Form 621; see Fig. 14.1). This questionnaire was developed by Nutrition CRSP Kenya Project senior personnel, and principally by the Field Anthropologist, and was based primarily upon preliminary observations of households' sanitary practices and conditions. The data collection instrument consisted of questions and observations on the personal hygiene practices of lead females, infants, toddlers, and schoolers; the sanitary practices related to care of clothing, food preparation, and living quarters; the hygienic condition of the compound; the impact of animals; the disposal of domestic wastes; and the source and quality of drinking water.

Six fieldworkers (including one supervisor) were trained to administer the Sanitation and Hygiene Questionnaire. Staff training was conducted under the supervision of the Field Anthropologist. The questionnaire was translated into Kiembu by well qualified bilingual speakers, and extensively pre-tested in the pilot study area prior to the commencement of the main study. Few problems with the instrument or its administration were uncovered, and those which did arise were easily resolved. Staff training both prior to and throughout fieldwork emphasized standardization in the administration of the questionnaire's questions and observations, and consistency in the assignment of codes and scores. Methodological details for data collection were explained clearly in the Sanitation and Hygiene Manual, which was utilized extensively by fieldworkers throughout the study.

The sanitation and hygiene data collected by Form 621 are complemented by actual observations that were conducted of several specific sanitary practices primarily for purposes of quality control. The practices that were observed included the number of times that TI's were bathed, the number of times that dishes were washed, etc. (Form 622; Fig. 14.2). See "Quality Control," below, for more details on these observations.

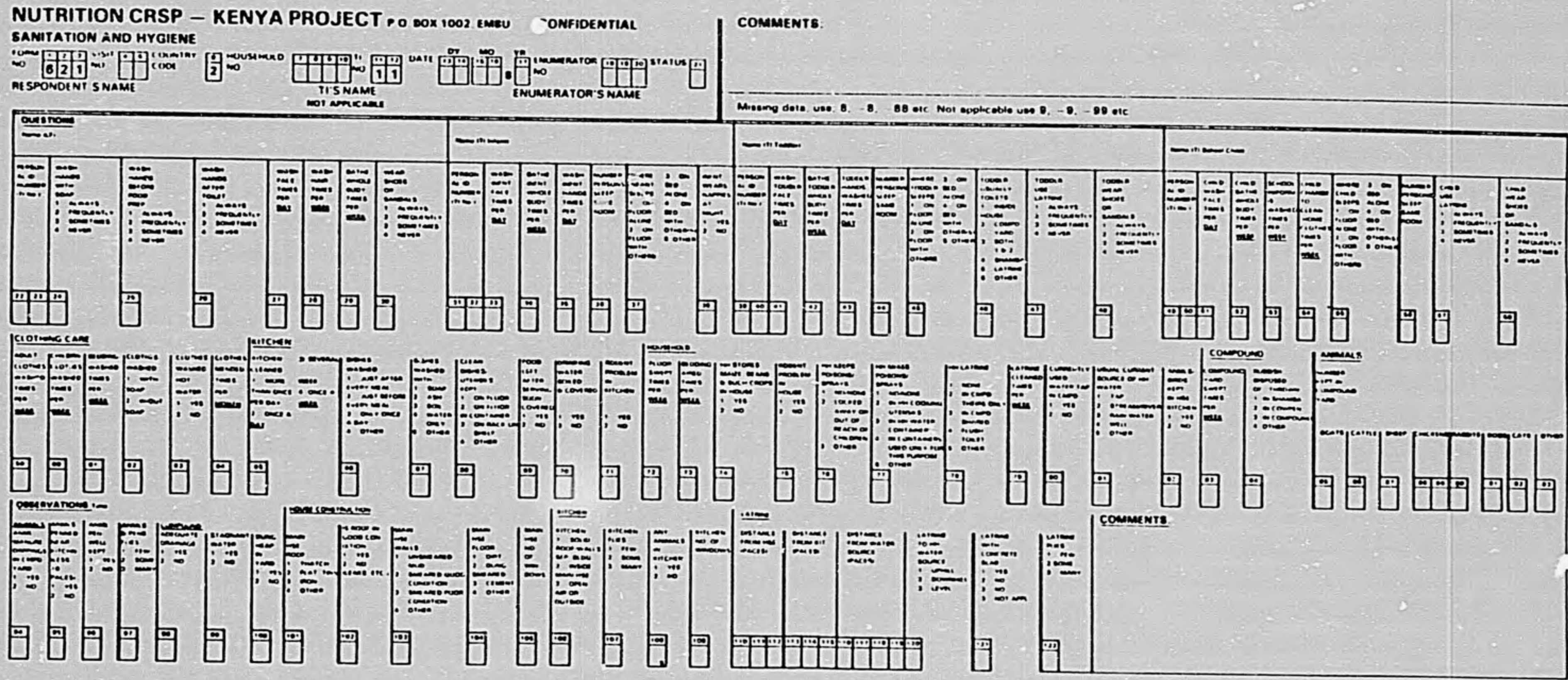
Finally, it is important to note that household water samples were collected twice and tested for bacterial contamination. Water samples were collected from the most common water source for most households, examined in the project's laboratory for E. coli growth with use of a dip-stick method (URISTIX), and recorded on Form 342.

TECHNIQUES OF DATA COLLECTION

After locating the lead female and receiving permission to administer the questionnaire, a fieldworker proceeded to administer the questions (each fieldworker carried a list of questions that corresponded with the abbreviated notations on the questionnaire form).

The first questions dealt with the hygienic practices of the lead female, followed by questions on the hygienic practices concerning the target infant, toddler, and/or schooler. The second part of the questionnaire included sections of questions regarding clothing care, kitchen, household, compound, and animal maintenance. The third section of the form required the fieldworker to make specific observations concerning the household animals, compound, house construction, kitchen and latrine. Regarding the latrine, the fieldworker was required to pace the distance to both the kitchen and the most common water source. Also noted was the extent of latrine use by toddlers and schoolers, as well as the defecation sites of the toddlers (e.g., whether they used sites in the compound other than the latrine). Finally, beginning in 1985, a strip of flypaper was hung in both the latrine and kitchen for 15 minutes during SAHY visits, and the number of flies attached to each was counted and recorded.

Household revisits were made when the initial visit was not successfully completed. In these instances fieldworkers made every attempt possible to schedule revisits when the lead female would be present. If the originally scheduled visit and two attempted revisits failed, an attempt was made to arrange to interview the lead male since a partially successful visit was considered better than not obtaining any information at all. If a household was missed completely, a copy of the questionnaire was completed with "missing data" for that visit.


NUTRITION CRSP – KENYA PROJECT P.O. BOX 1002 EMBU CONFIDENTIAL

SANITATION AND HYGIENE

FORM NO 621 VISIT NO COUNTRY CODE 2 HOUSEHOLD NO TI NO 11 DATE DY MO YR 8 ENUMERATOR NO STATUS

RESPONDENT'S NAME TI'S NAME NOT APPLICABLE ENUMERATOR'S NAME

COMMENTS

Missing data, use 8, -8, -88 etc. Not applicable use 9, -9, -99 etc.

QUESTIONS

CLOTHING CARE

KITCHEN

HOUSEHOLD

COMPOUND

ANIMALS

GOATS CATTLE SHEEP

OBSERVATIONS

HOUSE CONSTRUCTION

KITCHEN

LATRINE

COMMENTS

FIG. 14.1. Sanitation and hygiene form 621.

NUTRITION CRSP - KENYA PROJECT P. O. BOX 1002, EMBU
SANITATION AND HYGIENE OBSERVATIONS

CONFIDENTIAL

Form NO.: 6 2 2 (1 2 3) Visit No.: __ __ (4 5) Country Code: 2 (6) HH No.: __ __ __ __ (7 8 9 10) TI No.: 1 1 (11 12)

Date: __ __ __ __ __ (13 14 15 16 17) Enum. No.: __ __ __ (18 19 20) Status: __ (21) Arrival Time: __ __ __ __ (22 23 24 25) Departure Time: __ __ __ __ (26 27 28 29)

---

1 THE NUMBER OF TIMES THE LEAD FEMALE IS OBSERVED TO WASH OR NOT WASH HER HANDS JUST PRIOR (10 MINUTES) TO FOOD PREPARATION OR HANDLING

WASHED WITH SOAP	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (30 31)
WASHED WITHOUT SOAP	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (32 33)
NOT WASHED	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (34 35)

---

2. THE NUMBER OF TIMES THE TARGET INFANT IS OBSERVED TO BE WASHED (HANDS, FACE, LEGS, OR ENTIRE BODY)

H = HANDS F = FACE L = LEGS B = BODY	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (36 37)

---

3. THE NUMBER OF TIMES THE TARGET TODDLER IS OBSERVED TO BE WASHED (HANDS, FACE, LEGS, OR ENTIRE BODY)

H = HANDS F = FACE L = LEGS B = ENTIRE BODY	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (38 39)

---

4 THE NUMBER OF TIMES THE TARGET SCHOOLER IS OBSERVED TO WASH HANDS JUST PRIOR TO EATING, OR FEEDING OTHERS

# TIMES SCHOOLER EATS	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (40 41)
# TIMES SCHOOLER WASHES BEFORE EATING	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (42 43)
# TIMES SCHOOLER FEEDS OTHERS	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (44 45)
# TIMES SCHOOLER WASHES BEFORE FEEDING	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (46 47)

---

5 THE NUMBER OF CLOTH ITEMS (SUCH AS CLOTHING, BEDDING, OR OTHER) OBSERVED TO BE WASHED. (DESCRIBE ITEM(S) IN 'COMMENTS')

☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (48 49)

---

6 THE NUMBER OF TIMES THAT DISHES ARE WASHED WITHIN 30 MINUTES PRIOR TO SERVING FOOD

# TIMES FOOD SERVED ON DISHES	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (50 51)
# TIMES DISHES WASHED WITH SOAP	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (52 53)
# TIMES DISHES WASHED WITHOUT SOAP	☐☐☐☐☐☐☐☐☐☐	TOTAL ☐☐ (54 55)

COMMENTS

FIG. 14.2. Sanitation and hygiene observations form 622.

QUALITY CONTROL MEASURES

The quality control measures undertaken by the Sanitation and Hygiene Study included preliminary and ongoing staff training, standardization of the administration of questions, standardization of the assignment of codes to responses, consistency in the measurement of distances, and close supervision of fieldworkers.

The duties of the Sanitation and Hygiene supervisor were to: 1) schedule household visits, 2) monitor fieldworkers' attendance, 3) maintain records, 4) check forms, and 5) conduct independent interviews. Independent interviews were conducted on the same or next day on a 5% subsample of the regularly scheduled visits; the revisited households were selected by senior staff and were not known to the fieldworkers until after the scheduled visits had been completed. A preliminary analysis comparing the regularly scheduled data with the "revisits" data indicate that 80% of the values (for the variables currently being used to generate household scores) are identical for the two data sets. Additional work is required to generate a more precise understanding of the exact reliability of specific variables.

In addition to the quarterly administration of SAHY Form 621, a more detailed set of observations (Form 622) were carried out beginning in March 1985 by the food intake fieldworkers who, because of the food intake protocol, were in each household's house during daylight houses for two days each month. Because these fieldworkers had their food intake responsibilities well in control, they were capable of observing and recording with little difficulty the sanitation and hygiene practices listed on Fig. 14.2. The sanitation and hygiene observations were made in the same months that Form 621 was administered (and to the same households). It is expected that the values recorded from these observations will serve as a check on the validity of responses for questions inquiring about the same topics e.g., whether dishes are washed with soap or by some other means.

PREPARATION OF DATA FOR ANALYSIS

Data reduction of the information on Form 621 has been directed at generating a single score for every household visit. The development of these scores has been guided by the objective that they reflect realistic levels of household sanitation and hygiene and allow for the discrimination of, for example, households of high SAHY versus those of low SAHY, or changes in SAHY within households over time.

Due to the design of SAHY Form 621 it is not feasible to simply add, "as is," all values for all variables to generate a score. Rather, in light of field experience, it was necessary to ignore some variables, place ceilings on the values of some, and give additional "weight" to others. The transformation of variables on Form 621 is provided in Table 14.1. The result of these transformations is the compilation of a set of SAHY indicators that generates scores capable of realistically discriminating actual sanitation and hygiene levels.

In compiling the household visit scores, the values recorded for most variables have either been used "as is" (these are designated as "positive" in Table 14.1) or have been added as "negative" values. The reason for negating the values of certain variables is that the value of these variables increases while the quality of the sanitation/hygiene practice actually decreases. For example, because Variable 55 asks whether drinking water is boiled and covered and a response of "no" is coded as a "2" ("yes" = "1"), "2's" and "1's" for this variable have been tranformed to "-2's" and "-1's", respectively. In contrast, whereas Variable 56 asks whether there is a rodent problem in the kitchen and the possible response of "no" and "yes" have the same codes of "2" and "1", respectively, a "no" in this instance is a better indication of good sanitation; this latter variable is thus used "as is."

Finally, a few variables are characterized by scales in which alternative practices do not correspond either positively or negatively with their assigned values. Thus, for example, while some variables are characterized by five possible responses, which have been assigned values "1" to "5", it may actually be value "3" which is indicative of better hygiene (see, for example, Variable 52). The values of these variables have been recoded and are described in Table 14.1. A recommendation in the use of such a survey form in the future is to incorporate the above modifications from the start.

TABLE 14.1.
Disposition of values on sanitation and hygiene Form #621 in the compilation of household visit scores (see Fig. 14.1 for variable names).

Variable	Column	Disposition of Values	Other Comments
12	24	Negative*	
13	25	Negative	
14	26	Negative	
15	27	Positive†	
16	28	Positive	Anything > 3 =3
17	29	Positive	Anything > 4 =4
18	30	Negative	
19-43	31-58	Currently not used	
44	59	Positive	Anything > 4 =4
45	60	Positive	Anything > 4 =4
46	61	Positive	Anything > 3 =3
47	62	Negative	
48	63	Negative	
49	64	Positive	Anything > 4 =4
50	65	Negative	
51	66	Let 1 = 2 2 = 3 3 = 1 4 = 0	
52	67	Let 1 = 4 3 = 1 4 = 0	
53	68	Positive, but let 4 = 0	
54	69	Negative	
55	70	Negative	
56	71	Positive, but let 2 = 4	
57	72	Positive	Anything > 4 =4
58	73	Positive	Anything > 3 =3
59	74	Positive	
60	75	Positive	
61-62	76-77	Currently not used	
63	78	Let 2 = 3 3 = 2 5 = 0	
64	79	Positive	
65	80	Negative	
66	81	Let 1 = 4 4 = 1 5 = 0	
67	82	Positive	
68	83	Positive	Anything 4 =4
69	84	Negative, but let 4 = 0	
70,71,72	85,86,87	Let 0 = 0 Anything else = -1	
73	88-89	Let 00 = 00 Anything else = -01	

TABLE 14.1 continued.

Variable	Column	Disposition of Values	Other Comments
74,75	90,91	Let 0 = 0 Anything else = -1	
76	92	Let 0 = 0 Anything else = 1	
77	93	Currently not used	
78	94	Positive	
79	95	Positive, but let 9 = 2	
80	96	Negative, but let 9 = -1	
81	97	Negative, but let 9 = -1	
82	98	Negative	
83	99	Positive	
84	100	Positive	
85	101	Positive, but let 4 = 0	
86	102	Negative	
87	103	Let 1 = 2 2 = 3 3 = 1 4 = 0	
88	104	Positive, but let 4 = 0	
89	105	Positive	
90	106	Negative	
91	107	Negative	
92	108	Positive	
93	109	Positive	
94,95	110-112 113-115	Let 00-09 = 0 10-19 = 1 20-29 = 2 30-39 = 3 40-49 = 4 50+ = 5	
96	116-119	Let 000-199 = 0 200-399 = 1 400-599 = 2 600-799 = 3 800-999 = 4 1000+ = 5	If Column 80 = 3, then let columns 116-119 = value in columns 110-112
97	120	Let 2 = 3 3 = 2	
98	121	Negative, but let 3 = 0	
99	122	Negative	
100	123-126	Currently not used	

* "Negative" indicates that the recorded value is added as a negative value.

† "Positive" indicates that the recorded value is added "as is".

In summary, the values recorded on Form 621 have been transformed according to the rules provided in Table 14.1 ands summed to yield a total score for every household visit. It is these scores which are used in this report to represent household sanitation and hygiene. Due to the constrain of time, it has not yet been possible to analyze the observational data recorded on SAHY Form 622.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

The basic analyses conducted to date of the sanitation and hygiene data collected by Form 621 include a frequency distribution of household scores (all visits for each household combined), and calculations of the mean household score by month and the correlation coefficients of SAHY with several other variables.

By generating a total score for each household visit following the procedures outlined above, it becomes clear that there is considerable inter-household variability in sanitation and hygiene levels (mean household score = 36.1; variance of "between household" scores = 84.5; SD = 9.2; CV = 25.48%). The project's social scientists and other researchers familiar with households throughout the study area expected this finding from the data. Table 14.2 and Fig. 14.3 illustrate the distribution of household mean scores (all visits have been averaged for each household).

In determining whether seasonality influences SAHY levels, mean SAHY scores have been calculated for the months during which household visits were conducted. Based upon the monthly distribution of scores in Table 14.3, there appears to be no significant seasonal pattern. The mean scores from October 1984 through the end of 1985 are in fact quite similar. Interestingly, these scores are all lower than those of April and July of 1984. A possible explanation for this observation is that the drought, which reached its peak during the second half of 1984, contributed to a decrease in the quality of sanitation and hygiene levels which had previously been relatively high.

Related to the above findings is the observation that the "within household" variance over time is low (mean score = 36.1; SD = 6.1; CV = 16.90%).

The sanitation and hygiene data of households with pregnant and lactating lead females have been correlated with other variables. SAHY correlates positively with socioeconomic status, literacy of the lead male, and food intake, available energy, and anthropometry of the pregnant or lactating female. More specifically, household sanitation and hygiene has strong positive relationships with household socioeconomic status, the ability of the lead male to both read and write, and intake of calories, protein and fat, energy availability (caloric intake minus resting energy expenditure), and anthropometry, particularly weight and arm circumference, of the pre-pregnant and/or pregnant/lactating female (Table 14.4).

Significant negative correlations are found with age, morbidity, and resting energy expenditure of pregnant females. Thus, households whose pregnant/ lactating lead females are young, who experience both little significant and little low grade illness, and who have a low resting energy expenditure level experience higher sanitation and hygiene (Table 14.4).

The above correlations and other findings all make sense. Considerable additional work is necessary, however, to substantiate these observations and to better understand the nature of the relationship of sanitation and hygiene with numerous other variables. Additional work is also required to analyze the sanitation and hygiene observations (Form 622).

Preliminary analyses of the quality of drinking water have been conducted. Of 330 specimens of water, 12.3% were from water taps, 6.2% from streams and rivers, 5.2% from rainwater storage tanks, 5.5% from wells, and 70.6% from containers storing water from streams, rivers and wells (actual source not reported). Total bacterial counts and total

TABLE 14.2
The distribution of household sanitation and hygiene mean scores.

Score	Frequency	Percent
60-64	2	0.8
55-59	3	1.2
50-54	6	2.4
45-49	20	8.1
40-44	29	11.7
35-39	59	23.9
30-34	57	23.1
25-29	32	13.0
20-24	25	10.1
15-19	10	4.0
10-14	4	1.4
total	247	99.9

Mean 34.4 Minimum 12.1
Std Dev 8.9 Maximum 61.8

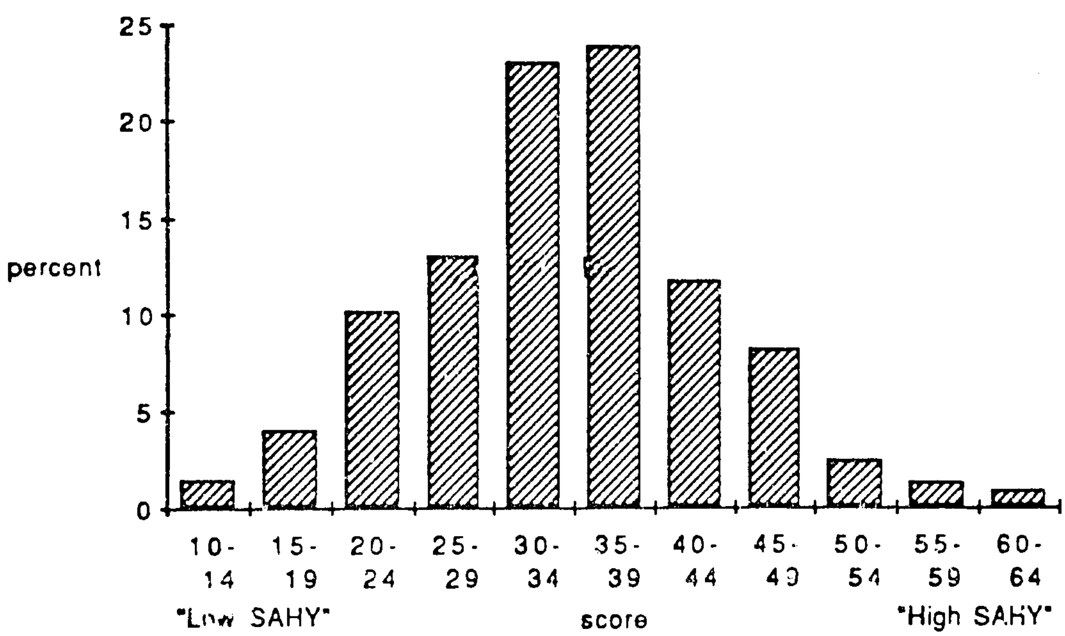


FIG. 14.3. Histogram of the distribution of household sanitation and hygiene mean scores.

gram-negative bacterial counts were done to determine the level of contamination. The total counts were coded as follows:

$1 = 10,\quad 2 = 10^2,\quad 3 = 10^3,\quad 4 = 10^4,\quad 5 \geq 10^5$

There was a significant difference in the level of contamination among the different water sources ($p < 0.0001$). Tap water was found to have the least contamination in both the total bacterial count and the total gram-negative bacterial count (means equal 1.350 and 1.150, respectively; see Table 14.5). Water from rainwater storage tanks was the next least contaminated (2.765 and 2.294, respectively), followed by that from streams and rivers (3.450 and 2.700, respectively). Water from wells was the worst contaminated, with mean counts equal to 4.000 and 3.500, respectively.

Additional work is required to investigate the possible relationships between household water contamination scores and household sanitation and hygiene scores, the incidence of diarrheal diseases, and other variables.

TABLE 14.3
Mean sanitation and hygiene scores (all households combined) by month.

1984	n	Mean Score	1985	n	Mean Score
January	0	----*	January	252	34.1
April	253	36.2	April	145	33.3
July	270	36.1	July	753	34.7
October	257	33.9	October	29	33.2

* The first SAHY visits were not conducted until April 1984.

TABLE 14.4.
The correlation coefficients of sanitation and hygiene with other selected variables, for households with pregnant lead females.

Variables	n	Corr. Coefficient	p <
HH Socioeconomic Status	118	0.46	.0005
Lead Male Literacy (Reading and Writing)	111	0.34 to 0.27	.005
Lead Female Caloric Intake Per Body Weight Throughout Pregnancy	78	0.27	.02
Lead Female Fat Intake Prior To Pregnancy	42	0.28	.05
Lead Female Fat Intake During Pregnancy	80-117	0.35 to 0.19	.05
Lead Female Fat Intake During Lactation	111-116	0.18 to 0.25	.05
Lead Female Energy Availability Prior to Pregnancy (Food Intake minus RMR)	21	0.48	.02
Lead Female Resting Energy Expenditure Prior to Pregnancy	21	- 0.47	.02
Lead Female Protein Intake Per Kg Prior To and During 1st Trimester of Pregnancy	42-80	0.29 to 0.22	.05
Lead Female Weight and Arm Circ. During Lactation	97-114	0.22 to 0.24	.02
Lead Female Age	119	- 0.20	.02
Lead Female Low Grade Illness Throughout Pregnancy	78-119	-0.20 to -0.22	.02
Lead Female Significant Illness During 2nd Trimester	106	-0.19	.05
Lead Female Significant Illness During Lactation (2nd Period)	117	-0.20	.02

TABLE 14.5
The means of total bacterial and gram-negative bacterial counts in household drinking water obtained from different sources.

Sources	Total Bacterial Mean Count*	Total Gram Negative Mean Count
Water Taps	1.350	1.150
Rain Water Storage Containers	2.765	2.294
Drinking Water Containers†	3.341	2.721
Streams and Rivers	3.450	2.700
Wells	4.000	3.500

* Mean count codes: 1 = 10, 2 = 102, 3 = 103, 4 = 104, 5 105.

† Water in these containers was obtained primarily from streams and rivers, although some was also obtained from distant wells.

REFERENCES

1. Feachem R.G., Bradley D.J., et al. Sanitation and Disease: Health Aspects of Excreta and Wastewater Management. New York: John Wiley and Sons, World Bank, 1983.

2. Esrey S.A., J.P. Habicht. Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. Epidemiol Rev 1986;8:117-28.

3. Thomas J.C. Risk factors for diarrhea among young children in rural Kenya. Ph.D dissertation, University of California, Los Angeles, 1987:27-36.

Chapter 15

TIME ALLOCATION

The Nutrition CRSP Kenya Project conducted a time allocation study among project households for a period of one year to learn how respondents spent their time during field research. The data were collected through the implementation of a program of "random spot observations," which basically involved visiting households unannounced (at random times of the day and random days of the week) and recording the activities being performed by individuals at the instant of the investigator's arrival. In all, some 86,000 individual observations were recorded of all members of 169 households over an entire annual cycle. The data are considered to be highly reliable, and the sample of observations is likely the largest available of its nature.

RESEARCH OBJECTIVES

The objective of time allocation field research was to collect data capable of describing how Nutrition CRSP respondents and other household members spent their time. It was anticipated that such data would be useful for addressing a wide variety of research topics and hypotheses, particularly those relating behavior to levels of food consumption. Questions such as the following are immediately amenable to analysis using the Kenya time allocation data:

1. Do households which enjoy higher levels of intake of energy, fat, protein, or other nutrients spend more time producing food and/or cash crops?

2. Do households with relatively good diets exhibit high levels of parent-child interaction?

3. Do adults or children with relatively low caloric consumption spend more time engaged in low-level energy expenditure activities than others?

4. Do children of larger households spend more time at "productive" work than children of smaller households?

5. How much "productive time" is "lost" by individuals experiencing poor health?

6. Do women spend more time than men performing activities typically targeted by planning agencies for development?

7. Is it more efficient to produce certain crops than others (measured, for example, by calories output per time input)?

8. Are certain months or seasons significantly more labor intensive than others?

9. Do households with high SES enjoy more leisure, recreation, and social time?

In short, the time allocation data are widely applicable to numerous research topics or problems. It is anticipated that the data will prove invaluable for a comprehensive understanding of the functional consequences of marginal or moderate malnutrition in the Kenyan study area.

Given the conditions of the study area, it was determined that a variation of the "random spot observations" technique (1), also referred to as "spot checks" (2), would be most appropriate for meeting the research objectives. Briefly, this technique involves visiting households unannounced and observing the behavior being performed by all individuals at the instant of arrival. Each recorded activity of behavior represents a "spot observation", and upon acquiring an appropriate number of observations it is possible to estimate the amount of time devoted to each activity by categories of individuals or even single individuals.

Four key conditions must be met for a time allocation study using spot observations technique to be successful: 1) respondents must not know when they will be visited, so as not to risk changes in their behavior 2) the times of the day and days of the week when visits are made must be randomized, 3) all times of a sampling period must be more or less equally represented, and 4) the study must be conducted over an entire year so as to take seasonality into account.

THE SAMPLE

The Time Allocation Study was conducted for twelve months, from March 5, 1985 through February 28, 1986. The households selected for this study were the 169 households enrolled during March 1985 in the "main study". The households were fairly evenly distributed among the four clusters (38 in Cluster 1, 41 in Cluster 2, 45 in Cluster 3, and 45 in Cluster 4), and the sample is regarded as representative of the study population. Data were collected on all individuals (not just "target individuals") residing in a given household at the time of a visit.

The time allocation data are divided among three distinct data subsets: the "Main Visits," "Night Visits" and "Sunday Visits." The "Main Visits" data constitute approximately 91% of the entire data set, and consist of those observations made on Mondays through Fridays from 7:00 am through 6:00 pm and on Saturdays from 7:00 am through 12:30 pm. A total of 59 visits were made to each household for this data subset.

Due to the general policy of restricting Nutrition CRSP fieldwork to daylight hours on Monday through Saturday (made at the request of the research households; but also for staff safety), time allocation visits were at first limited to these hours. Respecting the project's desire to collect some time allocation data during evenings and on Sundays, permission was granted by the study households to make occasional visits during these latter periods (the request for such permission was made by the Time Allocation fieldworkers during their household visits). It was therefore decided to collect data on one randomly selected evening of the week every other week, and on one randomly selected Sunday every month. The "Night Visits" were conducted from 6:00 pm through 9:00 pm; about four visits to each household over 19 evenings of work. "Sunday Visits" were made from 7:00 am through 6:00 pm; work on six Sundays yielded two visits to each household.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The spot observations technique offers a number of advantages over other time allocation techniques (e.g., recall, continuous observation, diary). Among its advantages are: 1) the technique is highly efficient for data collection (considerable data may be collected with relatively little effort); 2) the data are based on observation in most instances, rather than on recall which presumably is less reliable, 3) the technique does not influence observed behavior, since the recorded behavior is limited to that which is being performed at the instant of the investigator's arrival (respondents do not know when they will be visited), and 4) the data are readily amenable for computer key entry and analysis. A potential disadvantage is that households may not welcome investigators for such a purpose; this, however, proved not to be the case in the current study.

Prior to the commencement of the Time Allocation study as reported here, attempts by the Nutrition CRSP Kenya Project to collect time allocation data using techniques of "recall" and "continuous observation" did not succeed as they were either inefficient (i.e., they required considerable effort and cost to collect little data), not always reliable (especially "recall"), or influential upon respondent behavior (particularly "continuous observation"). Importantly, these latter techniques also do not easily yield data that are easily coded and thereby readily amenable for computer key entry and analysis.

In addition to designing the spot observations technique such that it met the conditions described above (i.e., unannounced, random visits representing all times of the day and days of the week over a year), the finalized technique had to meet two additional factors unique to the Kenya field project: 1) a need to keep personnel assigned to the study at a minimum because of limited financial resources, and 2) a desire to guarantee equal coverage of all households. To meet all these criteria it was decided that a technique involving a fixed route through the study area would be most appropriate. With the use of a field map and fieldworkers' knowledge of local terrain, the route was designed to minimize inter-household travel time.

Because it was expected that travel time between households would be greatly reduced by the use of bicycles, an in-depth search was made among existing staff to identify three male fieldworkers (females in the Embu area do not ride bicycles) to conduct the time allocation study. The major concerns in the selection of these individuals were that they 1) be interested in the study and willing to commit themselves to a year of work, 2) have a good rapport with all households throughout the study area, and 3) have excellent records for careful, reliable, and conscientious fieldwork.

Training of the selected fieldworkers commenced with detailed explanations of both the research objectives of the Time Allocation study and the proposed protocol for making household visits for the purpose of observing and recording behavior. The fieldworkers grasped the significance of these matters easily and, indeed, contributed several suggestions toward the refinement of the protocol. Upon finalizing the protocol and designing a data collection worksheet, the fieldworkers pre-tested and practiced the method in the project's pilot area for several days; the few minor problems and questions which arose were easily resolved.

TECHNIQUES OF DATA COLLECTION

Time allocation data were collected by one fieldworker working at a time (with the exception of Quality Control visits, see below). On the first day of the study, the first household on the route was visited at 7:00 am by the fieldworker scheduled for that day's morning shift. Proceeding to each subsequent household along the route (bicycles eased travel and minimized inter-household travel time), he was replaced at approximately 12:30 pm by the fieldworker assigned to the afternoon shift (rendezvous was facilitated by the use of walkie-talkies). The afternoon fieldworker continued along the route and made the final visit of the day by 6:00 pm; the subsequent household along the route was then visited the following day at 7:00 am. Upon reaching the end of the route, the fieldworker returned to the first household on the route. Throughout the year, each household was visited an average of 1.1 times per week in this manner.

It must be noted that a variety of factors including weather conditions (e.g., rain, high temperature), road and path conditions (e.g., mud, ruts), and length of visits all combined in such a way as to randomize the times when households were visited. That is, the total time required to complete the entire length of the route varied constantly, and as a consequence no household was consistently visited at the same time of day or on the same day of the week.

Prior to the commencement of the study a preliminary task was to design a data collection worksheet (Figure 15.1). In actuality, a unique worksheet was printed for each household listing its members and their respective pre-assigned ID codes. Before setting out for the field a fieldworker made sure that these household worksheets were ordered according to the sequence of the route. Importantly, the pre-printed worksheets allowed fieldworkers to know in advance who they could expect to observe at each household, and the data recording process was simplified since only the header information and activity descriptions were required to be recorded. New members were added to the form and ex-members were deleted as household composition changed.

Immediately prior to arrival at a house the fieldworker completed the header information on that household's worksheet. This included the "Visit No.," "Date," "Enum. No.," "Status," "Time," and "Total Rec. No." (the "Form No.," "Country Code," and "HH No." were pre-printed). Upon arrival at a house the fieldworker was required to make a mental note of the activity being performed by each member. Thus, as a hypothetical example, the fieldworker might observe the adult male sitting and watching other family members, the adult female feeding grass to cattle, the school-age son playing soccer, and the infant daughter sleeping. It was these activities, or "spot observations," which were then described on the worksheet under "Activity Description." Upon completion of a visit, which typically required only a few minutes, the fieldworker proceeded to the next household along the route.

In the absence of a member from the household compound, the fieldworker interviewed those present as to the activity that the absent individual was believed to be performing (e.g., "attending primary school," "planting maize," etc.). These non-observed activities were coded as "reported" data (under "Body Position" as "9"; see below), unless they could later be confirmed through actual observation (fieldworkers were required to look for and confirm the behavior of "absent" individuals who were anticipated to be within a range of 15 minutes from the compound). In the few instances when no household members were available, "missing data" (i.e., "0"'s) were recorded for each individual.

Again, the most critical responsibility of the fieldworker was to complete the "Activity Description" for each household member. The actual coding of the descriptions was less crucial as this could be completed at a later time. Indeed, it was not until the study had been underway for about two months before a preliminary codebook was available. At this point it became possible for the backlog of worksheets to be coded, and for fieldworkers to code the more common activities while completing worksheets along the route.

Every "activity description" was coded into a six-digit "activity code" and a one-digit "body position code" (see Baksh and Paolisso [3] for the codebook). Each "activity code," in turn, consists of a two-digit "general category" code, a two-digit "middle category" code, and a two-digit "specific category" code.

Using the codebook, the activity code for a given activity description was determined by first finding the "general category" to which the described activity belonged (e.g., Food Production, Recreation). Upon finding the proper general category in the codebook, the appropriate middle-level and specific-level descriptions and their respectives codes were easily located. Returning to the hypothetical example provided above, the man sitting and watching other family members would have been coded as "070562" ("07" = "Inactive" [general category]; "05" = "Idle" [middle category]; and "62" = "Observing Others" [specific category]). Similarly, the woman who was feeding grass to cattle would be coded as "054140"; the school-age boy playing soccer would have been coded as "100103"; and the sleeping infant daughter would have been coded as "070220".

The final code assigned to each observation is that of "Body Position" (3). In the example above, the man's body position would be coded as "2" ("Sitting"); the woman would be assigned "1" ("Standing"); the boy would receive "8" ("Running"); and the infant girl would be coded as "5" ("Reclining").

Finally, for the purpose of streamlining and reducing the costs of key entry a second form was designed (Fig. 15.2). The procedure for transferring data from the worksheets to the key entry forms was as follows:

Columns 1-3: "Form No." (pre-printed as "661").

Columns 4-6: "Visit No." (transferred directly from worksheets).

NUTRITION CRSP - KENYA PROJECT P. O. BOX 1002, Embu CONFIDENTIAL

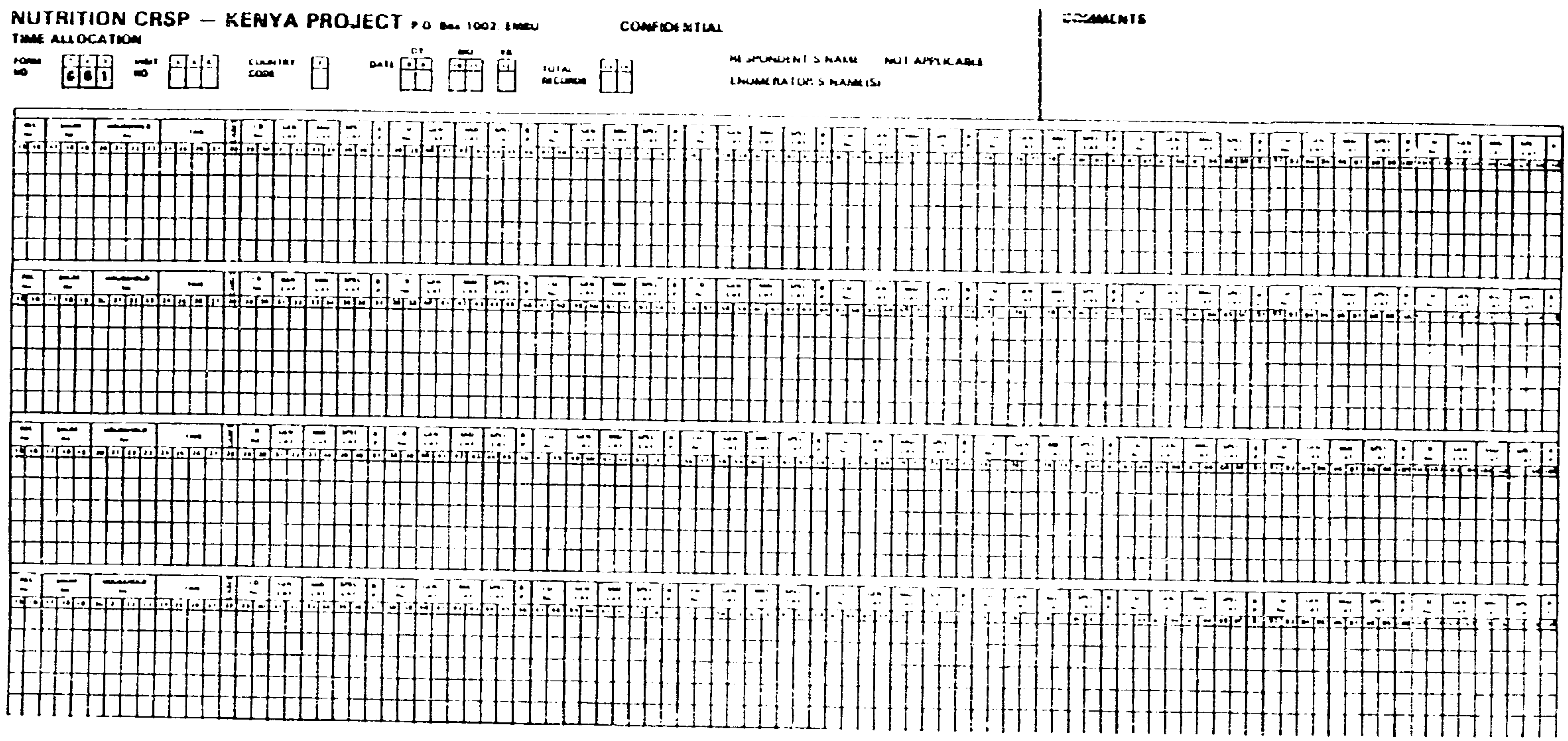
TIME ALLOCATION Form No.: 6 6 1 (1 2 3) Visit No.: __ __ __ (4 5 6) Country Code: 2 (7) HH No. __ __ __ __ (8 9 10 11) TI No.: 1 1 (12 13)

Date: __ __ __ __ __ (14 15 16 17 18) Enum. No.: __ __ __ (19 20 21) Status: __ (22) Time: __ __ __ __ (23 24 25 26)

NAMES OF HH MEMBERS	ID NO. 27	28		ACTIVITY CODES 29	30	31	32	33	34		BP 35	ACTIVITY DESCRIPTIONS

Comments

FIG. 15.1. The time allocation data collection worksheet.



NUTRITION CRSP — KENYA PROJECT P.O. Box 1002, EMBU

CONFIDENTIAL

TIME ALLOCATION

FORM NO 6 6 1 VISIT NO COUNTRY CODE DATE DY MO YR TOTAL RECORDS

RESPONDENT'S NAME NOT APPLICABLE

ENUMERATOR'S NAME(S)

COMMENTS

FIG. 15.2. The time allocation form used for entry of data onto computer.

Column 7: "Country Code" (always "2").

Columns 8-12: "Date" (Columns 8-9 = Day; 10-11 = Month; 12 = Year).

Columns 13-14: "Total Records" (unlike the "Total Rec. No." on the worksheet, which refers to the number of individuals observed in a household, "Total Records" here refers to the number of records (01-20) on a given key entry coding sheet).

Columns 15-16: "Record No."

Columns 17-19: "Enum. No." (transferred directly from worksheet).

Columns 20-23: "Household No." (transferred directly from worksheet).

Columns 24-27: "Time" (transferred directly from worksheet).

Column 28: "Cases" (refers to the number of spot observations available on a given record: "Cases" is = the number of individuals in a household for those households with 9 or less members; if a household contains 10 or more members, "Cases" is = 9 in the first record for that household and = the additional number of members beyond 9 in the subsequent record).

Columns 29-30: "ID No." (transferred directly from worksheet, anysubsequent individuals of the same record are recorded in columns 38-39, 47-48, 56-57, 65-66, 74-75, 83-84, 92-93, and 101-102.

Columns 31-36: "General, Middle, and Specific Category Codes" (transferred directly from worksheet; data for any subsequent individuals of the same record are available in Columns 40-45, 49-54, 58-63, 67-72, 76-81, 85-90, 94- 99, and 103-108.

Column 37: "Body Position" (transferred directly from worksheet; data for any subsequent individuals of the same record are available in Columns 46, 55, 64, 73 82, 91, 100, and109.

QUALITY CONTROL MEASURES

The quality control measures undertaken by the Time Allocation study were aimed at 1) standardizing the descriptions of observed behavior, 2) standardizing the assignment of codes to specific activities, and 3) error prevention. These objectives were largely accomplished through extensive preliminary and on-going training of the fieldworkers. Communication between senior field staff and fieldworkers occurred on a daily basis, and the Time Allocation Study was particularly fortunate in that its data collection field staff were exceptionally quick to learn and highly motivated. Once the study was underway the advice they sought was generally limited to the manner of handling rare or newly-observed behavioral activities.

To check the reliability of inter-observer activity observations and coding, a program of simultaneous observations was implemented. On one randomly selected day each week (commencing mid-way through the study), two fieldworkers arrived at households simultaneously and recorded their observations. Due to logistical purposes, these quality control visits were limited to the mid-day hours around the time when the morning shift was replaced by the afternoon shift. Although statistical analyses comparing the quality control data with the "scheduled" data have not yet been conducted, visual comparisons of the two data sets indicate that they are practically identical.

In the attempt to identify data errors, all ID and Activity codes, as well as header information, were checked thoroughly by senior staff. In addition, computer "range checks" were developed to identify any outstanding errors.

PREPARATION OF DATA FOR ANALYSIS

Before proceeding to discuss the Kenya data, a brief description of the general procedure for interpreting spot observational data is useful. Basically, the amount of time assigned to an individual or category of individuals (e.g., lead males, schoolers of "high" household SES, etc.) for any given activity is based upon the proportion of cases in which that activity was observed to the total number of observations made of that individual or category of individuals. The most basic assumption then made in calculating "time" is that the proportion of observed cases for each activity is equivalent to the proportion of time spent at those activities during the sampling period. Thus, for example, if "lead males" were observed to be "sitting idle" in 1,000 cases out of 10,000 observations made of lead males between the hours of 7:00 am and 6:00 pm on Monday through Friday, it may be estimated that these individuals spent 10% (i.e., 66 minutes) of their week-day "daylight" hours sitting idle. Thus, to describe how much time a given individual or category of individuals spent at each activity, it is necessary only to create frequency distributions of all activity observations.

A second assumption made of "spot observations" data, or at least of the Kenya data set, is that no activities other than sleeping or resting were performed in any significant amount between the hours of 9:00 pm and 7:00 am. This point actually becomes relevant only if one attempts to describe how much time individuals spent performing all activities based on a 24-hour period.

Finally, because the "Main Visits," "Night Visits," and "Sunday Visits" yielded different sample sizes (considerably fewer household visits were made at night and on Sundays), all three data subsets must be analyzed separately. The "Main Visits" data, in fact, should be sub-divided into "Morning Visits" and "Afternoon Visits". This is due to the availability of significantly more observations that were made in the mornings as a result of 1) visits conducted on Saturday mornings but not afternoons, and 2) fieldworkers working at a slightly slower pace during afternoons.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Analyses of the time allocation data to date have primarily involved generating simple descriptions of how categories of individuals spent their time. By way of illustrating the nature of such descriptions, a few examples are provided below. The examples indicate, first, how the average lead male and lead female allocate their time on an average day to various general activity categories, second, the amount of time spent at major food production activities by lead males and females of various clusters, and third, the amount of time spent by the same individuals at specific agricultural tasks. These examples illustrate the various levels of detail at which the time allocation data may by analyzed.

Since a major objective of any time allocation study is simply to learn how the average individual of any given category (e.g., lead males, female schoolers) spends his or her time on an average day, a first step of analysis is to generate such basic descriptions. These summaries are of considerable importance in themselves as they reflect general patterns in lifestyle.

Thus, for example, the Kenya time allocation data demonstrate that a number of important differences exist between how lead males and lead females spend their time (see Table 15.1 and Fig. 15.3). Although some of the differences are largely expected, such as the facts that females spend considerably more time at food production and care of self and others (including child care), and men spend more time at cash labor activities, other differences are perhaps more enlightening, such as the observation that males devote considerably more time to inactive, recreational, and social activities.

More insightful patterns will undoubtedly emerge from analyses that distinguish, for example, households of high vs low food intake, or households of high vs. low household SES.

Because data were collected on hundreds of specific activities, it is possible to break the "general categories" provided in Table 15.1 down into more specific categories. "Food production," for example, consists of "agricultural," "animal husbandry," and "wild food" activities. One way of illustrating the amount of time devoted to each of these more specific categories is provided in Table 15.2, where it becomes apparent that the bulk of food production time is spent at agricultural activities, which receive more attention from women than from men. Men, on the other hand, are more responsible than females for raising animals.

As a final example of the specificity to which the Kenya Project's time allocation data are amenable for analysis, the time devoted to specific agricultural activities can be calculated. The amounts of time devoted to "clearing," "digging," "planting," "weeding," "harvesting," and "other" activities by lead males and females is provided in Table 15.3. In Table 15.3 it can be observed that the average female spends significantly more time planting, weeding, harvesting, and engaged in "other" agricultural activities than the average male, but only slightly less time clearing and digging than the average male. Importantly, there is no extreme division of labor, except that women do spend about four times more time harvesting than men and, overall, devote more time to agricultural production.

In summary, an extensive and reliable data set is available on how the individuals of project households spent their time for an entire year. The examples provided above demonstrate that a wealth of data is available for the Kenya study population which can be used to address and understand a host of nutritional, health, agricultural, social, and other research topics.

TABLE 15.1

The time per day allocated to general activity categories by lead males and females, expressed in minutes and as percentage.*

General Category†	Lead Males		Lead Females	
	Minutes	Percent	Minutes	Percent
Eating/Drinking	41	5	44	5
Food Preparation	7	1	134	16
Care of Self & Others	49	6	145	17
Household Labor	36	4	131	16
Food Production	121	14	138	16
Cash Labor	252	30	48	6
Inactive	105	13	77	9
Education	0	0	0	0
Recreation	38	5	1	0
Social	152	18	91	11
Other	39	5	31	4
Total	840	101%	840	100%

* These and all subsequent data reflect the time spent by household members currently residing within the community. Thus, while 2.0% of lead males' time and 0.2% of lead females' time is spent "out of location" (e.g., living in a city or another district working or attending school), the data provided here are limited to daily life within the community.

† See Appendix A of the "Time Allocation Methods" manuscript (3) for the specific activities of each general category.

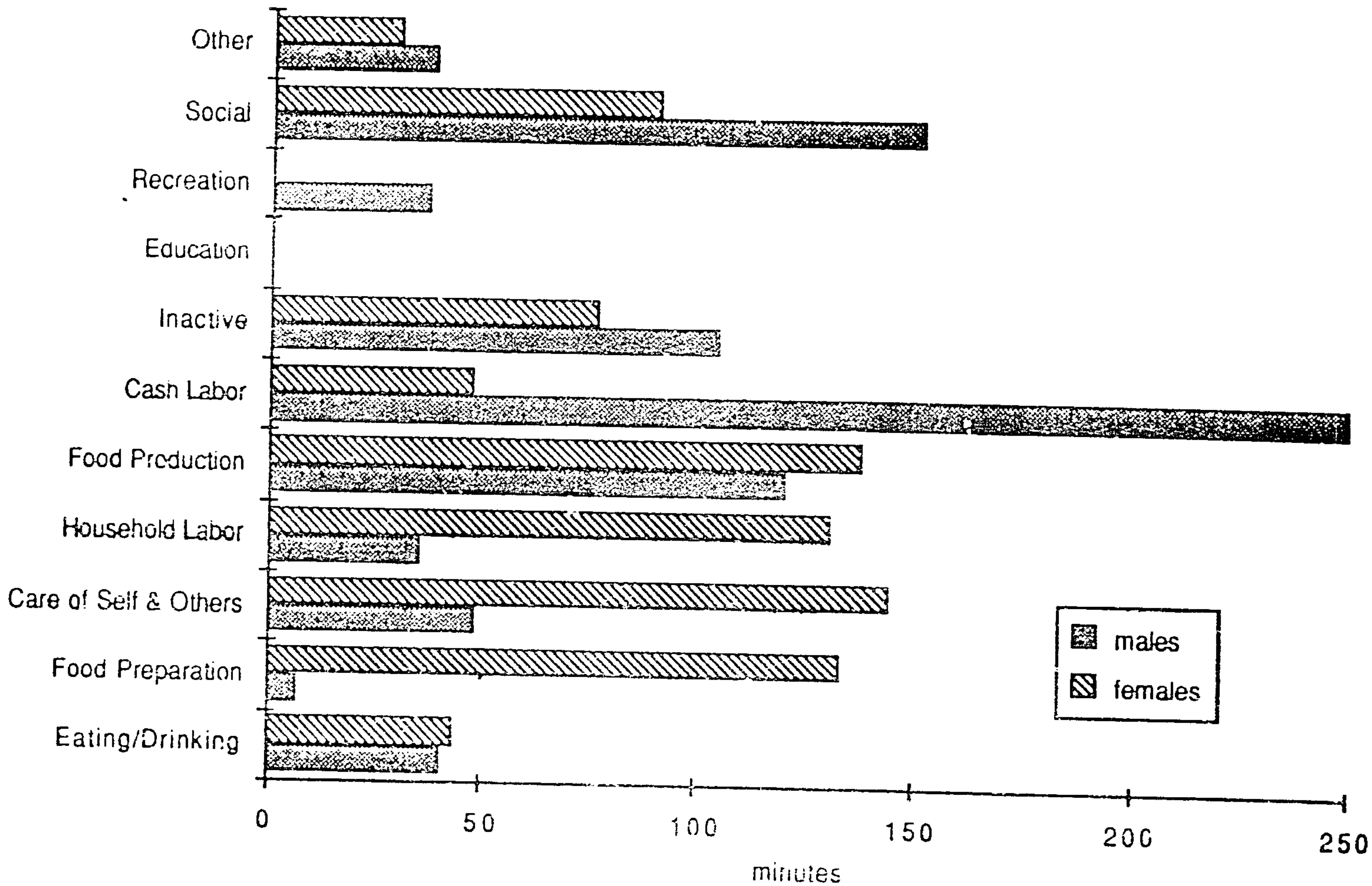


FIG. 15.3. The average time per day (7:00 am to 9:00 pm) allocated to general activity categories by lead males and lead females.

TABLE 15.2
The time per day allocated to food production categories by lead males and females, expressed in minutes.

Activity Category	Lead Males	Lead Females
Agriculture	73	113
Animal Husbandry	47	26
Wild Foods	1	0
Total	121	138

TABLE 15.3.
The time per day allocated to major agricultural activities by lead males and females, expressed in minutes.

Agricultural Activities	Lead Males	Lead Females
Clearing	3.4	2.8
Digging	15.7	12.4
Planting	9.7	16.8
Weeding	15.9	24.4
Harvesting	6.1	25.2
Unknown	10.0	5.6
Other*	12.0	25.4
Total	72.8	112.6

* Other includes fertilizing, thinning, mulching, terracing, winnowing, etc

REFERENCES

1. Johnson, A. Time allocation in a Machiguenga community. Ethnology, 14, 301-310, 1975.

2. Gross, D. Time allocation: a tool for the study of cultural behavior. Annual Review of Anthropology, 13, 519-58, 1984.

3. Baksh, M., M. Paolisso. Time allocation methods. Unpublished manuscript, School of Public Health, University of California, Los Angeles, 1986.

Chapter 16

AGRICULTURAL PRODUCTION

Considerable data on agricultural production were collected by the Nutrition CRSP Kenya Project. Interviews and observations of agricultural behavior, measurements of household garden area, and measurements of crop yields were conducted to gain a better understanding of the study population's nutritional status and economic condition. Although the bulk of available data have not yet been analyzed, it is expected that they will eventually shed considerable light on several research topics related to household food production and consumption, labor and potential for economic growth. The data collected on agricultural production strongly complement the socioeconomic data described in Chapter 13.

RESEARCH OBJECTIVES

Although the Nutrition CRSP is principally concerned with the "functional effects of food intake," food intake itself is intricately related to and dependent upon a host of factors, not the least of which is food availability. Because Embu households grow the bulk of what they consume, the Kenya Project felt that an understanding of the study population's agricultural production system would contribute significantly to an understanding of its nutrition, health and economy.

A primary objective of agricultural production fieldwork was, therefore, to collect the data necessary to better understand the relationship between food production and consumption. More specifically, the Kenya Project sought to collect data that would demonstrate 1) the amount of food produced by the average household, 2) the efficiency (e.g., kilos of produce per hour of labor) at which crops were produced, and 3) the types of constraints (e.g., land availability, labor, etc.) that prevented increased production.

THE SAMPLE

Two research methods were developed to collect agricultural data. One method, the Agricultural Crop Questionnaire (Form 671; Fig. 16.1), was designed to collect detailed data about the major food crops that were harvested, stored, sold, purchased, or planted each month by households. This questionnaire was administered monthly throughout 1984 and 1985 to the 247 households of the main study.

The second method, referred to as the Household Agricultural Production Study, centered around measurements of gardens and crop yields. This study commenced in March 1985 when there were 169 households in the main study. These households were fairly evenly distributed among the four clusters of the study area. A 25% subsample of households was randomly selected from each cluster, yielding a total of 42 households, from which both subsistence and cash crop production were measured for two consecutive growing seasons. The data collected from these 42 households are considered to be representative of the study area for the agricultural cycle of March 1985 to February 1986.

NUTRITION CRSP - KENYA PROJECT P. O. Box 1002, Embu CONFIDENTIAL
AG CROP HH QUESTIONNAIRE - MONTHLY RECALL 6/84 djc

Form No.: 6 7 1 (1 2 3) Visit No.: __ __ (4 5) Country Code: 2 (6) HH No.: __ __ __ __ (7 8 9 10) TI No.: 1 1 (11 12)

Respondent Name: ______________________

Date: __ __ __ __ __ (13 14 day, 15 16 mo., 17 yr.) Enum. No.: __ __ __ (18 19 20) Status: __ (21) No. of Records: __ (22) Enum.'s Name: ______________________

REC. NO.	FOOD CROP	CROP RAINS YR. CODE	AMOUNT HARVESTED (Kilos: Shillings)	AMOUNT SOLD (M. Boards, etc) (Kilos: Shillings)	AMOUNT PLANT/ LOCAL MARKET/ OTHER USES (Kilos: KSh.)
23	______	24 25 26	27 28 29 30 31 32 33 34 35	36 37 38 39 : 40 41 42 43 44	45 46 47 48 : 49 50 51 52
		IN HOME STORAGE NOW (Kilos):	53 54 55 56	PURCHASED IN LAST MONTH (Kilos: KSH.): 57 58 59 60 61 62 63 64	
	______	65 66 67	68 69 70 71 72 73 74 75 76	77 78 79 80 : 81 82 83 84 85	86 87 88 89 90 91 92 93
		IN HOME STORAGE NOW (Kilos):	94 95 96 97	PURCHASED IN LAST MONT (Kilos:KSH.): 98 99 100 101 102 103 104 105	
23	______	24 25 26	27 28 29 30 31 32 33 34 35	36 37 38 39 40 41 42 43 44	45 46 47 48 49 50 51 52
		IN HOME STORAGE NOW (Kilos):	53 54 55 56	PURCHASED IN LAST MONTH (Kilos:KSH): 57 58 59 60 61 62 63 64	

CROP CODES: 1 - Hybrid Maize; 2 - Local Maize; 3 - Beans; 4 - Bananas; 5 - Hybrid & Local Maize combined; 6 - Other (specify); 8, -8, -88, -888, -888: Missing Data: 9, -9, -99, etc: Not Appl.

RAINS CODES: 1 - Short Rains: 2 - Long Rains.
YR.: 3 (1983): 4 (1984); 5 (1985): 6 (1986).

Questions cover the 3 major FOOD crops grown by the HH. (Major - what the respon. thinks are the main 3 food crops for the HH.)
Questions pertain to the previous month (ie., in July, the questions are asked about June ... did you harvest any of that crop in June?).

FIG. 16.1. Agricultural crop questionnaire form 671.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The Agricultural Crop Questionnaire was designed prior to commencement of the main study. The intent of this questionnaire was to record economic and other information about the food crops of highest economic importance (in terms of production, consumption and/or distribution) by eliciting recall information about the major food crops that had been harvested, stored, sold, purchased and/or planted during the preceding month. Through extensive pilot testing, it was found that the major crops cultivated by the Embu were maize (both hybrid and "local"), beans and bananas. The codes adopted on the questionnaire were: 1 = hybrid maize, 2 = "local" maize, 3 = beans, 4 = bananas, 5 = hybrid and local maize, and 6 = other.

The Household Agricultural Production Study was developed in February 1985 and implemented in the following month. Up to that time the collection of agricultural data was based on respondent interviews, which left open to question the reliability of such key information as total household garden area and crop yields. In the attempt to collect accurate information on agricultural production, it was decided to actually measure a sample of gardens and weigh crop yields. Additional information on land tenure, agricultural inputs, cropping practices, and previous land use was also obtained.

Initially, three fieldworkers were trained to assist the senior staff (the Field Anthropologist, Field Director, and Social Scientist) in mapping gardens. All azimuth readings and linear measurements were made by senior staff. The field staff assisted in such ways as holding one end of the tape measure and positioning rods for azimuth sightings. The fieldworkers also explained the goals of the study to respondents and sought crop and planting information.

To save time on the part of senior staff and still ensure that gardens were measured according to schedule (measuring agricultural production is a laborious and time-consuming task; while small monocropped gardens require less than a day, large polycropped gardens often require two to three days), it was decided to train the three field assistants to make all necessary measurements. Practicing in non-CRSP gardens, these individuals quickly became proficient at measuring and recording both azimuth readings and linear distances, as well as drawing scaled maps of measured gardens. Upon training other fieldworkers to replace these individuals at the simpler tasks, it was eventually possible to draw upon several well-trained, two-person teams to perform garden mapping work.

TECHNIQUES OF DATA COLLECTION

The Agricultural Crop Questionnaire was administered monthly along with either the Socioeconomic Status Questionnaire, the Census Update Questionnaire, or the Sanitation and Hygiene Questionnaire.

In administering the Agricultural Crop Questionnaire, enumerators first asked respondents what they considered to be the three most important food crops (in terms of production, consumption, and/or distribution) over the past month. The three crops were recorded, and the following information was elicited for each: 1) whether the crop was planted during the long rains (mid-March through June) or short rains (October through November), or whether they were perennial (e.g. bananas); 2) the year the crops were planted (1983-1985); and 3) the household's reasons for considering the particular crop as important. In addition, if the crop was harvested during the past month, sold to any government marketing board, planted, sold locally or given to relatives, the amount in kilograms and Kenyan shillings was recorded. Finally, the amount of a crop in storage was noted, and the amount of a purchased crop was documented in kilograms and Kenyan shillings.

For the Agricultural Production Study, investigations of garden production began soon after households completed planting a new season's crops. The initial visit to each of the 42 study households was devoted to administering the Garden Mapping Questionnaire (Fig. 16.2), conducting visual inspections of the households' gardens, and scheduling appointments for mapping.

NUTRITION CRSP - KENYA PROJECT

GARDEN MAPPING QUESTIONNAIRE

HOUSEHOLD No. ________ DATE ________

1. How was the land acquired?

   a.) Purchased Yes ____ No ____

   b.) Inherited Yes ____ No ____

   If yes, from whom?

   c.) Rented Yes ____ No ____

   If yes, for how much per season? __________ Ksh.

   d.) Given Yes ____ No ____

   If yes, from whom?

   e.) Other

2. What farm inputs have you used this season?

   a.) Animal manure Yes ____ No ____

   b.) Compost manure Yes ____ No ____

   c.) Chemical fertilizers Yes ____ No ____

   If yes, for what crops?

3. Did you rotate maize and beans this season? Yes ____ No ____

4. Is soil erosion a problem in your shamba? Yes ____ No ____
   If yes, how do you prevent soil erosion?

5. Have you visited or been visited by an Agricultural Officer since the short rains last year? Yes ____ No ____
   If yes, what was the reason for the visit?

6. Did you hire labor to work in the shamba this season? Yes ____ No ____
   If yes, what was the arrangement?

FIG. 16.2. The garden mapping questionnaire.

Field staff returned to each household as scheduled, at which time the lead male or female accompanied team members to their garden to identify its exact boundaries as well as any subdivisions within it. Actual mapping began once the field staff were confident of the boundaries. Two invaluable items of equipment used to measure a garden were a Brunton transit (International, hand-held model) and a 30-meter fiberglass tape measure. The Brunton transits were used to 1) measure azimuths and thereby determine horizontal angles, 2) measure vertical angles (percent of grade or slope), and 3) set up research units within garden plots. While Brunton transits served the function of determining the azimuth readings of point A to point B, B to C, etc. in the mapping area, the tape measures were used to measure the distance between the points.

Upon selecting a starting point designated as "Coordinate A", the team leader held his/her position while an assistant walked along the first "side" of the boundary carrying one end of the tape measure. Upon reaching the end of the side (i.e., the point at which the boundary took a turn, or the end of the 30-meter tape, whichever came first), the assistant marked the spot with a rod or stake, and the point was designated as "Coordinate B". The distance between the two coordinates was read and recorded; the team leader took the azimuth reading with the Brunton transit by sighting on the rod held at "B." After recording the azimuth reading, the team leader moved to "B" and the assistant proceeded to the end of the next "side" (i.e., to "Coordinate C"). This procedure continued around the boundary until the starting point was reached, at which time the team turned its attention to the distinct plots within the garden.

Beginning from known coordinates along the boundary, the team used the same procedure for mapping any distinct crops assemblages within the boundaries (examples of crop assemblages were "maize only," "maize intercropped with beans," "cassava," "arrowroot," "grasses," etc.). Finally, all fallow areas were mapped as well.

Upon completing the measurements of a garden's boundaries and its sub-plots, a map was drawn of the garden to scale with use of a protractor and ruler (a scale of 1:500 was used for gardens acres; a scale of 1:1000 was used for larger gardens). All coordinates, crop assemblages, and other important information were labelled on the map. Finally, the area of all gardens and subplots was calculated fr the sealed maps with use of a planimeter.

The completed maps provided the baseline component for estimating garden production. Within a few weeks after measuring and mapping gardens, fieldworkers returned to the now semi-mature gardens to resolve any discrepancies on the maps and to rank maize and bean plots according to their anticipated level of production.

It was necessary to rank maize and bean plots because 1) it was not possible to actually weigh yields from every maize and/or bean plot of every garden, and 2) the yield (weight per area) of these crops varies tremendously depending on the particular crop mix employed. Regarding the latter point, some households plant only maize or beans in a given plot, while others intercrop the two crops (placing emphasis upon one as the principal crop, with the general consequence that the other fares poorly). Since farmers (and field staff, who themselves are farmers) can usually predict the quality of a crop before the harvest, scales were developed and every plot was ranked according to its anticipated level of production. The rank of each crop assemblage was based on a scale of low to high: for "maize" and "maize with beans", a five-level ranking scale was used; for "beans" and "beans with maize", a three-level ranking scheme was employed (Table 16.1).

TABLE 16.1
Ranks of maize and beans plots.

Crop Assemblages	Possible Ranks
Maize Only	High, Medium High, Medium, Medium Low, Low
Beans Only	High, Medium, Low
Maize with Beans	High, Medium High, Medium, Medium Low, Low
Beans with Maize	High, Medium, Low

After determining the area of every maize and/or bean plot and ranking the plots according to their anticipated level of production, the final task was to weigh crops from a subsample of plots. The plots selected for sampling were determined by, first, summing the area of each of the 16 ranked categories (e.g., "maize only - high," "maize only - medium high," etc.), and then randomly selecting plots until 20% of the total area within each category had been selected. For example, after determining the total area of the plots categorized as "maize only - high," individual plots were randomly selected until their combined area equalled or surpassed 20% of the total area of plots in this category.

The maize and bean yields of each plot within the 20% sub-sample were weighed as follows: for plots that contained beans, the entire harvest was weighed immediately after being threshed; for maize plots, the ears harvested from every fifth row were set aside and their kernels were weighed after they had dried and removed from the cobs. Field staff assisted household members in the harvesting and threshing activities, in return for their cooperation with the Agricultural Production Study.

QUALITY CONTROL MEASURES

Quality control measures were aimed at ensuring the collection of high quality data. Because the Agricultural Crop Questionnaire was administered concurrently with that of either Socioeconomic Status, Census Update or Sanitation and Hygiene (depending on the month), the quality control measures used were the same as those applied to these latter instruments. These measures included revisits to randomly selected households, and on-going training and supervision (see "Quality Control" in Chapter 13 for more information on this topic). The quality control data collected during revisits have not yet been compared with the data collected from the regularly scheduled visits.

Collection of high quality data for the Agricultural Production Study was primarily ensured by the high involvement of senior staff throughout the data collection process. Much of the data were, in fact, measured and recorded by senior staff. The remainder were collected by well-trained fieldworkers who were supervised daily by senior staff.

It is noteworthy that garden area measurements are guaranteed to be accurate as a consequence of the map-making process; in drafting a garden's perimeter to scale, the starting and ending points must necessarily be identical, thereby forming a polygon. The few discrepancies that did occur were easily resolved by returning to the gardens and re-measuring the angles or distances in question.

It is also important to note that all crop yields were weighed separately by at least two fieldworkers. The scales used for this purpose were calibrated weekly.

PREPARATION OF DATA FOR ANALYSIS

Data collected by the Agricultural Crop Quesuonnaire (Form 671) are computerized and amenable to statistical description and hypothesis testing.

Data collected by the Household Agricultural Study are currently in their raw form; time and financial resources have not yet allowed garden area or crop yield measurements to be computerized, compiled, or otherwise analyzed.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

As expected, households consistently reported, in response to the Agricultural Crop Questionnaire, maize (Zea mays) and beans (Phaseolus vulgaris) to be two of the three most important crops (Table 16.2). Indeed, of 6,007 responses, maize was reported as an important crop 2,416 times, and beans were important 2,422 times. Bananas (Musa spp.) were reported as important 856 times, and all other crops, including cassava (Manihot esculentum), arrowroot (Colocasia antiquorum), potatoes (Solanum tuberosum), millet (Eleusine coracana), and sorghum (Sorghum vulgare) were reported as important a total of 313 times.

Unfortunately, due to time and financial restrictions, no other analyses have been conducted to date on the agricultural data.

Regarding the Agricultural Production Study, it should be noted that the maize and bean weights will give an excellent idea of households' total production. This information will be invaluable when compared with agricultural recall data for the same households. Upon being analyzed, the Agricultural Production Study data will not only contribute immensely to the Nutrition CRSP's overall research objectives, but will also represent one of the most detailed investigations available of agricultural based populations.

TABLE 16.2
The most important crops reported by respondents in response to the agricultural crop questionnaire.

Crop	Number of Times Reported
All Maize	2,416
Hybrid Maize	(565)
Local Maize	(1,775)
Hybrid Maize and Local Maize	(76)
Beans	2,422
Bananas	856
Other	313
Total	6,007

Chapter 17

ACTIVITY ENERGY EXPENDITURE

The investigation of energy expended by adults in the performance of representative activities formed a small but significant non-core research component of the Nutrition CRSP Kenya Project. Two complementary research strategies were employed to determine the adult energy expenditure of representative activities. One strategy utilized cardio-cassette monitors (CCM's) to systematically sample heart rates throughout entire days of normal activity, and then to measure heart rates for several specific activities. The same specific activities were then measured for ventilation and oxygen consumption by a Max Plank Institute Respirometer (MPIR).

RESEARCH OBJECTIVES

A major objective for studying the energy expenditure of activity was to test the hypothesis that changes in food intake bring about social and biological responses of energy expenditure significance. More specifically, it can be hypothesized that a decrease in energy intake results in both a decrease in metabolism (see Chapter 12) and a decrease in the performance of high energy demanding activities. Thus, in times of food scarcity, behavioral changes might include a shift towards less physical activities (i.e., towards more sleeping, resting, and indoor activities) and less social activities (e.g., inter-household visiting), as well as the performance of activities at either a slower rate or in a more energy efficient position (e.g., sitting instead of standing).

Theories regarding the relationship between food intake and energy expenditure in activity, and the necessary methodologies for data collection, are not well developed (1). The Nutrition CRSP Kenya Project sought, therefore, to 1) collect detailed information on the energy costs of representative activities, and 2) refine existing research methodologies.

Specifically, the project attempted to answer two interrelated questions:

1) Do adults conserve energy during periods of food scarcity by altering behavior to emphasize less energy expesive activities?

2) Do individual responses vary depending on the age, sex and physiologic status?

THE SAMPLE

The activity energy expenditure study was conducted from July 1985 through January 1986. This "late start" was a consequence of staff and equipment limitations.

Because of transport and other logistical limitations, a small number of households located close to the Karurumo RMR laboratory were selected. Table 17.1 describes the respondents, their basic anthropometric characteristics, and, for females, whether they were pregnant or lactating.

While the sample is obviously very small, the project was very successful in collecting a large number of measurements. For the MPIR study, a total of 203 measurements of activity were conducted: 96 for lead males (01's), and 107 for lead females (02's). The CCM study is considerably larger: five to six full day measurements were made per respondent, with approximately 30 heart-rate segments per tape.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

Two data collecting techniques were employed in the investigation of activity energy expenditure. The first strategy utilized cardio-cassette monitors (CCM's) to record heart rate for activities performed during a normal day as well as for specific other activities; the second research activity utilized a Max Plank Institute Respirometer (MPIR) to determine the energy expenditure of the same specific activities measured by the CCM's. The development of these two research methodologies is discussed in this section.

TABLE 17.1
Respondents in the energy expenditure study, their general anthropometric characteristics, and, for females, their maternal status.

HH	Male (01)/ Female(02)	Pregnant/ Lactating	Age*	Ht (cm)†	Wt (kg)†
4007	M	NA	35	158	45.2
4007	F	Yes	34	148	63.8
4009	M	NA	48	155	57.3
4009	F	No	45	156	45.6
4018	M	NA	36	173	61.5
4018	F	Yes	23	150	40.6
4020	M	NA	24	163	53.6
4020	F	Yes	21	151	48.8
4026	M	NA	34	177	55.5
4026	F	Yes	22	164	62.4
4030	M	NA	28	160	55.0
4051	M	NA	60	167	52.2
4051	F	No	54	149	48.6
4056	M	NA	31	164	50.4
4056	F	Yes	31	158	52.0

* Age figures are from Census Update.

† Height and Weight were recorded just prior to first MPIR measurement.

The original conception of the activity energy expenditure study called for the use of a single measurement instrument, the cardio-cassette monitor (CCM). These lightweight activity recorders (Cardiodyne Cardiocassette II) are attached by a belt to the waist, and monitor heart rate through the use of three disposable chest electrodes. They can be programmed to either automatically activate a measurement period of fifteen seconds every fifteen minutes, and thus produce a sample of heart rate measurements over a range of unspecified daily activities, or run continuously and thus measure respondent heart rate for a specified activity (eg. weeding). In both program modes, the CCM produces a tape of heart rates which is played back through a single channel EKG (Hewlitt-Packard Model 1500B) to print out a copy of heart rates over a known period of time. Through the use of an ergometric test (pedaling against an increased load) while measuring respondent heart rate and oxygen uptake (using Beckmann MMC), energy expenditure values could be ascribed to varying heart rates.

According to the original CCM research design, a sample of ten lead females (five pregnant; five non-pregnant) would have worn the cardio-cassette monitor for one day each week for an entire year. The data collection period would have been eight hours of direct activity measurement (with the instrument programmed to record every fifteen minutes for fifteen seconds), with 16 hours of recall. Unfortunately, due to main study demands for staff time, principally in the area of RMR measurement, the beginning date for the activity energy expenditure study was postponed until August 1985, which reduced the length of the study to six months. Additionally, logistics required that the sample be selected from households located near the Karurumo RMR laboratory, which effectively reduced the number of pregnant women in the sample. The sample was, however, expanded to include lead males (Table 17.1).

In addition to changing the proposed sample size, the originally proposed methodology was modified as well after initial pilot tests. The original protocol requested respondents to activate the CCM every 15 minutes to describe the activity they were about to perform. The CCM then ran for 15 seconds before resuming the 15 minute/15 second measurement cycle. Unfortunately, respondents varied in their consistency and accuracy of self recording. In many cases, for example, respondents explained activities ex post facto, or gave multiple task descriptions for single fifteen-second recorded segments. In other cases, respondents varied in the frequency of recording activities: some completed a cassette intended for eight hours' use before mid-day, while others recorded only a few minutes of description. And finally, some respondents were diligent in the morning, but remiss in the afternoon, thus producing a good description of the early hour activities and a poor description of the afternoon hours. In summary, the technique raised doubts about the reliability and usefulness of the measurements.

The solution to the sampling distortion created by individual self-description of activity was to ask respondents to refrain from recording their activities. That is, the CCMs were programmed for their fifteen minute/fifteen second for an eight hour period, but no information on the activities producing the heart rates was recorded.

Because the original goal of the energy expenditure study was to assign "energy price tags" to activities recorded in the time allocation study, project field staff designed a study complementary to the CCM study to measure the energy expenditure of selected representative activities for specified periods of time. A Max Plank Institute Respirometer (MPIR) was employed for this purpose. The MPIR is a portable, lightweight (8.5 lbs.), gas meter/sampling instrument whose straps enable it to be worn like a backpack. As a respondent (fitted with a mask containing a two-way respiratory valve and connected to the instrument via plastic tubing) performs an activity, the respirometer measures the volume of expired air and collects a sample for analysis of the remaining oxygen content. This analysis is done with an oxygen analyzer (Teledyne 331-B) which enables simple and direct analysis of the concentration of oxygen over the 0-25% range with a sensitivity of 0.125%.

Once the expired air volume and oxygen consumption are determined, the respondent's caloric expenditure can be derived by using the Weir formula (2). Based on the principle that 4.92 kilocalories of energy are released from each liter of oxygen consumed by the body, the formula states:

$$\text{kcal} = 4.92 \times \text{VE(STPD)} \times (20.93 - \%O_2) \times .01$$

The Kenya Project used a modified MPIR that allowed continuous monitoring of volume and O_2 consumption. Earlier versions employed a sampling bag attached to the respirometer which physically had to be disconnected and fitted to the inlet tube on the oxygen analyzer. The project's modified machine used tubing to connect the sampling outlet directly to the inlet on the O_2 analyzer, thus allowing continuous determination of changes in O_2 consumption. The modified respirometer also used a digital readout to record continuous expired gas volume. These two modifications allowed uninterrupted minute by minute measurements of energy expenditure during each test. The Weir formula was used to determine energy expenditure values for each minute of activity. The use of the Weir formula allows simple, indirect determination of energy expenditure and eliminates the need to measure carbon dioxide production. The error involved in eliminating this latter step is estimated to be ± 0.5% (2).

The modified protocol required simultaneous MPIR and CCM measurements of respondent energy expenditure for representative activities. The activities selected for measurement are listed in Table 17.2. These activities bracket the range of expenditure rates for daily activities. Importantly, the measurement values for these activities are directly and indirectly applicable to activities observed in the time allocation study.

The field anthropologist and the RMR laboratory staff were responsible for conducting the energy expenditure studies. The anthropologist, who had previously used a respirometer in other field settings, recorded all MPIR measurements, thus ensuring quality data. The anthropologist also assisted an RMR technician, trained in exercise physiology, in the implementation of the CCM protocol. The technician was expertly qualified to read CCM tapes and supervise the incremental work tests (pedaling against an increasing load). The technician also supervised field staff in the attachment of the CCM monitors and the collection of instruments at the end or recording periods.

TABLE 17.2
Representative activities used in the MPIR/CCM energy expenditure study.

1.	Lying down	9.	Weeding with hoe
2.	Sitting	10.	Harvesting maize
3.	Standing	11.	Threshing beans
4.	Washing hand/legs	12.	Chopping wood
5.	Washing Dishes/Utensils/Cooking*	13.	Walking unloaded
6.	Picking Coffee	14.	Walking loaded (5 kg)*
7.	Harvesting beans	15.	Walking loaded (10 kg)*
8.	Weeding with Panga	16.	Walking loaded (20-25 kg)*

* Measurements were obtained for women only; men expressed reluctance to perform such "women's work."

TECHNIQUES OF DATA COLLECTION

The CCM and MPIR studies differed from many other CRSP research components in their dependence on automated or semi-automated instrumentation. If properly calibrated and fitted to the respondent, the Cardio-Cassette Monitors and the Max Plank Institute Respirometer produce continuous indirect measurements of energy expenditure. This section reviews the daily protocol for the CCM and MPIR studies, emphasizing the role played by staff in interfacing between these instruments and the study group.

As mentioned above, the CCM study began in July 1985 and continued for six months. The goal of the study's research methodology was to collect data on the lead male and female of one household per day from 8:00 a.m. until 4:00 p.m. The eight study households were visited according to an established rotation, with each household being monitored on every eighth work day. Thus, if a household was scheduled for a Monday visit, it would be visited again on Thursday of the following week, etc; by the sixth week, the household's scheduled visit day would again be Monday. This eight-day rotation insured that households would be visited on different days of the week.

The daily protocol for the CCM study required minimal staff involvement. A schedule for household visits was established and posted in the Karurumo RMR laboratory. Two fieldworkers were assigned to the CCM study to assist the

RMR technicians. The former were responsible for attaching the monitors to the respondents in the morning, retrieving the instruments in the late afternoon, and collecting recall data on evening activities. The latter maintained the equipment in good working order, operated the EKG machine to produce hard copies of the taped heart rate, and logged out the data to the data management office in Embu. On average, these activities required an hour per day from both field and laboratory staff. During the remainder of the day, these individuals continued their usual assignments.

Briefly, the daily protocol for the CCM study was as follows. Prior to leaving for the scheduled household, the fieldworker inspected and tested the two field cardio-cassette monitors to insure that the machines were in good working condition (strong batteries, blank cassette, clean recording head, unbroken electrode wires, etc.), and secured the necessary disposable electrodes (six/day), alcohol and cotton swabs for cleaning the skin prior to attaching the electrodes. At 7:30 a.m., a project vehicle transported the fieldworker to the scheduled household where she attached the electrodes to the respondent's chests, secured the monitors to their waists, recorded the date, household number, and respondent's name at the start of each tape, and activated the fifteen minute/fifteen second program for each. The respondents were reminded that they should follow a normal day's routine and that she would return at 4:00 p.m. to retrieve the monitors.

Attachment of the CCM's required approximately 20 minutes. Upon completion of this task, the fieldworker was transported to the previous day's household to record the past evening's and early morning's activities. The fieldworker asked for and recorded the activities for each hour prior to going to bed, as well as those activities performed early that morning.

The collection of the recall data completed the fieldworker's morning CCM responsibilities and she was transported back to field office to begin other assigned work. At 3:45 the vehicle returned her to the study household to retrieve the monitors. The monitors and tapes were returned to the RMR laboratory where the laboratory technician read the tapes using the EKG machine.

The above daily protocol was implemented for the entire six months of the study. The daily data collection was complemented by periodic measurements of heart rate and VO_2 uptake. Known as the Incremental Work Tests, these laboratory measures were obtained through the use of the EKG (to measure heart rate), the Beckmann MMC (to record VO_2 uptake), and a bicyle ergometer (to provide increased activity load). These tests required respondents to pedal a stationary bicycle at a frequency of 60 rpm while an increasing load resistance was applied. Heart rate and V02 measurements were recorded every 30 seconds while the load was increased 0.5 kg every minute, up to a maximum of 4.0 kg. On average, each respondent completed five measurements of heart rate and VO_2 uptake. Subjected to regression analysis, these measurments are expected to establish a linear relationship between heart rate and VO_2 uptake, thus providing a framework for converting field measurements of heart rate to caloric expenditure (See Appendix F).

Upon completing the CCM investigation of daily energy expenditure, field staff began the MPIR study of the caloric costs of specific activities (see Table 17.2). The anthropologist and one of the CCM fieldworkers were successful in scheduling day-long household visits during which respondent activity could be measured. As explained above, measurement of energy expenditure for specific activities involved the use of both the MPIR and the cardio-cassette monitors. The following discussion reviews the protocol for each of these instruments within the context of a hypothetical household setting.

The team arrived early at the scheduled household and generally began working with the lead male, since this individual often had off-farm obligations during the day. After explaining the tasks to be performed, the field supervisor attached the cardio-cassette monitors to the respondent. This was done in exactly the same manner as for the CCM study. After recording on the tape the respondent's background information and the activity being measured, the fieldworker turned the machine off until the beginning of the activity to be measured. Once the activity began (say, for example, "weeding with a hoe"), the continuous recording mode was turned on. The machine continuously recorded heart rates until turned off at the end of the test.

While the fieldworker operated the cardio-cassette monitor, the anthropologist focused on the MPIR. A data sheet was used to record the following information: test no., date, time, respondent/household identification no., activity description, temperature, barometic pressure, minute expired gas volume (liters), and minute percentage of O_2 in sampled expired gas. The above information is required by the Weir formula to calculate caloric expenditure.

Just prior to commencement of the activity, the oxygen sensor was calibrated by drawing ambient air over the sensing membrane and adjusting the needle to read 20.9%. Also the MPIR's gas volume counter and an accompanying digital stopwatch are zeroed. For each test minute, the percent O_2 and the volume of gas expired were recorded.

The measurement of each activity lasted 7-8 minutes. The first two to three minutes were used as a warm-up, allowing the MPIR to stabilize and the respondents to become comfortable with wearing the machine and performing the activity. The remaining five minutes contained the values used to calculate energy expenditure. Respondents were requested to undertake the activity in a normal manner, and were repeatedly cautioned against changing their work pattern because of the test situation.

QUALITY CONTROL MEASURES

The collection of energy expenditure data was closely supervised by senior field staff. On a weekly basis, the heart-rate monitor tapes were reviewed, and fieldworkers were observed during the implementation of field protocol. All MPIR measurements were collected by the staff anthropologist who carefully followed the necessary procedures.

In addition to closely monitoring field staff performance, the cardio-cassette monitors and the Max Plank respirometer were regularly serviced and cleaned. Suspect components were replaced and, in the case of the MPIR, the machine was periodically recalibrated in the RMR lab.

PREPARATION OF DATA FOR ANALYSIS

The energy expenditure data were collected during the final months of fieldwork. During this period, Project computer resources were committed to the entry of main study core data and its verification for completeness. The energy expenditure data were not, therefore, computer entered in Kenya and, due to UCLA staff concerns regarding corrections of the Beckmann algorithms (see Chapter 12) which affect the V02 measurements in the Incremental Work Test, have not yet been computer entered at UCLA. The MPIR data (203 measurements), which are independent of corrections in the MMC, have been computer entered. The calculations presented in Table 17.3 are based on these data.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

General descriptive statistics based on the MPIR data are presented in Table 17.3 This summary shows the mean kcal/minute values for the 16 measured activities, by lead male and lead female. The table shows clearly the high and low expenditure activities and the amount of variation from the mean for both male and female. Additionally, mean expenditure figures per kilogram of body weight, which facilitate intermeasurement comparison are presented. Table 17.3 represents description trends in the data which in the future will be explored in more detail.

TABLE 17.3
Mean adult expenditure values for respresentative Embu activies (kcal/min).

	Males (n = 8)			Females (n = 7)		
Activity	mean kcal	mean sd.	mean kcal/wt.	mean kcal	mean sd.	mean kcal/wt.
Lying	0.91	0.13	0.02	1.06	0.18	0.00
Sitting	1.11	0.09	0.02	1.08	0.19	0.02
Standing	1.07	0.15	0.01	1.04	0.13	0.02
Washing	2.95	0.50	0.05	2.98	0.60	0.05
Cooking	--	--	--	1.87	0.48	0.04
Weed/panga	4.31	0.63	0.08	4.27	0.78	0.08
Weed/hoe	5.43	1.51	0.10	4.76	0.97	0.09
Pick Coffee	1.92	0.48	0.04	1.66	0.35	0.03
Harv Maize	2.68	0.56	0.05	2.53	0.35	0.05
Harv Beans	3.75	0.48	0.07	3.05	0.53	0.06
Thresh Beans	5.78	0.89	0.10	5.15	1.03	0.10
Chop Wood	5.43	1.16	0.10	4.50	0.79	0.09
Walk	3.51	0.45	0.07	3.61	0.77	0.07
Walk 5 kg	--	--	--	3.47	0.53	0.07
Walk 10 kg	--	--	--	3.33	0.55	0.07
Walk 25 kg	--	--	--	3.68	0.86	0.07

Analysis of the energy expenditure data has just begun. Considerable additional work is necessary to test the hypotheses that prompted this research.

REFERENCES

1. Sackett R. The field measurement of energy expenditure. a review of theories and methods. Ms. Thesis. University of California, Los Angeles, 1985.

2. Durnin J.V.G.A and R. Passmore. Energy, Work and Leisure. London: Hueneman Educational Books, 1967, pg. 17.

Chapter 18

ADULT LITERACY

The Nutrition CRSP Kenya Project conducted a literacy test in the latter half of 1985 to assess the reading and writing ability of the project's adult respondents. This exercise involved developing and administering reading and writing tests to the lead males and females of both current and "graduated" households. In all, 479 adults were tested from a total of 247 households.

RESEARCH OBJECTIVES

The objective of the literacy study was to assess the reading comprehension and writing ability of the lead males and lead females of the Nutrition CRSP households. It was anticipated that this information would be useful for determining whether the quality of a household's nutrition, as well as its health, sanitation and hygiene, socio-economic status, and other functions are associated with the literacy level of one or both lead adults.

THE SAMPLE

An attempt was made to administer the Adult Literacy Test to all lead adults who had at some time participated as respondents in the Nutrition CRSP study. The vast majority (about 90%) of these adults were tested, including 233 males and 243 females. The remaining individuals had either moved outside the community, died, refused to cooperate, or were unavailable for some other reason. The individuals tested were fairly evenly distributed among the four clusters, and the sample is regarded as highly representative of the lead adults in the study population. Each individual in the sample was tested once, with the exception of those individuals tested twice for purposes of quality control.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES, AND STAFF TRAINING

Adult literacy was assessed through the administration of both reading and writing tests. These tests were developed from passages extracted from the English Reading Textbooks (prescribed by the Inspectorate of the Ministry of Education) used widely thoughout Kenya as standard texts in both governmental and non-governmental schools. Passages were extracted from the texts used for Standards One to Seven and Forms One to Four; the objective was to select a passage from each text that should be comprehensible to students at that level of education. The exam had the benefit, therefore, of not only ranking the performance of respondents objectively, but also of indicating the actual level of education at which respondents were literate (see Chapter 2 for a discussion of educational facilities available in the study area, and Chapter 3 for a discussion of educational levels attained by Nutrition CRSP lead adults).

The literacy exam comprised four parts: the reading test, the writing test, and a subjective assessment made by the fieldworker of each test.

The Reading Test consisted of eleven reading passages lettered "A" to "K", which represented school Standards One to Seven and Forms One to Four, respectively (Appendix G). A set of three comprehensive test questions was developed for each reading passage. All passages and test questions were translated into Kiembu by well-qualified bilingual speakers, and each respondent was given the choice to be tested in English or Kiembu.

The Writing Test consisted of eleven dictation passages lettered "a" to "k" which, again, represented Standards One to Seven and Forms One to Four, respectively (Appendix G). Again, these dictation passages were translated into Kiembu, allowing those respondents who were more literate in Kiembu than English to be tested in their first language.

Finally, an assessment scale was developed in which the fieldworker ranked a respondent's reading and writing ability as either good, fair or poor. A major purpose for this scale was to allow for the possibility that finer distinctions could be made between respondents of otherwise identical scores.

Staff training was conducted under the supervision of the Field Psychologist. The exam was pre-tested in the pilot study area to identify any possible problems with the exam itself or its administration; the few minor problems which did arise were easily resolved. Training emphasized standardization in the administration of the test, accuracy in correcting the exams, and consistency in the assignment of scores.

TECHNIQUES OF DATA COLLECTION

Three fieldworkers were trained to administer the Literacy Test (two of these fieldworkers were previously responsible for conducting the project's cognitive tests; the third had carried out child care-giving/interaction and a variety of other investigations). Upon arrival at the household, a fieldworker first verified the presence of the lead adults and obtained their consent to be tested at that time. A comfortable, well lit place, preferably a quiet room with a table and chairs, was selected for the test to be carried out; other members of the family were asked to perform their usual household chores or other activities elsewhere.

Prior to the commencement of the study a computer-ready data collection form was designed (Figure 18.1). Immediately after arrival at a house the fieldworker completed the header of the form for the lead adult to be tested, and what the last class was that he/she had completed in school. The last class attended was recorded in the "Comments" section at the top of the form, along with any other known information that might have influenced the TI's performance on the exam (e.g., poor eyesight).

The exam portion of the test was carried out in the following order: 1) the reading test, 2) the writing test, 3) assessment of reading ability, 4) assessment of writing ability.

The Reading Test

The fieldworker first asked the target individual to review quietly the passage which represented the last class he/she attended at school. After finishing, the TI was asked to read the passage aloud twice, after which the fieldworker withdrew it and asked the accompanying comprehension questions.

If the TI passed two of the three comprehension questions for the first passage, the fieldworker recorded the "pass" as a "1" in that passage's corresponding column on the form, and proceeded to administer the next, more difficult one. Proceeding to increasingly difficult levels, the test was discontinued if and when the TI failed two of the three comprehension questions for two successive passages. A failure was recorded as a "2".

NUTRITION CRSP - KENYA PROJECT P.O. Box 1002, Embu CONFIDENTIAL
ADULT LITERACY TEST

COMMENTS

FORM NO: 5 4 2 (1 2 3) VISIT 0 1 (4 5) COUNTRY 2 (6) HOUSEHOLD NO: ___ ___ ___ ___ (7 8 9 10) TI ___ ___ (11 12) DATE DY ___ ___ (13 14) MO ___ ___ (15 16) YR ___ (17) ENUM ___ ___ ___ (18 19 20) STATUS ___ (21)

TI's NAME ____________________ ENUMERATOR'S NAME ____________________ Missing Data, use 0,00, etc. Not applicable, use, 9, -9, etc.

READING TEST (1=PASS, 2=FAIL)		
A	☐	22
B	☐	23
C	☐	24
D	☐	25
E	☐	26
F	☐	27
G	☐	28
H	☐	29
I	☐	30
J	☐	31
K	☐	32

WRITING TEST (1=PASS, 2=FAIL)		
a	☐	33
b	☐	34
c	☐	35
d	☐	36
e	☐	37
f	☐	38
g	☐	39
h	☐	40
i	☐	41
j	☐	42
k	☐	43
ASSESSMENT OF READING ABILITY	☐	44
ASSESSMENT OF WRITING ABILITY	☐	45

ASSESSMENT OF READING ABILITY

(1 = GOOD, 2 = FAIR, 3 = POOR)

1. Good = fluent; rapid reading; accurate identification of words.
2. Fair = words accurately read after stumbling for more than 45 seconds; no assistance needed from examiner; slow, ponderous reading.
3. Poor = words left out; asks for help; inacurate words used; stumbling for more than 60 seconds and needs prompting by the examiner

ASSESSMENT OF WRITING ABILITY

(1 = GOOD, 2 = FAIR, 3 = POOR)

1. Good = quick reproduction with 2 or less errors.
2. Fair = three errors in reproduction; stumbling over spelling for more than 45 seconds; no assistance needed from examiner.
3. Poor = more than 3 errors in reproduction; words left out; assistance asked for; gives up.

FIG. 18.1. The computer-ready form used for the adult literacy test.

If the individual failed two of the three questions for the first passage read, he/she was asked to read the easier, preceding passage. After reading that passage twice the respondent was asked its three accompanying comprehension questions, and this process was repeated until the TI passed two of the three comprehension questions for two successive passages. All easier remaining passages than these were credited as "passes", and the Reading Test was terminated. Each column beyond the two successive failures on the test was recorded with a "9" (equivalent in value to a "2"), to indicate passages not actually tested.

Finally, if a respondent claimed not to be capable of reading, the test was not administered and columns on the exam portion of the form were coded with "9"'s. In instances when a respondent was not examined, the exam portions of the form were coded with "0"'s to indicate "Missing Data".

The Writing Test

For the Writing Test the TI was requested to write down passages as they were dictated. The first passage selected for dictation represented, again, the last class the TI had attended at school. The passage was dictated twice, clearly and at a normal reading speed. After the second round of dictation, the passage was read a final time to allow the respondent a chance to check for errors.

The fieldworker then examined the writing sample for errors. For passages a to c, two errors were permitted, and for passages d to k, three errors were allowed. An error in writing was defined as either: 1) a spelling error, 2) a word left out or misplaced, or 3) use of an incorrect word. If the TI passed the initial passage the pass was recorded as a "1" in the appropriate column, and the fieldworker proceeded to the next passage of greater difficulty. The TI was requested to write down that passage, which was then corrected, and the test proceeded in this manner until two successive failures were recorded, at which time it was discontinued.

If the TI failed the first writing passage, the fieldworker selected the preceding, easier passage and asked the TI to write down the dictation. This process was repeated until two successive passes were recorded. All passages less difficult than these were credited. As with the Reading Test, each column beyond two successive failures on the test was recorded with a "9" (equivalent to a "2"), to indicate passages not tested.

Finally, as with the Reading Test, if a respondent claimed not to be capable of writing, the test was not administered and columns on the exam portion of the form were coded with "9"'s. In instances when a respondent was not examined, the exam portions of the form were coded with "0"'s to indicate "Missing Data".

Assessments of the Quality of Reading and Writing Ability

After the reading and writing exams, the fieldworker assessed the reading ability of the TI as either "Good" (fluent, rapid reading; accurate identification of words); "Fair" (words read accurately but after stumbling for more than 45 seconds; no assistance needed from examiner; slow, ponderous reading); or "Poor" (words left out; asked for help; inaccurate words used; stumbling for more than 60 seconds; a need for prompting by the examiner).

Finally, the supervisor assessed the writing ability of the TI as either "Good" (quick reproduction with two or less errors); "Fair" (three errors in reproduction; stumbling over spelling for more than 45 seconds; no assistance needed from examiner); or "Poor" (more than 3 errors in reproduction; words left out; assistance asked for; gives up).

In the "Assessment of Ability" portion of the form, "Good" was recorded as a "1", "Fair" as a "2", and "Poor" as a "3".

QUALITY CONTROL MEASURES

The quality control measures undertaken by the Adult Literacy Study were aimed at: 1) standardizing the administration of the reading and writing tests, 2) standardizing the assignment of Pass/Fail and Good/Fair/Poor scores upon correcting the exams, and 3) error prevention. These objectives were largely accomplished through both extensive preliminary and ongoing training of the fieldworkers by the Field Psychologist. In addition, the Field Psychologist conducted the Quality Control revisits (N=29), accompanied the fieldworkers on numerous regular visits, and reviewed all data forms to ensure that they were properly completed.

PREPARATION OF DATA FOR ANALYSIS

A respondent's reading and writing levels may be ranked in two ways: by identifying the highest passage passed (for each test), or by adding the total number of passages passed (for each test). The reason for this distinction is that instances exist in which respondents failed certain passages, only to have passed ones of greater difficulty. Thus, as a hypothetical example, while both respondent x and respondent y may have passed passage F on the Reading Test, respondent y may have somehow failed passage E. The options, therefore, are whether to grant a score of "6" points to both respondents x and y for having passed passage F, or to give the score of "6" only to respondent x, and a score of "5" to respondent y for having actually passed only five passages.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

The Reading Test and Writing Test data have been analyzed in both ways outlined above and, as expected, the technique of identifying the highest passage passed yields a slightly higher ranking. In actuality, however, there is extremely little overall difference between the two, the mean levels for men's reading and writing ability based on the highest passages passed are 5.8 and 5.3, respectively, vs. 5.7 and 5.2 based on the total number of passages passed; similarly, the mean levels for women's reading and writing ability based on the highest passages passed are 3.2 and 2.4, respectively, vs. 3.1 and 2.3 based on the total number of passages passed.

To simplify the task of relating literacy scores with other data sets, it has been decided to select one of the above techniques. So as not to penalize individuals for having failed a passage which they were no doubt capable of passing, as indicated by the fact that they passed one or more of increased difficulty, we have decided to present and analyze scores that reflect the highest passage passed. The distributions of the Reading Test and Writing Test scores for men are provided in Table 18.1; the scores for women are available in Table 18.2.

Perhaps the most obvious pattern to emerge from the distributions of scores in Tables 18.1 and 18.1 is that men are significantly more literate than women. Indeed, it is fair to state that at least twice as many men are literate than women. Thus while 23.2% of the men can read at the level of Form Four, only 8.2% of the women read at this level. Similarly, 30.5% of the men write at the level of Form Four, but only 9.1% of the women write at this level. Of equal importance, while 25.3% of men cannot read at all, 48.6 women cannot read, and while 32.2% of men cannot write at all, 60.5% of women cannot write.

TABLE 18.1.
The distribution of reading test and writing test scores for male respondents.*

Level Passed	Reading # Cases	Reading %	Writing # Cases	Writing %
0 (No School)	59	25.3	75	32.2
1 (Std. One)	1	0.4	19	8.2
2 (Std. Two)	13	5.6	11	4.7
3 (Std. Three)	11	4.7	3	1.3
4 (Std. Four)	25	10.7	6	2.6
5 (Std. Five)	12	5.2	10	4.3
6 (Std. Six)	5	2.1	4	1.7
7 (Std. Seven)	7	3.0	6	2.6
8 (Form One)	15	6.4	13	5.6
9 (Form Two)	5	2.1	3	1.3
10 (Form Three)	26	11.2	12	5.2
11 (Form Four)	54	23.2	71	30.5
Totals	233	99.9	233	100.2

* The Mean Reading Level Passed is 5.7 (equivalent to studying at the level of Standard Six) and the Mean Writing Level Passed is 5.2 (equivalent to studying at the level of Standard Six).

TABLE 18.2.
The distribution of reading test and writing test scores for female respondents.*

Level Passed	Reading # Cases	Reading %	Writing # Cases	Writing %
0 (No School)	118	48.6	147	60.5
1 (Std. One)	3	1.2	12	4.9
2 (Std. Two)	14	5.8	20	8.2
3 (Std. Three)	13	5.3	6	2.5
4 (Std. Four)	28	11.5	5	2.1
5 (Std. Five)	12	4.9	8	3.3
6 (Std. Six)	1	0.4	1	0.4
7 (Std. Seven)	10	4.1	4	1.6
8 (Form One)	4	1.6	6	2.5
9 (Form Two)	8	3.3	4	1.6
10 (Form Three)	12	4.9	8	3.3
11 (Form Four)	20	8.2	22	9.1
Totals	243	99.8	243	100.0

* The Mean Reading Level Passed is 3.1 (equivalent to studying at the level of Standard Four) and the Mean Writing Level Passed is 2.3 (equivalent to studying at the level of Standard Three).

A second important finding that emerges from the data in Tables 18.1 and 18.2 is that individuals tend to either be highly literate or not literate at all. Thus, while more than one third of the men passed the Reading Test at the levels of Forms Three and Four, about the one-fourth cannot read at all and the remainder are distributed between these extremes. Similarly, while well over one-third of the men passed the Writing Test at the levels of Forms Three and Four, another third cannot write at all. The women's scores, despite being considerably lower, also support this pattern. Thus, while nearly half the women cannot read, about one-eighth read above the level of Form Three and the remainder are distributed between these extremes; similarly, while nearly two-thirds of the women cannot write, about one-eighth can write above the level of Form Three. Finally, it is noteworthy that of the individuals who fall between the extremes of high and low literacy, a relatively high percentage of both men and women read at the level of Standard Four.

These and other findings of the literacy data will no doubt prove important in interpreting and understanding nutrition, health, and other topics studied by the Nutrition CRSP Kenya Project.

Chapter 19

ANXIETY AND DEPRESSION

The idea to investigate the prevalence of anxiety and depression was conceived by the field physician and nurses of the Nutrition CRSP Kenya Project who witnessed several apparent emotional problems and psychosomatic complaints among adults in study households. Because these states of mental health can influence food intake, morbidity, or other variables, a questionnaire was used to elicit information on anxiety and depression from project respondents. Preliminary analyses of the data indicate that women are significantly more anxious and depressed than males.

RESEARCH OBJECTIVES

The Nutrition CRSP Kenya Project decided to conduct a study of the emotional status of lead males and females of project households after recognizing that a few individuals appeared to be experiencing moderate mental health problems. The morbidity staff (particularly, the physician and nurses) noticed that a number of individuals consistently appeared to be depressed and/or anxious, and complained heavily of what appeared to be psychosomatic illnesses. Realizing that the state of one's mental health can influence the quality of an individual's nutrition and physical health, as well as a household's sanitation and hygiene, socioeconomic status, and other functions, the project decided to investigate the emotional status of lead adults. The Anxiety and Depression questionnaire was administered to determine the prevalence of these states of affect.

THE SAMPLE

An attempt was made to administer the Anxiety and Depression questionnaire to the lead adult males and females of all Nutrition CRSP study households. A total of 214 adult males and 228 adult females representing 239 households of a possible 247 households were tested once during late 1985 and early 1986. The individuals tested were fairly evenly distributed throughout the study area, and the sample is regarded as highly representative of the lead adults in the study population.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The Anxiety and Depression questionnaire (Form # 951, Columns 1-41; see Fig. 19.1) was extracted from a more extensive questionnaire used to screen patients with possible psychiatric illness. The larger questionnaire has been standardized on psychiatric patients in Columbia, Sudan, the Philippines, and India by the World Health Organization (1). In Kenya, the instrument was standardized on psychiatric patients at the Kenyatta National Hospital (2-4).

Nutrition CRSP-Kenya Project   CONFIDENTIAL
P.O. Box 1002, EMBU.

"ANXIETY AND DEPRESSION SELF REPORT QUESTIONNAIRE"
(PART I OF FORM 951)

FORM # _ _ _ (1 2 3)   VISIT # _ _ (4 5)   COUNTRY _ (6)   HH # _ _ _ _ (7 8 9 10)

TI _ _ (11 12)   DAY _ _ MO _ _ YR _ (13 14, 15 16, 17)   TI NAME ________

ENUMERATOR _ _ _ (18 19 20)   STATUS _ (21)   ENUMERATOR'S NAME ________

CODES: 1 = NO   2 = YES

1. Niuricagwa ni kiongo kwa wingi?
(Do you often have headaches?) — 22

2. Wendi waku wa kuria ni muthuku?
(Is your appetite poor?) — 23

3. Niukomaga nai?
(Do you sleep badly?) — 24

4. Ni uvavukaga naivenya?
(Are you easily frightened?) — 25

5. Njara ciaku ni itetemaga?
(Do your hands shake?) — 26

6. Ni wegucaga guoya kana kieva?
(Do you feel nervous, tense or worried?) — 27

7. Uthii waku wa-nda wa irio ni muthuku?
(Is your digestion poor?) — 28

8. Ni ukoragwa wina thina ugiciria wega?
(Do you have problems thinking?) — 29

9. Ni wegucaga ntaimukenu?
(Do you feel unhappy?) — 30

10. Ni uriraga makiria ya muno?
(Do you cry more than usual?) — 31

11. Ni wonaga vinya kwenda maundu maku ma muthenya?
(Do you find it difficult to enjoy your daily activities?) — 32

Continued

Fig. 19.1 The Anxiety and Depression Self Report Questionnaire

Fig. 19.1 continued.

12. Ni wonaga vinya gwika itua? (Do you find it difficult to make decisions?)	__ 33
13. Ni uthinagwa ni wira waku wamuthenya? (Is your daily work suffering)	__ 34
14. Ukoragwa wina thina wa kuruta wira wa maica maku? (Are you unable to play a useful part in life?)	__ 35
15. Ni utete wendi wa indo? (Have you lost interest in things?)	__ 36
16. Ni wigucaga wi mundu wa mana? (Do you feel that you are a worthless person?)	__ 37
17. Wanagia na meciria ma gukorwa utai thayu? (Has the thought of ending your life been in your mind?)	__ 38
18. Ni wigucaga wi munogu indi cionthe? (Do you feel tired all the time?)	__ 39
19. Ukorogwa ukithinua ninda maita mengi? (Do you have uncomfortable feelings in your stomach?)	__ 40
20. Niunogaga na karugi? (Are you easily tired?)	__ 41

The questions selected for use by the Nutrition CRSP project were from a scale that had been validated for measuring anxiety and depression. This test instrument consisted of 20 questions designed to evoke "yes" or "no" responses. "Yes" responses indicate the presence of anxiety/depression, and "no" responses suggest their absence. The questions were translated into Kiembu by well-qualified bilingual speakers, and translated back into English by other bilingual speakers to ensure that meaning was not lost in the English to Kiembu translation.

Staff training was conducted by the project's Field Psychologist and Field Physician. Staff training sessions emphasized the need to establish excellent rapport with respondents, administration of the questionnaire, and accurate recording of responses.

Upon pre-testing the questionnaire in the pilot area adjacent to the project's study site, it was learned that four of the 20 questions occasionally aroused some difficulty with comprehension; the technique for resolving this difficulty is explained below.

TECHNIQUES OF DATA COLLECTION

The project's two cognitive fieldworkers were trained to administer the Anxiety and Depression questionnaire. Due to the personal nature of some questions, administration of the questionnaire required that excellent rapport be created between fieldworker and respondent. Because the two fieldworkers had previously conducted numerous tests among each household and were well-respected throughout the study area by both men and women, they had little difficulty securing complete cooperation from nearly all respondents.

After informing a household's lead male and female that the project would like to ask specific questions about their health, a fieldworker assured the respondents that, as was the case for all information collected from them by the Nutrition CRSP Project, the information learned from this test would be completely confidential. If a respondent was reluctant to be tested, or if a fieldworker felt that the respondent would not give valid responses, the individual was not tested. If an individual granted permission to be tested, a comfortable, quiet place was selected for the administration of the questionnaire. If both lead adults were available for testing, the test was administered separately to maintain rapport and confidentiality; all other individuals were asked to perform their usual household chores or other activities elsewhere.

After filling in the appropriate header information on the computer-ready form, the TI was requested to ask if he/she had any difficulty understanding or answering any of the questions about to be asked. Each question was asked in Kiembu in exactly the same manner as it was worded on the questionnaire, and the response was recorded as a "no" (code = 1) or a "yes" (code = 2) in the corresponding column.

In cases when a question aroused a vague response such as "sometimes", "occasionally", or "maybe", the fieldworker repeated the question limiting the time of reference to the preceding two weeks. For example, if, to the question, "Do you often have headaches?", the respondent replied, "sometimes," or "when I am in the sun for a long time", the fieldworker then asked, "In the last two weeks how often have you had headaches?" A response of "three times" (or more) was coded by the supervisor as a "yes," and one less than three as a "no".

As mentioned above, it was recognized during pilot-testing that certain questions occasionally tended to arouse some difficulty in comprehension and response. In particular, questions 13, 14, 15, and 18 sometimes required clarification. When a respondent expressed difficulty with one of these questions, an alternative and somewhat simplified question was asked. The alternative questions (English version) were as follows:

Question 13. Do you feel you do less work than usual?
Question 14. Do you feel what you do is beneficial?
Question 15. Do you feel like not doing anything the whole day?
Question 18. Do you feel tired the whole day?

TABLE 19.1
The frequency distribution of anxiety/depression scores for lead males and lead females.

# of "yes" responses	Males		Females	
	# of cases	percent	# of cases	percent
0	80	37.4	33	14.5
1	42	19.6	50	21.9
2	32	15.0	28	12.3
3	15	7.0	31	13.6
4	10	4.7	22	9.6
5	15	7.0	17	7.5
6	5	2.3	11	4.8
7	7	3.3	7	3.1
8	3	1.4	8	3.5
9	2	0.9	9	3.9
10	2	0.9	2	0.9
11	0	0.0	6	2.6
12	0	0.0	1	0.4
13	0	0.0	2	0.9
14	0	0.0	0	0.0
15	1	0.5	0	0.0
16	0	0.0	1	0.4
total	214	100.0	228	99.9

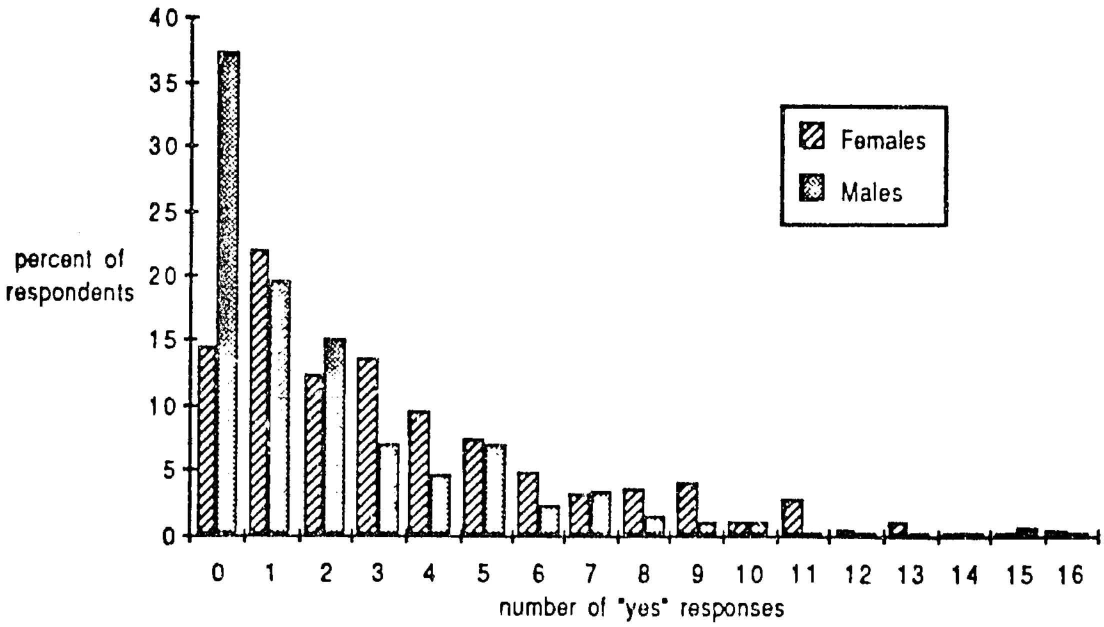


FIG. 19.2. The frequency distribution of anxiety/depression scores for lead males and lead females.

Again, if any of these questions aroused a vague response like "sometimes," the fieldworker limited the question to refer to the preceding two weeks.

QUALITY CONTROL MEASURES

The quality control measures undertaken by the Anxiety and Depression study were aimed at: 1) standardizing the administration of the test questions, 2) recording the appropriate responses properly, and 3) error prevention. These objectives were largely accomplished through both extensive preliminary and ongoing training of the fieldworkers by the Field Psychologist and Field Physician. In addition the Field Psychologist accompanied the fieldworkers on numerous household visits and reviewed all data forms to ensure that they were properly completed.

PREPARATION OF DATA FOR ANALYSIS

The Anxiety and Depression data are readily amenable to analysis due to the simplified nature of the questionnaire. Indeed, to estimate an individual's emotional state, relative to others' in the study, it is merely a matter of adding the number of "yes" responses.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

The frequency distribution of "yes" responses for adult males and females is provided in Table 19.1 (see also Fig. 19.2). As can be seen from the table, females reported significantly more "yes" responses than males (e.g., only 14.5% of females reported no "yes" responses, while 37.4% of males reported no "yes" responses).

Using the level of eight or more "yes" responses as an indicator of emotional difficulty, about 12.7% of females and 3.7% of males appear to be experiencing problems. Further analyses will investigate whether the households of these individuals eat less nutritious diets, experience higher morbidity, or have lower socioeconomic status than other households.

REFERENCES

1. Harding T.W., et al. Mental disorders in primary health care: a study of their frequency and diagnosis in four developing countries. Psychological Medicine, 10, 231-241, 1980.

2. Dhadphale M., Ellison R.H., Griffin L. Frequency of mental disorders among outpatients at a rural district hospital in Kenya. The Central African Journal of Medicine, 28(4), 85-89, 1982.

3. Dhadphale M. The frequency of mental disorders in the outpatients of two Nyanza hospitals. The Central African Journal of Medicine, 29(2), 29-32, 1983.

4. Dhadphale M., Ellison R.H., Griffin L. The frequency of psychiatric disorders among patients attending semi-urban and rural general out-patient clinics in Kenya. Brit. J. Psychiat. 142, 379-383, 1983.

Chapter 20

ALCOHOL CONSUMPTION

The Nutrition CRSP Kenya Project conducted a survey to estimate the amount of alcohol consumed by household lead adults. Although the types and amounts of beer and other alcoholic beverages consumed were supposedly documented through the collection of data on food intake, project personnel recognized that such consumption was probably being under-reported, at least for adult males.

The Alcohol Consumption survey was conducted during the last two months of fieldwork by a well-trained fieldworker, and the data are regarded as highly reliable. Preliminary data analyses suggest that the average adult male consumed significantly more beer than recorded by food intake investigations; adult females, on the other hand, consumed virtually no beer, which supports the finding of the food intake measurements. It is noteworthy that virtually no alcohol other than "traditional" homemade beer or "commercial" bottled beer was consumed by household respondents; for this reason, the "alcohol consumption study" would have been more aptly named the "beer consumption study".

RESEARCH OBJECTIVES

The Nutrition CRSP Kenya Project designed and implemented the Alcohol Consumption questionnaire to determine the types and amounts of alcoholic beverages "normally" consumed by lead adults of the project's study households. Although this information was ideally collected by food intake field staff, project personnel recognized that alcohol consumption, a socio-culturally sensitive issue, was probably being under-reported. A principal reason why alcohol consumption is a sensitive issue is because, even though the bulk of alcohol consumed in rural areas is traditionally fermented beer (i.e., homemade), the production of such beer is illegal in Kenya (1). Thus, although study households largely trusted the Nutrition CRSP Project and its field staff, the possibility clearly existed that at least some respondents were reluctant to consume beer while being visited by strangers, or to volunteer that beer had been consumed outside the household. It must also be noted that while it is men who consume virtually all beer in the community, the food intake staff was comprised solely of young adult females. Several factors contributed therefore to a realization that significantly more alcohol was possibly being consumed than reported. The Alcohol Consumption survey sought to determine if in fact this was the case.

Two research objectives directed the desire to obtain accurate information on the amount of alcohol consumed by adult respondents. The first was intimately related to a major objective of the study, namely, to estimate as accurately as possible the amount of energy consumed by project respondents. Assuming that the consumption of alcoholic beverages was significantly under-recorded by the food intake staff for at least some respondents due to reasons beyond their control, an objective of the alcohol consumption study was to collect reliable data that would indicate whether the energy intake was under-reported for any target individuals. Any necessary compensations will be incorporated into future analyses of food intake.

Second, if some respondents were consuming large amounts of alcohol, it would be important to determine whether this behavior is related to other behaviors or "functional outcomes." It can be hypothesized, for example, that individuals who consume large amounts of beer (either traditional or commercial) experience high rates of morbidity. It can also be hypothesized that the households of individuals who consume high quantities of commercial beer are characterized by high socio-economic status, since this beer is quite costly compared to traditional beer. Another possible relationship worthy of investigation is whether high beer consumption is correlated with the emotional status (i.e., anxiety/depression) of either the individual in question or his spouse.

THE SAMPLE

An attempt was made to administer the Alcohol Consumption questionnaire to the lead adult males and females of all Nutrition CRSP study households. All lead adult females and 223 lead adult males of 239 households were interviewed once during February and March of 1986.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

The Alcohol Consumption questionnaire (Form #951, Columns 42-75; see Fig. 20.1) was developed by Nutrition CRSP Kenya Project field staff. Specifically, the Field Director and Field Anthropologist worked closely with several fieldworkers to develop questions that would elicit valid responses on alcohol consumption. An important point that must be stressed is that the fieldworker selected to conduct the interviews was extremely well-trained and experienced, and, of equal importance, was very well-liked in the community and maintained an excellent rapport with virtually all respondents.

The questionnaire was designed to ask questions about the consumption of both traditional and commercial beer; other forms of consumed alcohol were recorded under "Comments." Emphasis was placed upon eliciting the average number of cups (16 ounces) of traditional beer and bottles (500 milliliters) of commercial beer that were "normally" consumed over specific time periods. It was learned early during pilot testing that, while respondents who consumed commercial beer could report with little difficulty approximately how many bottles they consumed on average during a month, those who consumed traditional beer had difficulty providing an estimate of the number of cups consumed beyond the time frame of one week. Regarding this last point, it was eventually found to be most convenient to divide the week into two periods: Monday through Friday, and Saturday and Sunday. This facilitated men's recall because their drinking behavior on weekends and weekdays often differs. Thus, for traditional beer, respondents were asked how many cups they normally consumed during the period from Monday through Friday, and how many on a typical weekend.

NUTRITION CRSP - KENYA PROJECT CONFIDENTIAL

ALCOHOL CONSUMPTION QUESTIONNAIRE (Part II of Form 951)

HH:____ TI:____ DATE :__ __ __ __ __ ENUM: __ __ __ STATUS: __
42 43 44 45 46 47 48 49 50

---

1. On average, how many cups of traditional beer do you drink during the week (i.e., Monday-Friday)?

__ __ __
51 52 53

2. On the average, how many cups of traditional beer do you drink during the weekend (Saturday and Sunday)?

__ __
54 55

3. Is there a particular time of year when you drink more traditional beer than usual? (1 = No, 2 = Yes, 9 = Not Applicable)

a. No or Yes

__
56

If "Yes," during which of the following? (Tick each)

b. _ Harvest time

__
57

c. _ Holidays

__
58

d. _ Coffee payouts

__
59

e. _ Other cash crop payouts (tobacco or cotton)

__
60

f. _ Other (specify: ________)

__
61

4. On average, how many bottles of commercial beer do you drink in a month's time? Large bottles (or equivalent) =

__ __ __
62 63 64

FIG. 20.1. The alcohol consumption questionnaire.

5. Is there a particular time of the year when you drink more commercial beer than usual? (1 = No, 2 = Yes, 9 = Not Applicable)
a. No or Yes

_ 65

If "Yes," during which of the following? (Tick each)

b. _ Harvest time

_ 66

c. _ Holidays

_ 67

d. _ Coffee payouts

_ 68

e. _ Other cash crop payouts (tobacco or cotton)

_ 69

f. _ Other (specify: _________)

_ 70

6. During the week (Monday-Friday, do you ever drink in the morning? (1 = No, 2 = Yes, 9 = Not Applicable)
a. No or Yes

_ 71

b. If "Yes," on how many days per week?

_ 72

7. Has your spouse ever told you that you drink too much traditional beer? (1 = No, 2 = Yes)

_ 73

8. Has your spouse ever told you that you drink too much commercial beer? (1 = No, 2 = Yes)

_ 74

If "Yes," what were his/her reasons? ____________

9. Enumerator Question:
How reliable do you consider the information provided by the respondent on alcohol consumption to be?
(1 = Highly Reliable, 2 = Probably Reliable, 3 = Questionable) _ 75

Comments:

FIG. 20.1 continued.

Recognizing that drinking behavior can vary as a consequence of the availability of cash (from coffee payouts or the harvest of other crops) or on holidays or other occasions, an effort was made to take these variations into account. When estimating beer consumption, therefore, respondents were encouraged to take into account significant variations from, for example, month to month or weekend to weekend.

In the effort to determine whether any respondents may have been suffering from alcoholism, a series of three questions were designed to elicit information on this topic.

Finally, because this questionnaire was rather sensitive and therefore subject to possible unreliable responses, the fieldworker was asked to subjectively rank the overall reliability of each respondent's estimates. The fieldworker knew most respondents extremely well, and so his rankings of data reliability are extremely important.

The Alcohol Consumption protocol was extensively pre-tested in the project's pilot study area both throughout the development of the questionnaire and after the final version had been achieved. Importantly, the extensive pilot testing enabled the fieldworker to finely tune his interaction skills in such a manner as to approach respondents and administer the questionnaire with their complete confidence and trust.

TECHNIQUES OF DATA COLLECTION

A single fieldworker was responsible for conducting the alcohol consumption interviews. Because the sampling objective was to administer the questionnaire to as many respondents as possible, the fieldworker was given freedom to schedule his household visits as he thought best.

More than was the case for other questionnaires, a considerable amount of time was spent in the administration of this one establishing rapport with respondents. Although the questionnaire could easily have been completed within five minutes, the fieldworker commonly spent 15 minutes or more chatting with the respondent until he felt the respondent would be comfortable discussing alcohol consumption. Because the fieldworker knew the brief questionnaire intimately, he was able to jot down brief notes on responses during its administration, so as not to lose flow in the interview. The form was completed in detail after leaving the household.

The most difficult aspect of the conducting interviews was to estimate "averages" in those cases in which respondents consumed beer irregularly. Fortunately, most respondents either consumed extremely little or no beer, or consumed fairly fixed amounts regularly (e.g., two cups of traditional beer every evening, or five bottles every Saturday night). For the more difficult cases, the fieldworker inquired extensively about drinking patterns so as to gain an appreciation for the variation, and eventually settled upon an estimate with the respondent. In all cases, the fieldworker recorded estimates that were conservative. That is, if anything, the data on amounts of beer consumed are low.

Because no data were available on the energy value of traditional beer in the Embu area, several beer samples, made by various recipes, were collected from the study area. These samples were subsequently analyzed for alcohol, caloric, and protein content by the Department of Food Science and Technology, University of Nairobi. The mean values are recorded in the CRSP Kenya Food Composition Data Base.

QUALITY CONTROL MEASURES

The fieldworker administering the Alcohol Consumption questionnaire was consulted daily by the Field Director and/or Field Anthropologist. So as not to risk obtaining untruthful answers by accompanying the fieldworker to households, however, the fieldworker administered all interviews (after the pilot study) on his own. No revisits were conducted.

Nevertheless, because of the exhaustive pre-testing of the questionnaire and the personality and expertise of the fieldworker, the data are regarded as highly reliable.

It is noteworthy that prior to the commencement of the Alcohol Consumption survey several fieldworkers who knew all households well were interviewed by project senior staff in the attempt to identify individuals who were known to be heavy drinkers. These interviews resulted in a list of 32 lead adult males. It is expected that the heaviest drinkers identified by the Alcohol Consumption survey will include these 32 individuals.

PREPARATION OF DATA FOR ANALYSIS

The data on alcohol consumption are readily available for analysis. The data of immediate importance are those on the average numbers of cups of traditional beer consumed from Monday through Friday and on weekends, and the number of bottles consumed monthly. Weekly consumption of homemade beer for any given respondent is calculated, obviously, by adding the Monday through Friday figure with the weekend figure. Daily consumption estimates are calculated by dividing the weekly figures by seven, and the monthly figures of consumed commercial beer by 30.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Due to time and financial restrictions the data on alcohol consumption have only been cursorily examined to date. An effort has not yet been made, for example, to determine whether significant discrepancies exist between the amounts of beer consumption recorded by the food intake investigations and by the study reported in this chapter. Nor have efforts been made to correlate beer consumption with socio-economic status, morbidity, anxiety/depression, or other variables.

Preliminary analyses of the data, however, present several interesting observations. First, it is quite apparent that women drink virtually no beer. And, as indicated in Table 20.1, the small amount of beer which is consumed is limited to local traditional beer. These data support the data obtained by the food intake investigations. The finding is also supported through interviews with project fieldworkers, who can be regarded as excellent informants.

Men, on the other hand, were found to consume significant amounts of beer, especially the traditional variety. Certain individuals in particular consumed large amounts (Table 20.2). The mean daily consumption of traditional beer was 2.7 cups per day.

REFERENCE

1. Nout M.J.R. Aspects of the Manufacture and Consumption of Kenyan Traditional Fermented Beverages. 1981.

TABLE 20.1
The number of 16-ounce cups of traditional beer consumed per week, and the number of bottles (equivalent to 500 mls) consumed per month, by the average lead man and woman (by cluster).

	Men			Women		
	N	Traditional (Cups)	Commercial (Bottles)	N	Traditional (Cups)	Commercial (Bottles)
Mean	223	18.7	6.5	239	0.2	0.0

TABLE 20.2
The number of traditional cups (16 ounce) and commercial bottles (500 ml) of beer consumed per day by lead men.

	Traditional		Commercial	
# Cups/Bottles Per Day	# Men	%	# Men	%
0-1	106	47.5	211	94.6
2-3	40	17.9	9	4.0
4-5	36	16.1	2	0.9
6-7	16	7.2	1	0.4
8-9	13	5.8	0	0.0
10-11	7	3.1	0	0.0
12-13	2	0.9	0	0.0
14-15	0	0.0	0	0.0
16-17	0	0.0	0	0.0
18-19	1	0.4	0	0.0
20-21	1	0.4	0	0.0
22-23	0	0.0	0	0.0
24-25	0	0.0	0	0.0
26-27	0	0.0	0	0.0
28-29	1	0.4	0	0.0
	223	99.7	223	99.9

Chapter 21

DROUGHT EXPERIENCES AND RESPONSES

This chapter describes the impact of the 1983-84 drought on the study population in Embu District and the responses to that drought by the community and by the Nutrition CRSP Project.

THE 1983-84 DROUGHT

The Embu study area is comprised of two agroclimatic zones: an upper zone (zone II) with altitudes of approximately 4000 to 5000 feet, and a lower zone (zone III) ranging between 4000 and 3000 feet. Rainfall varies with respect to altitude and aspect (exposure to moisture). Total annual rainfall for the area averages from between 500 to 1300 mm. There are two rainy seasons per year. The long rains fall during the months of March, April and May, while the short rains come during October, November and December with the heaviest rainfalls recorded during the months of April and November. Use of the terms "long" and "short" is a generalization as the length of the rainy seasons varies considerably. The agricultural year begins in October with some crops not harvested until after the March-May rains.

Unlike other districts in Eastern province, Embu District has generally been considered a high yield agricultural region not subject to serious drought or severe food shortages. In Table 21.1 Downing, Mungai and Mutri have calculated the probabilities of different levels of drought occurring in any given year based on observed drought over the past 76 years. These calculations rest on the assumption that the minimum amount of rainfall required for dryland agriculture is 300 mm per growing season. For the long rains these probabilities signify that a mild drought should occur every 2.8 years, a moderate drought every 4.5 years and a severe drought every 12.5 years. For the short rains the frequencies are 2.4 years for a mild drought, 3.4 years for a moderate drought and a severe drought could be expected every 5.6 years (1). A drought did occur in the study area in 1983-84. A failure of the short rains in 1983 and the long rains in 1984 resulted in very poor harvests of maize, beans and millet in the upper zone, and almost complete crop failure in the lower zone. It was reported that maize production nationwide was 50% below normal, and that wheat was nearly 70% below normal (2). Table 21.2 compares the seasonal averages over the last thirty years with the rainy seasons of 1984 and 1985. The worst yearly total for the long rains recorded during the period from 1951 to 1980 was 231 mm (1); the long rains of 1984 measured 283 mm. CRSP rainfall data collection was not started until January of 1984 and so there is no documentation of the failure of the 1983 short rains. While the rainfall for the month of April 1984, appears substantial, it should be noted that the bulk of this rain fell within a four-day period. Such concentrated rainfall is inadequate for agricultural production and, therefore, did little to alleviate the drought. Figure 21.1 shows monthly rainfall totals during the main study period.

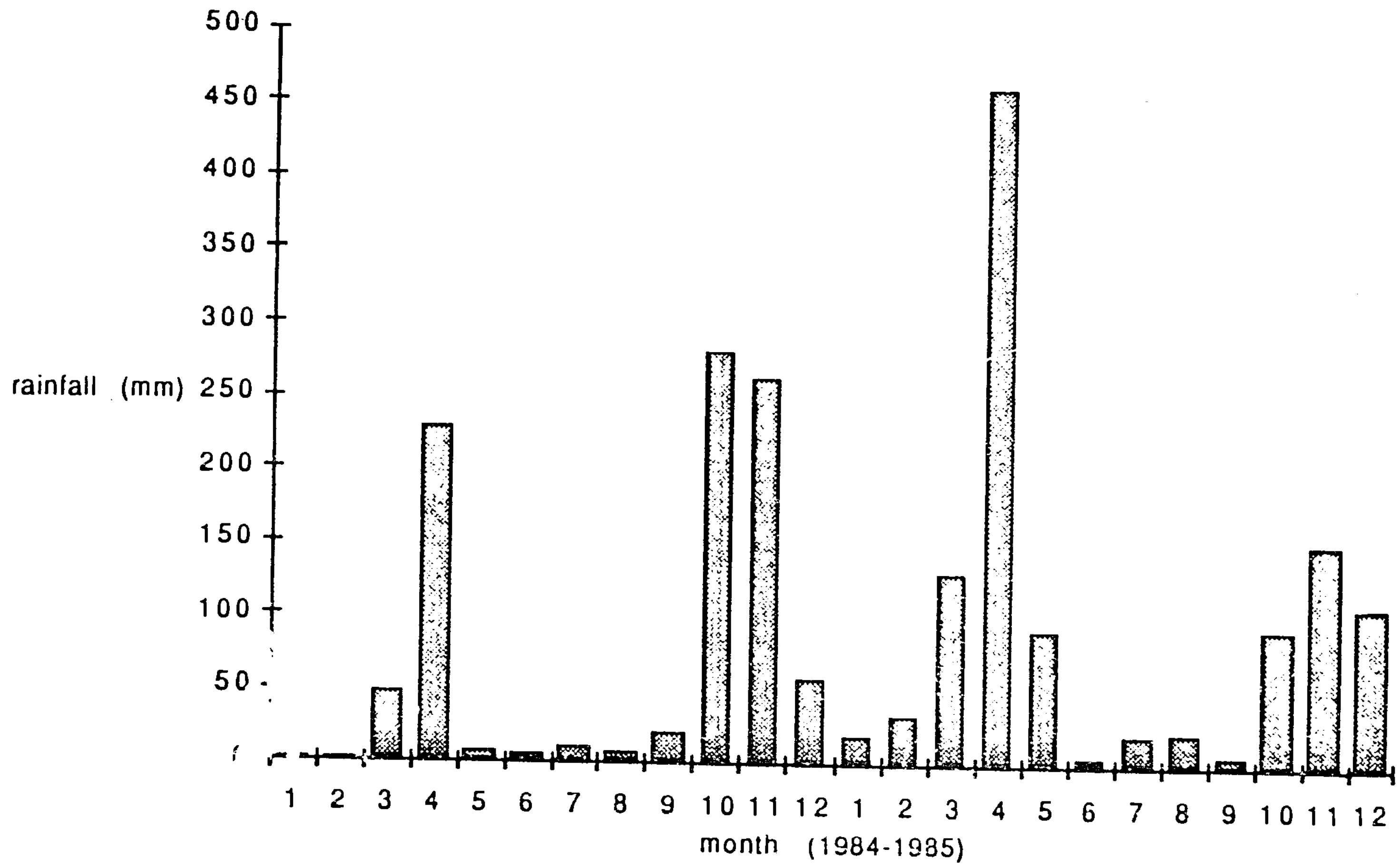


FIG. 21.1. Monthly rainfall totals for the study area during the main study period. (Data for January through June of 1984 were taken from the Embu Agricultural Research Station. The remaining data were collected by project staff; the totals presented here represent an average of all clusters).

TABLE 21.1

Annual drought probabilities for Embu District based on observed drought over the last 76 years.

	Level of Drought		
	Mild	Moderate	Severe
Long rains	.36	.22	.08
Short rains	.41	.29	.18

TABLE 21.2

Comparison of short rains and long rains during study period with averages over the thirty year period from 1951 to 1980.*

Rainy season	Year	Rainfall (mm)	Mean Rainfall (mm) 1951 - 1980†
Long rains	1984	283	549
Short rains	1984	603	401
Long rains	1985	683	549
Short rains	1985	356	401

* Rainfall data represent averages for the four clusters in the study area.

† Average rainfall for the entire District of Embu.

Drought does not necessarily translate into famine. Agricultural and economic systems (sharing food supplies within family networks, drought resistant crops, off-farm employment as well as production of cash crops) have been developed which enable families to overcome the effects of reduced rainfall. The problem occurs when these survival strategies cannot cope with the scale or duration of the food shortages. This was the situation in Embu during the 1984 drought. For various reasons families were not able to offset the impact of food shortages so that adverse effects on health and nutritional status resulted and external assistance became necessary.

IMPACT OF THE DROUGHT

The effects of the drought were felt throughout the study area. Even though the drought began in 1983, its full impact was not seen until mid-1984. Study data documented reduced food intake, lowered levels of nutritional status, and negative impact on pregnancy outcome.

Food Intake

Quantitative food intake information was obtained on each study household as well as target individuals within those households. Results for all study households reveals that from April through September 1984, there was an overall decline in household food intake (Figure 21.2). The lowest months for food intake were September, October and November of 1984. After the emergency food assistance program was, initiated food intake rose markedly. The type of food that was being consumed during this period also changed. Food intake enumerators noted that there was an increase in the consumption of wild plants and insects as well as in the purchase of more processed foods such as refined maize meal.

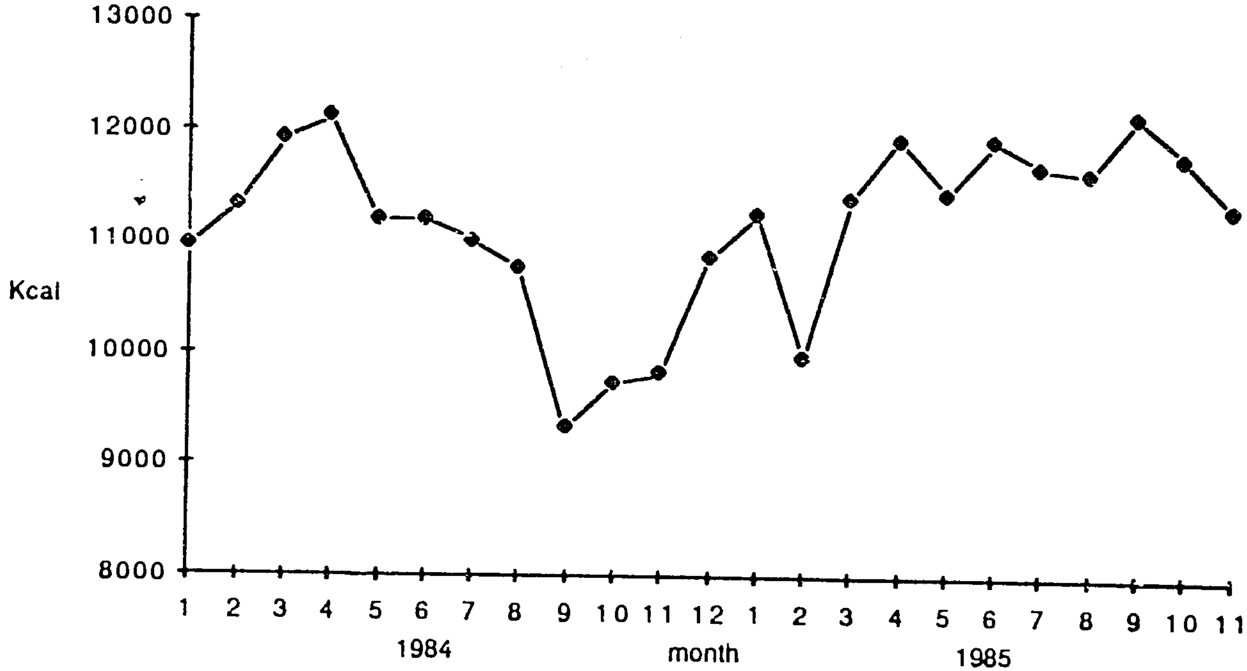


FIG. 21.2. Average daily household food intake for all households.

Figure 21.3 illustrates food intake by target individual. Lead adults and schoolers show a decline in intake during the famine months. While toddlers do not show the corresponding decrease, they do indicate a relatively flat period where food intake did not rise as would be expected for this relatively rapidly growing age group.

Based on anthropometry and food intake results the project staff estimated that approximately 30% of the study households were severely affected by the famine with another 30% moderately affected. The lower, more arid zones were hit the hardest by the drought. Starting in June of 1984, CRSP field staff reported that many households were without food and lacked the resources to obtain food. Stored food was usually non-existent within the household and there were no community stores or granaries. Some foods were available in local markets but prices had escalated and households did not have adequate purchasing power to buy this food. Green mangoes and papayas were being cooked and eaten when available. With alarming regularity, however, food intake enumerators reported little or no food being prepared on the days of their visits. Furthermore, it was the impresion of CRSP Activity Observation Teams that more adults and school age children were leaving home to "forage" and "scavenge" for food.

Nutritional Status

Most striking during the famine period was the shift from a prevalence of 2% severe PEM to 6% among children prior to the food relief program. In addition, obvious clinical cases of wasting, edema and other signs of Kwashiorkor were noted.

Adult males and females, as a group, showed considerable weight loss during the lean months. Figures 21.4 and 21.5 illustrate the decline in body weight suffered by lead males and non-pregnant, non-lactating lead females during October, November and December of 1984. Among school age children and toddlers, 65 to 70% did not gain any weight from August to December 1984, and 14 to 24% experienced weight loss during that time. Figure 21.6 shows changes in the average monthly weight for age for schoolers by percent of median. These scores show a dramatic decline in weight until November of 1984 when the famine was at its severest point. There were also increases in the level of stunting among schoolers during this period. Figure 21.7 indicates a change in height for age for schoolers that corresponds appropriately with the weight change seen previously.

The impact on toddlers was less a matter of severe weight losses than it was a situation of little to no growth. Figure 21.8 indicates an interrupted weight gain during the famine months, and Figure 21.9 shows very little increase in height over the period of measurement. Eleven toddlers received emergency treatment at the Mission Hospital rehabilitation unit. Further refinement of the data needs to be carried out to fully understand the impact of the famine on this group.

Pregnancy Outcome

Another manifestation of the declining food supply was the effect on pregnancy outcome. Analysis showed that women who were in their last trimester of pregnancy during the famine, as a group, demonstrated a decrease in pregnancy weight-gain and an increase in the percent of infants born with birth weights between 2501 and 2800 gms. Figure 21.10 shows weight-gain by timing of third trimester. The famine was hardest on those women experiencing their third trimester during the months of October to December, 1984. Weight-gain from the beginning of the third trimester to within 30 days of birth, and to within 15 days of birth both showed marked decreases from other cohorts. Figure 21.11 illustrates the percent of infants born with low birthweights (low birthweight is divided into two groups - those below 2500 gms and those between 2501 and 2800 gms). The percent of births below 2500 gms appears to remain relatively constant throughout the drought period. The 2501-2800 gm category, however, rose markedly during the famine months and then dropped off after this period.

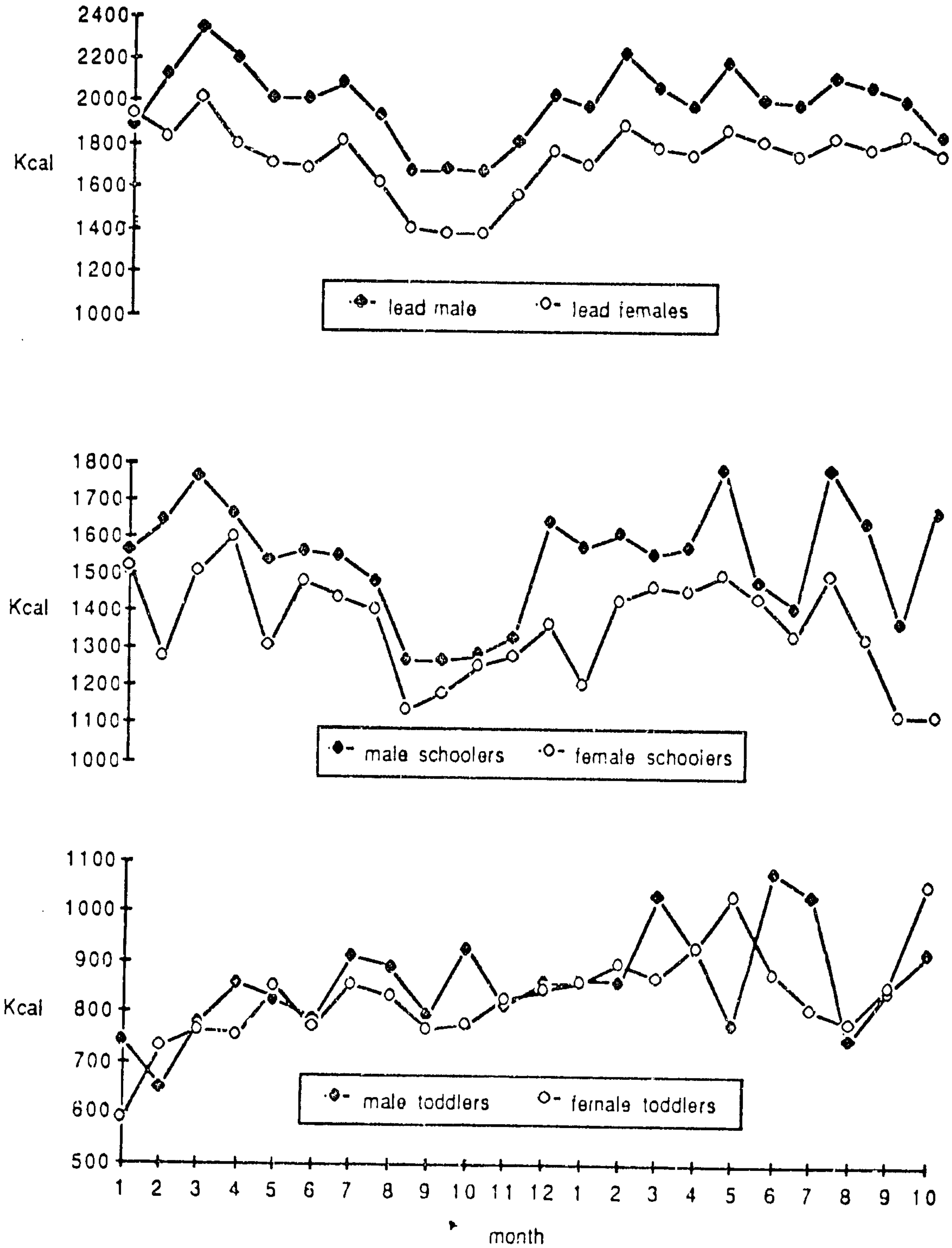


FIG. 21.3. Mean daily food intake by target individual by month for 1984-1985.

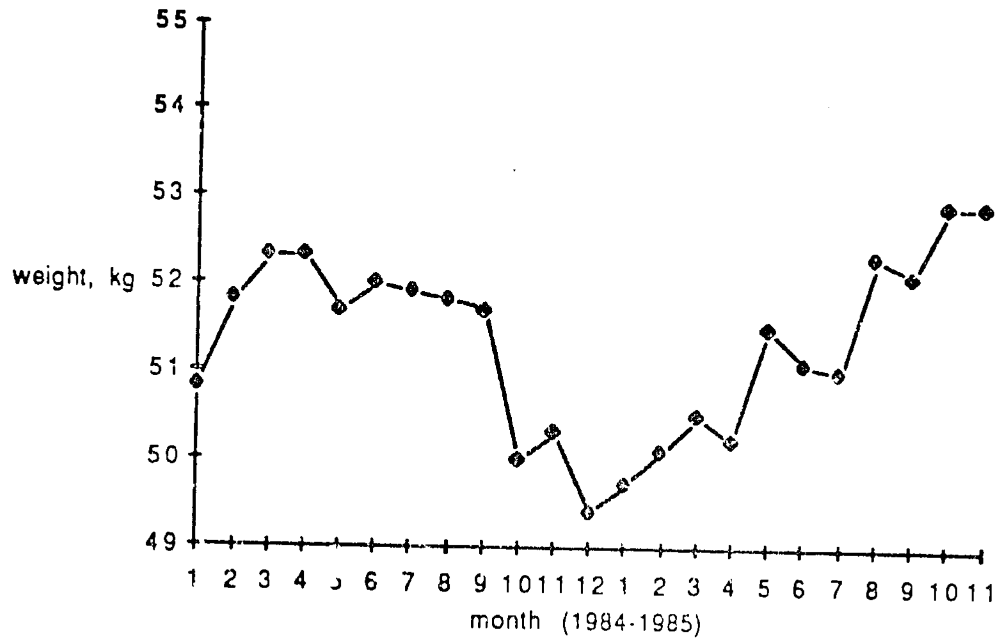


FIG. 21.4. Mean monthly body weight for non-pregnant, non-lactating lead females.

FIG. 21.5. Mean monthly body weight for lead males.

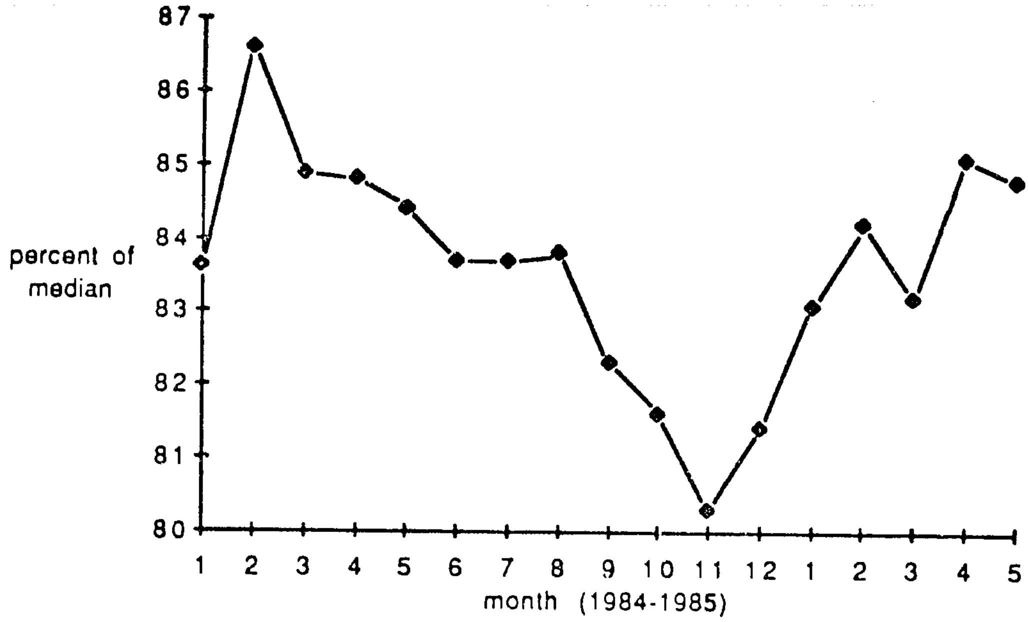


FIG. 21.6. Mean monthly weight for age for schoolers as percent of median.

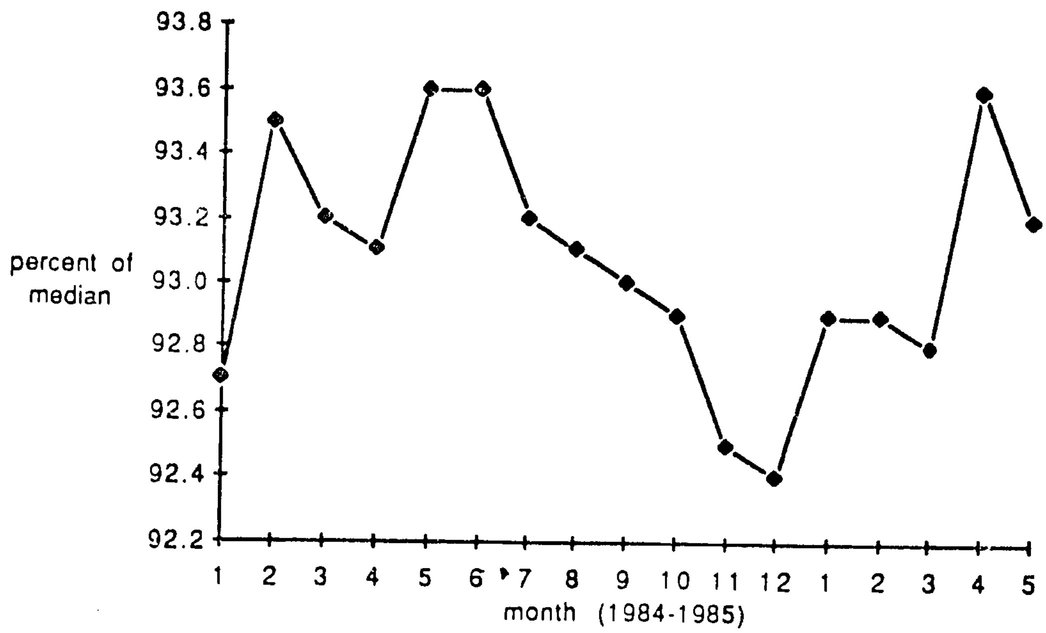


FIG. 21.7. Mean monthly height for age for schoolers as percent of median.

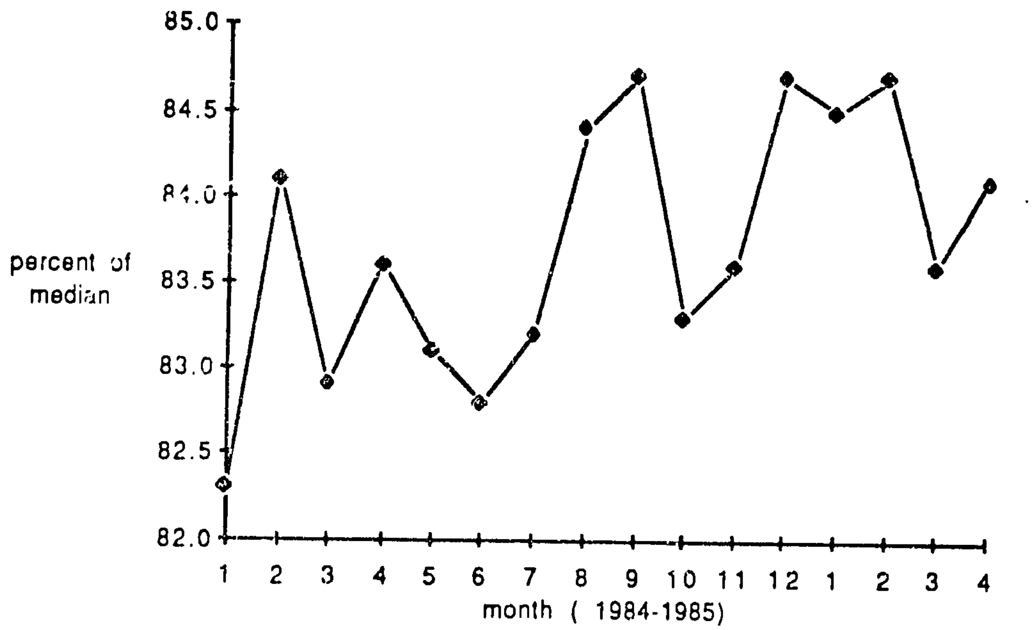


FIG. 21.8. Mean monthly weight for age for toddlers as percent of median.

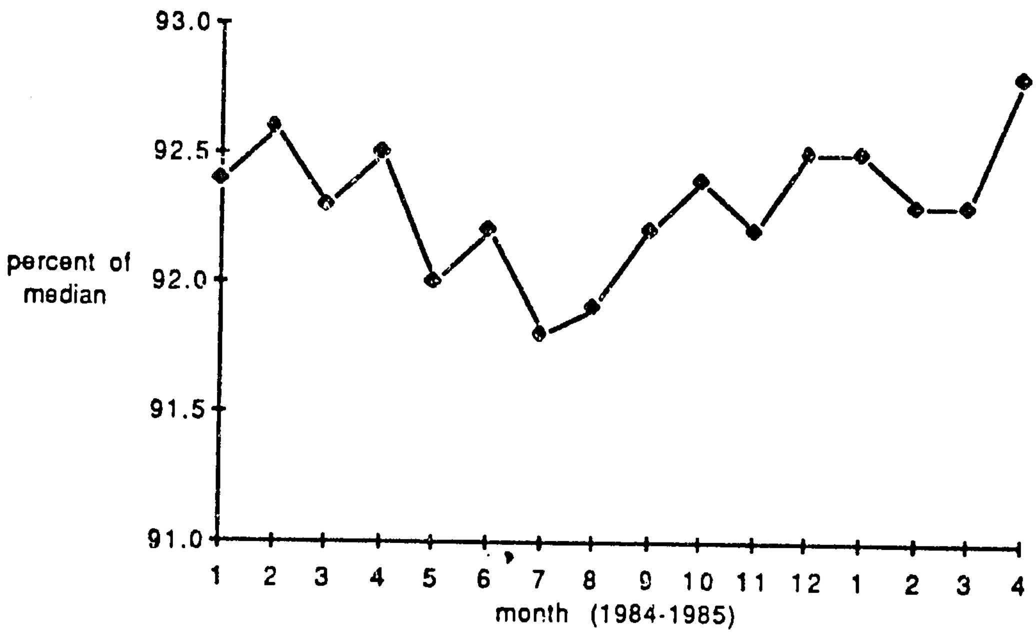


FIG. 21.9. Mean monthly height for age for toddlers as percent of median.

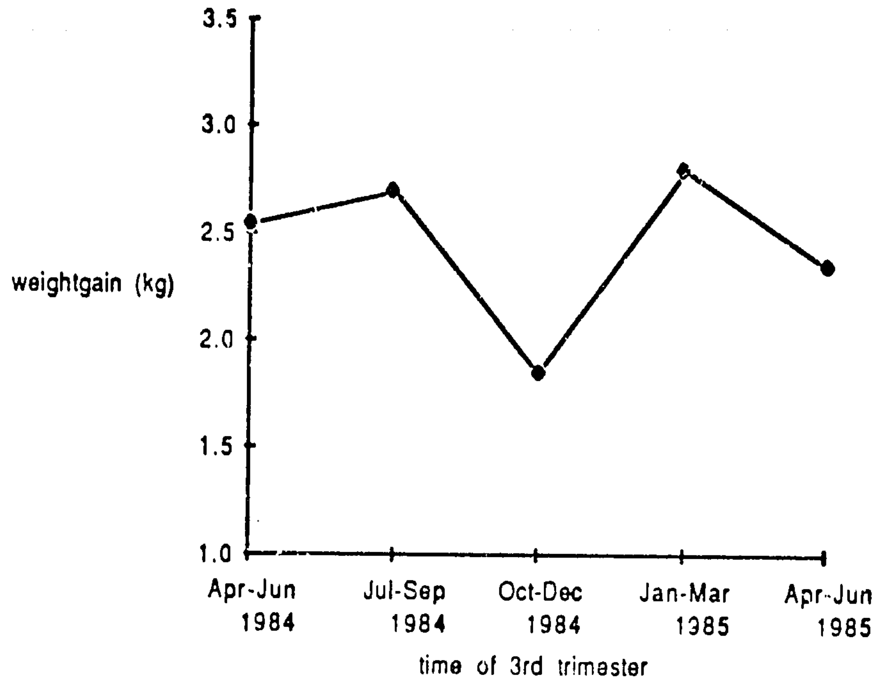


FIG. 21.10. Maternal weight gain from the beginning of the third trimester to 30 days before birth by timing of third trimester.

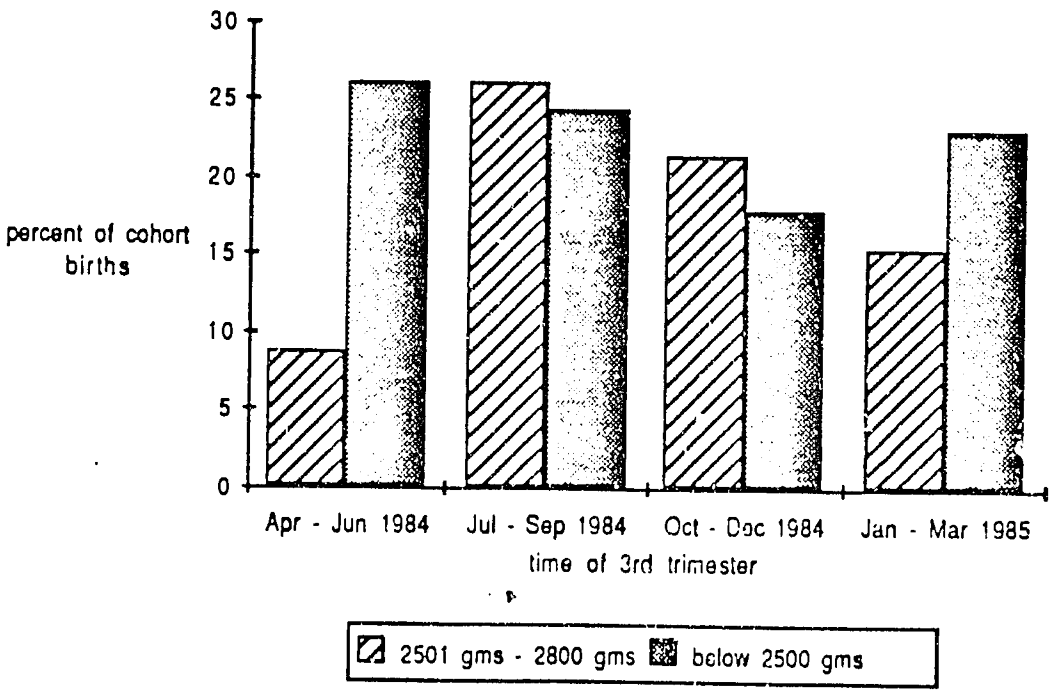


FIG. 21.11. Low birthweight babies as percent of cohort.

RESPONSE TO THE FAMINE

The first line of defense against famine lies within the household and the community. Coping strategies are adapted to try to reduce the adverse effects of the food shortages. After these strategies have been exhausted, it is necessary to involve outside groups to secure a stable and adequate food supply. In the case of Embu, the outside groups were primarily the Nutrition CRSP Project and the Kenyan Government.

Community and Household Response

The coping strategies which were employed by the individual households and the community were intended to reduce the immediate effects of the food shortage. These strategies, however, also carried negative longterm consequences which were often unavoidable given the serious situation in which families found themselves. The most frequent strategies employed during the Embu drought were:

1) Food sharing -- It was common for households to share food with other households while food was available in adequate quantities. As the supply of food decreased, however, the ability of sharing to have a substantial impact on food shortages declined. Families which had members integrated into the cash economy (through salaried employment or businesses) had access to still adequate but expensive food supplies. This group was small and could not provide enough food to alleviate the severe widespread shortages.

2) Foraging for food -- Family members would forage for whatever food supplies could be found in the area. Diets were supplemented with local plants, insects and rodents. This is a traditional response to famine in Kenya and elsewhere. The Kithioro famine in 1918 was imported into Embu from Gikuyu when the Agikuyu came foraging for food. They so depleted local food supplies that Embu was soon engulfed in famine (3).

3) Food reserves -- Very few families had stored food and, therefore, this option was not a central strategy for survival.

4) Purchase of food -- This was problematic due to the sporadic scarcity of various staple foods in the markets. At times, families were forced to purchase and consume more expensive, less nutritious processed foods (such as refined flour and bread) to supplement their diets. In addition, the cash necessary for purchasing food was not readily available. Since the purchase of food was often the only viable option, families were forced to seek cash through means such as:

   a. Selling animals (particularly goats) -- this had the immediate effect of flooding the market and lowering the prices as well as the long term effect of reducing the farmers stock.

   b. Employment -- this was not a very useful strategy given the scarcity of jobs and the fact that most farmers did not have marketable skills.

   c. Selling possessions -- this did not generate much income as most families had very little to sell. Some families reported selling tools or farm implements which had a negative long term impact as it reduced the farmers ability to grow food when more favorable climatic conditions returned. Furthermore, as with animals, the selling prices were low during this time and the farmer could not get a fair price for his possessions.

   d. Loans -- this was mainly an option only open to farmers who were members of organizations such as the coffee operatives. The greatest equity a farmer had was his land but few owned enough to support an adequate loan. Loans could place the farmer in long term difficulty if future yields were not large enough to cover repayment.

e. Other income generating activities -- this included the production of baskets, sisal rope and some carpentry work. These activities, however, were also subject to the depressed economy of the area and their impact was marginal.

5) Other sources of food -- the primary alternative source of food was to eat the seed that was to be used for bean and maize planting when the rains returned. While this was useful in addressing the immediate problem, it carried the danger of prolonging the hardship period. When the rains did come there was insufficient seed to plant full crops. This was further compounded by the fact that in many cases, cash reserves had been used to buy food and were not available to replace the seed.

Nutrition CRSP Project Famine Assistance

For humanitarian and ethical reasons the Nutrition CRSP Project entered into famine relief efforts to offset the impact of the severe food shortages in the area. These efforts were channeled through local community Famine Relief Committees formed throughout the drought-stricken areas by the Office of the President, Government of Kenya (GOK). Due to its close scrutiny of the situation, its interaction with the local community, its ability to obtain the necessary food commodities through personal contacts with the World Food Program, UNICEF, the Netherlands Embassy and various relief organizations, the Nutrition CRSP Project was able to obtain maize and other food aid with a relatively short lag time. The rapid response time of the project in mobilizing food assistance was a critical factor in assuring that the impact of the drought was no more severe than it was.

In planning the famine assistance program, the project was particularly concerned to see assistance go to those who were in greatest need. Local Famine Relief Committees as well as Chiefs and Subchiefs identified families at greatest risk in their areas. Their criteria included household size, land productivity, and the economic situation of the household. The Nutrition CRSP Project examined research data on food intake and nutritional assessment and also prepared a list of households that appeared to be in greatest need. The listing prepared by the community leaders coincided by 60% with that of the CRSP Project. All households identified by the community groups and the Nutrition CRSP Project were included in the food distribution program. In addition, all households which were under study by CRSP were automatically included in the famine relief efforts.

Distribution Activities

Famine relief commenced on September 15, 1984. Nine different locations were selected as Famine Relief Distribution Centers. These included the project field offices in each of the four clusters and sites in the markets of Kathanjure, Kinthithe, Kathanguri, Karurumo and at special sites in Kasafari and Kigumo (areas which were assisted but were not part of the CRSP study area). The distribution centers were supervised by senior project personnel and staffed by project field workers and community volunteers. Recorders called off the names of the recipients from a registration list to come forward as other assistants weighed and distributed the rations. All recipients were required to sign the list or leave a thumb print. Initially maize was distributed to 277 study households and 869 non-study households. Each household received a ration of 12-16 kilograms of maize at the first distribution.

The date of the second distribution was October 9, 1984. Since total supplies of maize were of limited quantity, rations were allocated according to the total number of persons per household. Households with two or less persons received 5 kg; households with three to six persons received 10 kg; and households with over six persons received 15 kg of maize. In late October the maize rations were increased slightly for all households. By this time, 1,269 households were receiving allocations.

In December of 1984 plans were made to continue famine relief through February of 1985. An anthropometric screening of non-CRSP households in Kyeni-South Location and in contiguous sublocations in the drier areas was held in order to identify additional families with malnourished children to be registered for famine relief. All children under 10 years of age were screened (see Table 22.3). Households were selected for assistance if one or more of the children were at least moderately wasted and/or severely stunted (- 1 SD wt/ht and/or -2 SD ht/age).

TABLE 21.3
Anthropometric screening of non-CRSP households (children under 10 years of age) for possible inclusion in the famine relief program. [Number/(percent)]

Sub-location	Severe Malnutrition wt/ht ≤ -2SD	Moderate Malnutrition wt/ht ≤ - 1SD	Severe Stunting ht/ag ≤ - 3SD	Total Screened
Kigumo	94 (17.2)	--	192 (53.0)	548
Kasafari	7 (8.0)	33 (37.9)	31 (35.6)	87
Karaumu	18 (6.8)	86 (32.7)	111 (42.2)	263
Kathanguri	43 (14.6)	118 (40.1)	105 (35.7)	294

Because of the limited nutritional value of maize and because a large number of households were totally dependent on relief for all food supplies, beans, dehydrated skim milk and oil were added to the maize rations. These goods were usually purchased locally (with funds coming from UNICEF and the Dutch Embassy) at very high prices with only a small amount being donated. Rations of each of these items were distributed just prior to Christmas and at 2-3 week intervals through February 1985. During this phase of the distribution effort 1,538 households were receiving allocations.

Estimate of Household Rations and Seed Allocations

The two primary objectives of the famine relief effort were to provide households with emergency subsistence rations and seeds for planting. The target of the food relief program was to provide an average of 1,500 kcals per person per day or about 50 kgs of maize per household per month. The main assumptions were that little else other than relief food would be available; the situation would continue for at least six months; the distribution of food within the household would most likely not be equitable; and that even this ration could probably not supply a nutritionally adequate level of energy intake. To meet this intake objective for the Embu area required about 340 tons of maize over a six month period. As it turned out, in spite of the tremendous efforts by all those involved, CRSP allocations averaged less than the desired 50 kg per household per month.

The second aspect of the relief effort was the distribution of seeds for planting when the rains returned in October of 1984. It was observed that seeds had been eaten during the drought and replacement seeds in the local markets were prohibitively expensive or not available. Therefore, to allow families to produce their own food supplies, it was critical that seed replenishment be included in the relief program.

The Nutrition CRSP project requested seed from BARAC (Black Americans in Response to African Crisis) and World Vision. Bean seeds for planting were obtained and distributed with households receiving 6-10 kg each. A total of 1,260 households received seeds just as the long rains started in March, 1985. An additional shipment of Katumani hybrid maize and bean seed was received from World Vision in 1985, 2,000 kgs of maize were distributed in March of 1985 and 5,000 kgs of bean seed were distributed in October of 1985.

The CRSP famine relief program came to a close in March of 1985. By that time the rains had returned and Embu households were again becoming self-sufficient in their food production capacity. Between September of 1984 and March of 1985 the assistance program had distributed food relief totaling 193,524 kgs (213 tons) of maize, 35,946 kgs (39.5 tons) of beans, 4,092 liters of oil and 5,696 kgs (6.3 tons) of dehydrated skim milk. In addition the program distributed 5,000 kgs (5.5 tons) of maize seed and 15,900 kgs (17.5 tons) of bean seed for planting.

Rehabilitation Unit

In addition to the food and seed relief activities, a low cost, temporary rehabilitation unit was set up at the Mission Hospital in Kyeni to treat children suffering from severe protein energy malnutrition (both Kwashiorkor and Marasmus). A large tent was erected with sufficient space to house 30 mothers and their children. Mothers carried out the feeding and care of their children under the supervision of the physician and nurses. The hospital, with the aid of food relief, was able to serve three nutritious meals per day for the children and mothers. The average stay of a child was about three weeks.

LESSONS LEARNED

The Embu drought of 1983-84 demonstrated the need to better understand the nature of such events and the full impact of the various responses to them. From the experiences and observations of the Nutrition CRSP Project some valuable lessons have been learned. These include:

1) The need for household and community food storage facilities and practices.

2) The need for shifts in agricultural practices to increase the number and quantity of drought resistant crops and varieties grown (e.g. millet and sorghum) as well as the willingness and ability of farmers to switch to "famine crops" (e.g. cassava) during a period of food shortages.

3) The need for household and community seedbanks.

4) Increased income generation, cash availability or credit schemes to allow farmers to purchase food and seed during emergencies.

5) The ability of the central government to move food produced in one area to areas where food is in short supply.

6) A simple but valid information gathering system which can monitor community markets, household food supply and availability, crop yields, rainfall, and nutritional status in order to act as an "early warning system" for potential food problems.

7) Water schemes to protect the farmers against complete reliance on rainfall for their crops.

The major lesson learned from the experience of the drought was that farmers such as those in Embu are highly vulnerable to environmental fluctuations. The existing infrastructure needs to be strengthened in order to insulate communities from the ravages of famine. The experience of the Nutrition CRSP Project highlighted the need to develop preventive interventions that would provide positive avenues for dealing with the sudden climatic changes that induce critical food shortages.

IMPACT OF THE FAMINE ON THE RESEARCH DESIGN

The drought and subsequent famine which affected the study area was totally unanticipated. The Nutrition CRSP Project was obligated to grant assistance in the form of food relief and seeds, but this assistance raised questions about its impact on the research findings. Since food intake was coded according to source (purchased, home grown or gift) it is possible to document from where families were receiving their food. A more significant problem was documenting the pattern of food consumption during the month. The famine caused food consumption to be sporadic and given that food intake was determined on only two days of measurement per month there was the possibility of misrepresenting the severity of the famine. This produced a picket fence picture where the family either ate nothing on out of the two days of measurement or they ate more than usual due to the sudden availability of food.

Other potential problems caused by the famine were changes in diet such as a shift to more processed foods which could still be bought in the market and more wild foods being eaten. In addition, the normal pattern of activities was disrupted with adults and children spending more time looking for food. These factors need to be taken into account when the data produced by this study are analyzed. In some ways the food shortage period offers the opportunity to explore more aspects of moderate to severe nutrition that the original study design envisioned. In view of this, additional data were collected on the response to famine. Form 663 (Drought questionnaire) was developed to enable further analysis of the event. Follow-up studies have also been proposed to shed more light on the impact of the famine.

REFERENCES

1. Downing T.E., Mungai D.N., Muturi H.R. Drought Climatology of Central and Eastern Kenya, published in Climatic Variability and Agricultural Production in Central and Eastern Kenya, Nairobi, National Environment Secretariat, Ministry of Environment and Natural Resources, 1985.

2. Cohen John M., Lewis David B. Role of government in combatting food shortages: lessons from Kenya 1984-85, published in Drought and Hunger in Africa, edited by Michael H. Glantz, Cambridge, Cambridge University Press, 1987; 269-296.

3. Mwaniki H.S.K. The Living History of Embu and Mbeere, Nairobi, East African Literature Bureau, 1975.

Chapter 22

DATA MANAGEMENT

This chapter briefly reviews the procedures employed to manage the large amounts of data generated by the Nutrition CRSP Project. These procedures include the collection of data, entry of data onto computer tapes in Kenya, error correction, and the final handling of the data at UCLA in preparation for analysis.

DATA CAPTURE

The basic instruments for data collection were the data collection forms. Forms were developed to record particular data topics. They were designed to be "user friendly" so as to facilitate their use by field data collectors. The forms were conducive to fast and accurate computer entry, collected information in manageable record lengths and presented a consistent approach to "missing" and "not applicable" data codes. All forms started with a common 21 character heading in which the form number, visit number, country code, household number, target individual number, date, enumerator number and status were recorded. This allowed for easy and consistent identification of important characteristics throughout the entire data set. Most forms were the same size and had a colored carbon copy (carbons were burned after use to maintain confidentiality).

To the extent possible, forms were designed to be "computer-ready," thus minimizing copying errors and misinterpretations of observations. The forms were primarily self-coding; little field office coding was required as observations were directly recorded on the forms or were recorded on a "menu" (e.g. type of delivery of last child). This type of common data collection to key entry form was not feasible for some data topics such as food intake and morbidity which required detailed codes to be assigned (e.g. modified USDA indexes of food codes and the morbidity diagnostic coding). This coding was done by specially trained personnel and supervised by senior staff members.

Central to the data collection process was the identification system. Each household was assigned a unique four-digit number. The first digit of the number designated the cluster and the subsequent three digits specified the household. Each individual within a household was given a unique two-digit number (see Chapter 5). This system allowed for entry of data by cluster, household and/or individual.

DATA FLOW, TRACKING AND COMPUTER ENTRY IN KENYA

The design of the project called for as much data management and data entry as possible to be done in Kenya and given the large amount of data collected by the Nutrition CRSP Project, there was a clear need for reliable support systems. The reasons for this were 1) the responsibility of the project to train Kenyans in the procedures of data management, and 2) the feeling that data error correction could best be handled at the site of the study. In view of these factors it was decided that Kenyan data management activities had to include at least key entry onto computer tape, computer range checking and error correction capabilities.

Various data management facilities were explored to identify which one best met the needs of the project. The University of Nairobi computer facility at Chiromo Campus offered the use of its ICL British Mainframe. However, after further investigation it was discovered that this computer could not produce IBM readable tapes. Since UCLA and Berkeley were both committed to IBM compatibility, the University of Nairobi option had to be dropped and the private sector enlisted. After the first company selected could not handle the volume of data to be processed, agreement was reached with Comprite to supply all data entry services for the balance of the study.

In the field, completed forms were turned into each of the four cluster offices where the date, visit number, household number, target individual number, number of pages and number of records for each form was logged. These logs established an important part of the data flow process since they were used to verify that all the scheduled visits had been made. The form-log was also used as a tracking instrument for the forms as it remained attached to the forms until they were ready for permanent storage.

Completed forms were transferred daily from the cluster offices to the Data Management Office in Embu. The data management staff checked all forms for obvious errors, completeness and proper logging. If any discrepancies were found the forms were returned to the field where the appropriate supervisor and enumerator tried to find the source of the error. If the source of error could not be identified or the correct value determined, the variable in question was coded as "missing data".

Originals of the forms were sent to Comprite once a week. Forms were grouped into batches by form number and cluster which made it possible for Data Management and Comprite to keep track of all forms. To further facilitate data tracking, each weekly delivery was also assigned a title depending on the tape number (magnetic tapes were produced once a month) and the week number. For example, the first delivery of the first month was assigned the title of "tape 1 week 1" and the second delivery for that month was titled "tape 1 week 2". When Comprite received a weekly delivery, a representative counted each batch of forms to verify the totals.

After data had been entered onto tape, entries verified 100% and corrections made, all forms were returned to the Embu office. The original forms were filed by household number in folders and after checking the duplicate copies to be sure that they contained all the corrections that were on the originals, they were stored in batches. Near the end of the project one complete set of data forms was sent to UCLA where the final data editing was conducted and the copies were sent to the University of Nairobi. Each month two identical tapes were made. One was sent to UCLA and the other was stored in Embu until the conclusion of the study at which time all tapes were given to the University of Nairobi. The tapes at the University of Nairobi will be replaced by the final "clean" data tapes upon completion of the project.

ERROR CORRECTION IN KENYA

Comp-rite developed a "checklist" program to list the record reference by tape number, week number, batch number, page number and expected number of records for that page. This program generated comments whenever records were not verified, page numbers were missing or the number of records entered and verified did not tally with the expected number. The on-line data entry program flagged any records that were not verified. These would not be edited nor entered onto tape until they were verified, thus insuring 100% verification. After the information from the checklist was reconciled, an input edit program was run to produce an Error Report and a batch summary which was used as a counter check to the batch log.

Correction lists were printed out and sent back to the Embu Data Manager within one week from detection after data entry. The error lists were examined by the data manager who consulted with the appropriate senior field staff so that appropriate error detection and possible correction could be attempted.

Primary Error Detection

Error detection started initially when the function supervisors checked the forms brought in by the cluster office. Supervisors were responsible for all errors on the forms and had to sign off on a form when it was checked. More checking was done when the forms were received in the Embu office by the data management personnel. When errors were detected the forms were returned to the field the following day for correction.

Secondary Detection - Range Checks

Secondary detection was carried out by an input edit after data entry and verification was completed. Prior to the entry of data, a list of the variables on each form, their column location and allowable ranges were submitted to the computer service. The allowable ranges were determined by the principal investigators and set to eliminate suspect values that exceeded reasonable limits. Any record that was found to have one or more errors (values out of range) was printed out and the columns that contained the errors specified. The data management personnel then pulled all forms which contained errors, circled the error and sent them back to the appropriate field supervisor for the source of the error and possible correction.

Corrections were then sent to the computer service (either the forms or the output with the corrections written in red) where they were entered and verified. An input edit program was run again for further verification. After the corrections had been entered and verified the data was entered onto the magnetic tapes.

Post-Tape Error Detection

Errors detected after data had been transferred to tape were listed and circulated to UCLA and Embu on a form specifying the record and the correction. These errors were detected at the Embu office, by UCLA investigators in Los Angeles and by the Management Entity data management group in Berkeley.

DATA MANAGEMENT PERSONNEL

The data management group grew from one person to 23 people at the height of the project in late 1984 and early 1985. The Data Manager in Embu was a Kenyan staff member with a Bachelor of Science degree in mathematics from the University of Nairobi. She was supported by an Assistant Data Manager who had a Master of Public Health degree. The balance of the data management staff was composed of data assistants, processors and calculators.

PROCESSING OF DATA TAPES AT UCLA

A total of 28 magnetic tapes were received from Kenya during the period of July 1984 to July 1986. Upon arrival at UCLA, the contents of each tape were recorded in the Data Management Log Book. The tapes contained what material was available for shipping at the time. Thus, a tape could contain data from any of the various functions. To the extent possible the tapes were organized by form number so as to simplify the computer procedures needed to make the tape ready for analysis.

The tapes were uploaded onto disks on the IBM 3090 MVS/XA System Computer at the UCLA Office of Academic Computing (OAC). Records were sorted by form number and placed in data files according to form number. Table 22.1 lists the data files that have been created as of August, 1986 and their respective sizes. Conceptually, the files were organized by household, by date of collection and, where appropriate, by target individual. For example, anthropometry files were ordered as: household A, date 1, lead female [data], toddler [data]; date 2, lead female [data], toddler [data], etc. For reproductive interval history, however, all information would be on the same lead female, so that file would be ordered as: household A, lead female, date 1 [data], date 2 [data], etc. For SES all information would be on the household only, so the order would be: household A, date 1 [data], date 2 [data], etc. For convenience some files were further separated by target individual. It should be stressed that this is a conceptual description of the files. The computer disk file may be physically organized in a totally different configuration.

TABLE 22.1
Cross reference of Kenya files to basic files.

Basic File	Form Number	Kenya File Name	Number of Records
Entry/exit/change	611	Entry/exit/change	1130
Mortality	331	Mortality notification	4
Household Intake	114	Meal prep. summary	38845
	115	Consumer unit	@34000
	122	Recipe nutrients	38845
	121	Household nutrients	--
individual intake	116	TI/non-TI summary	26675
	119	Individual Nutr. (hand calc)	6074
	120	Individual nutrients	--
Supplemental feeding	421	Supplemental Feeding	--
Anthropometry - target	211	Anthropometry	20082
- non-target	211	Anthropometry	--
Metabolic adaptation	711	RMR	4712
Disabilities/chronic disease	301	Disability/chronic disease	727
Reproductive history	411	Reproductive history	288
Physical assessment	---	Physical exam	1996
	323	Clinical exam, summary	344
Pregnancy outcome	413	Pregnancy outcome	138
Pregnancy survey	412	Pregnancy survey	5857
Lactation/infant feeding	421	Lactation questionnaire	879
Lab assessment/immunology	341	Lab/physiology samples	2136
Immunology/water contam.	342	Immunology/water contamination	1025
Morbidity episodes	313	Morbidity-indiv 4 week	5788
	314	Morbidity-indiv 4 week	8764
	315	Morbidity-HH 4 week	8970
Adult cognitive	541	Cognitive adult summary	674
Infant cognitive	511	Cognitive infant summary	312
Toddler cognitive	521	Cognitive toddler summary	315
	523	Cognitive toddler-30 mo.	230
Schooler cognitive	531	Cognitive schooler summary	462
Infant behavior	512	Infant interaction	6406
	513	Infant behavior	131
Toddler behavior	522	Toddler interaction	9933
Schooler behavior	532	Schooler classroom observation	494
	533	Schooler playground	1516
	534	School attendance/performance	211

Continued.

TABLE 22.1 continued

Basic File	Form Number	Kenya File Name	Number of Records
HH sanitation/hygiene	621	Sanitation/hygiene questionnaire	1305
	622	Sanitation/hygiene observations	424
Demography	612	Census update	11505
Household SES	631	SES	1402
Community climate	651	Weather data	566
Childcare/sanitation, LF	641	Care-giving activities	32471
Time allocation	661	Time allocation	13978
Adult literacy	542	Adult literacy test	524
Agriculture CR	671	Agricultural crop questionnaire	6963
Market survey	681	Market survey summary	131
Alcohol/depression	951	Depression/alcohol questionnaire	499
		Total Records	297731

DATA CORRECTION AT UCLA

Complete frequency distributions were done for each variable on each form to identify errors, missing data and outliers. Questionable values were checked against the field data forms to ensure accuracy. "Missing data" codes were made uniform for all forms and errors and outliers that could not be corrected were coded as "missing data" for all analysis purposes. Also, logic and range checks were run on the data files, especially those involving similar measurements over time. The ranges used during this stage of the data correction were the same ones used to check the data in Kenya. Results of these runs were sent back to Kenya for checking. Visual inspection of outputs became an important method for error detection. Files were then modified as needed. Problems encountered were 1) duplication of input (two records of the same form for the same individual); 2) values within range but unlikely because of previous or succeeding values (e.g. a toddler's height within range but decreasing over a single time interval); and, 3) logical inconsistencies across forms or across time. Due to the excellent work of the Kenyan data management staff and the field workers who knew their study participants, very few problems were encountered. Special computer runs were also made to identify possible missing forms. When missing forms could not be explained queries were sent to Kenya.

Occasionally, as variables were transferred to working data files, errors in the data were discovered. Any changes were made on the working files and the form specific data files. Occasionally, it was not possible to reconcile the differences in two data sources, so no change was made. In these cases the individual record was used as is or was deleted depending on the specific analysis. It should be recognized that these discoveries of problems with data will continue in any reasonably complex data set. A variable may pass range checks, logical checks and time checks, but be called into question when viewed in some different context, when displayed in a distribution, or when compared with some new information.

PREPARATION OF ANALYTIC FILES

After the transfer of data to form specific disk data sets, special combinations of these data were pulled together into temporary working files. Thus, information about height and weight, number of siblings, SES scores, days of school attendance and food intake for schoolers might be combined on a single disk file and used in analysis. Variable modification and creation were performed on these working files. If a variable was to be retained it would be transferred back only after checking and preliminary use. Most working variables were not transferred back as they could be easily recreated from the original variables.

ARCHIVING OF DATA

After all data tapes were received and data files established for each form number, the files were transferred onto magnetic tapes and archived onto the UCLA Office of Academic computing archive list. When data tapes arrived from Kenya a UCLA programmer made a duplicate of the tape and sent it to Management Entity at Berkeley. Additional data (such as laboratory results for nutrition contents and physiologic sample examinations) were also sent to Management Entity as soon as the data were received at UCLA. Data sent to Berkeley included the form specific data tapes described above.

Chapter 23

THE EFFECTS OF MATERNAL FOOD INTAKE ON PREGNANCY OUTCOME AND INFANT GROWTH

The major research questions addressed in this chapter are: Does maternal food intake during pregnancy affect pregnancy outcome, and does maternal food intake during lactation affect changes in infant size from 0-6 months? The specific questions investigated include:

1. Does food intake affect pregnancy weight gain?
2. Does food intake affect birth weight and other parameters of the infant's endowent at birth?
3. Does food intake during pregnancy and lactation affect the growth of the infant in the first six months of life?

Related questions of the effects of maternal intake on infant morbidity and cognitive development will be addressed at a future time.

The first major section of this chapter reviews the descriptive findings of the major variables used in the analysis of the effects of maternal food intake on pregnancy outcome and infant growth. The second section, "Analytical Approach," describes the multiple regression correlation approach used for the analyses. Analyses of "Maternal Intake and Pregnancy Outcome" and "Maternal Intake on Lactation" are presented in the third and fourth sections, respectively. Finally, the last section summarizes the major findings. The preliminary analyses presented here are considered a basis for more complicated statistical analyses and modeling to be carried out in the future.

REVIEW OF DESCRIPTIVE FINDINGS OF THE MAJOR VARIABLES USED IN ANALYSIS

Ideally, lead females who delivered during the study should have been monitored from the pre-pregnancy state through lactation. Pre-pregnancy data are available, however, for 83 of 138 women, or 60% of the sample. Only one of these 83 women was lactating within three months prior to becoming pregnant. A total of 97 women were followed during all three trimesters, 119 were followed during their second and third trimesters, and 19 women were followed only during the third trimester. There were two stillbirths, three perinatal deaths, and three miscarriages, leaving 130 infants to be followed during lactation. The descriptive data are based on cross-sectional analyses at different periods. Longitudinal analyses will be performed in the future.

Food Intake

Energy intake per day during pregnancy is reported by trimester (based upon the average of two days of intake per month) (see Table 23.1). In general, pre-pregnancy intakes were higher than those during pregnancy (possibly due to morning sickness), and intake gradually decreased from the first to the third trimester, especially during the last two weeks of pregnancy. Energy intake then increased by approximately 25% in the first month of lactation. Kcal and protein intakes were below the most recent FAO and USDA recommended daily allowances (1, 2).

TABLE 23.1
Food intake: mean daily pre-pregnancy and pregnancy, kcal, protein, fat, and carbohydrate intake.*

	Pre-Preg. n = 40	Trim. 1 n = 80	Trim. 2 n = 108	Trim. 3 n = 117
KCAL/d	1851 ± 587 (657 - 3079)	1590 ± 492 (359 - 2775)	1482 ± 492 (398 - 2909)	1351 ± 475 (220 - 2504)
KCAL/kg/d	37.9 ± 12.4 (11.7 - 73.8)	32.2 ± 10.0 (6.8 - 50.4)	28.3 ± 9.1 (8.7 - 57.5)	24.6 ± 8.5 (4.2 - 47.3)
PROT(g)	56.3 ± 23.1 (20.3 - 112.6)	45.9 ± 17.3 (8.9 - 88.0)	41.6 ± 15. (9.4 - 89.4)	37.9 ± 15.4 (4.5 - 80.0)
PROT/kg/d	1.2 ± 0.5 (.4 - 2.0)	0.9 ± .4 (0.2 - 1.9)	0.8 ± 0.3 (0.2 - 1.6)	0.7 ± 0.3 (0.1 - 1.3)
FAT(g)	27.8 ± 10.5 (9.1 - 56.8)	22.7 ± 9.2 (5.8 - 63.6)	23.0 ± 10.7 (5.2 - 72.2)	20.0 ± 8.6 (4.5 - 50.8)
CARB(g)	370.0 ± [illegible] (143.3 - 636.5)	321.4 ± 100.2 (71.5 - 600.8)	293.8 ± 96.8 (75.5 - 574.0)	270.0 ± 97.4 (42.4 - 523.5)
TOTKCAL (period of entire pregnancy)		398,665 ± 107,081	(163,254 - 672,672)	
TOTKCAL2 (2nd and 3rd trimesters)		260,338 ± 80,124	(79,605 - 478,119)	

* Cross-sectional data

The decline in food intake during pregnancy may well reflect an extreme seasonal effect, as about half of the pregnancies occurred during the severe drought (see below.) The possibility that the two days of measured intake were biased towards days immediately prior to women going into labor was found not to be the case. A Chi-Square analysis of those delivering within seven days prior to versus more than seven days prior to the day of food intake data collection, and the reported intake (less than 1000 versus greater than 1000 Kcal), indicated no significant differences. A high percent of women reported "morning sickness" not only in early pregnancy, but also in the 8th and 9th months.

The mean total Kcal (TOTKCAL) intakes during the period of entire pregnancy and during the 2nd and 3rd trimesters were 398,665 and 260,338 Kcal, respectively (these values are about 65% of widely quoted recommended intakes). Thus, rather than energy intake increasing in pregnancy, a decrease occurred as pregnancy progressed. The mean daily energy intake during all of pregnancy was 1477 Kcal. This is about 600 Kcal less per day than that recommended by FAO and USDA (1, 2), or 170,000 Kcal less for the entire pregnancy.

The mean daily Kcal intake during the first six months of lactation returned to pre-pregnancy levels (between 1771 and 1830 Kcal/day) (see Table 23.2). Few women took supplemental vitamins or minerals during pregnancy; iron was mentioned most often as having been taken (by 5% of women). Whether these women were anemic or not will have to be determined. Vitamins and minerals were not taken at all during lactation.

TABLE 23.2
Food intake: mean daily kcal, protein, fat, and carbohydrate intake during lactation.

	Lactation 1 (0-45d) n = 118	Lactation 2 (46-135d) n = 124	Lactation 3 (136-180d) n = 122
KCAL/d	1830 ± 729 (574 - 3701)	1791 ± 488 (448 - 3136)	1771 ± 529 (515 - 3461)
KCAL/kg/d	35.5 ± 13.9 (10.5 - 77.7)	35.5 ± 9.6 (10.9 - 64.6)	35.0 ± 10.3 (12.3 - 61.2)
PROT(g)	51.0 ± 23.1 (8.5 - 106.2)	53.7 ± 17.1 (16.8 - 108.2)	53.3 ± 19.7 (13.4 - 115.2)
PROT(g)/kg	1.0 ± 0.4 (0.2 - 2.5)	1.1 ± 0.3 (.3 - 2.1)	1.1 ± 0.4 (0.3 - 2.3)
FAT(g)/d	27.5 ± 15.1 (4.4 - 90.3)	26.1 ± 10.4 (4.7 - 68.9)	24.9 ± 9.8 (4.1 - 53.2)
CARBO(g)/d	363.4 ± 146.7 (111.5 - 856.4)	355.1 ± 93.9 (90.0 - 594.6)	348.2 ± 104.2 (98.9 - 696.5)

Protein intake during pregnancy paralleled the overall decrease in food intake, and levels were slightly below the RDA and FAO recommendations. During lactation, protein intake returned to the pre-pregnancy levels of 51.0 to 53.3 g/day, or a daily intake of 1.0 to 1.1 g/kg. Protein was supplied mainly by maize, beans, millet, and sorghum. Only 7.6% of the protein was of animal origin (mainly cow milk consumed in tea). The main sources of fat, which was low in the diet, were milk, lard, margarine, avocado, and macadamia nuts (see Chapter 6). The main sources of carbohydrate were maize and refined sugar.

Anthropometry

Estimates of life-long nutritional experience were based on height and head circumference measurements. Estimates of nutritional condition in early pregnancy were based on Wt/Ht^2 [Body Mass Index (BMI)], mid-upper arm circumferences (MUAC), sums of fatfolds, and derived estimates of fat stores and protein stores based on anthropometry obtained during the first trimester. These measurements are also available for the pre-pregnancy period on a smaller sample. Trimester values are based on the mean ± SD of three months per trimester and are presented in Table 23.3.

Women in the pregnancy sample, because of both generally low stature and low weight, showed a weight for height ratio which was 90-93% of reference data (3), and a BMI of 21 ± 2. Few women were wasted, and three were extremely obese 75 kg. The women's mean height was 154.3 cm, the average pre-pregnancy weight was 50.7 ± 7.6 kg, and the mean 1st trimester weight was 50.5 ± 7.7kg. Mean head circumference was 53.5 ± 1.4 cm. In terms of risk factors for low birth weight, 31% of the women were less than 152 cm, and 31% were under 46 kg. Younger women were lighter than older women.

Pregnancy Changes in Weight, Fat, and Protein Stores

The focus of anthropometry was to determine changes in weight, fat, and protein stores during pregnancy and lactation. The following variables were used to assess energy stores: BMI (Wt/Ht^2), mid-upper arm circumference (MUAC), sum of three and six fatfolds (S_3FF and S_6FF), percent of body weight as fat (PF) based on Durnin's equation (4), arm fat area (AFA), arm muscle area (AMA), and arm muscle circumference (AMC), using the Gurney Jelliffe nomogram (5).

Pregnancy weight gain was found to be less than half of the recommended values of 12.5 kg (6, 7). The mean weight gain was 11.9% of the pre-pregnancy weight (Table 23.4), which is considered sub-optimal when compared to USA and UK recommendations (6, 7). Only 8.4% of the women gained more than 10 kg (see Fig. 23.1). In the first trimester there was a slight weight loss compared with the pre-pregnancy values, probably due to vomiting and/or anorexia in early pregnancy. Mean weight gain in the second and third trimesters was approximately two and three kg, respectively. The majority of women actually lost weight during the last month of pregnancy, particularly in the period within 15 days of delivery (the mean loss was -.22 ± .67 kg), possibly due to late pregnancy "morning sickness." Also, restrictions of intake during the 3rd trimester to limit the size of a newborn at birth is not uncommon in Kenya.

TABLE 23.3
Anthropometry during pregnancy by trimester - all seasons combined (mean ± S.D., range).

	Pre-Pregnancy (n=90)	Trim. 1 (n=90)	Trim. 2 (n=111)	Trim. 3 (n=121)	Postpartum 7-10d (n=115)
Weight(kg)	50.7 ± 7.6 (38.9-78.6)	50.5 ± 7.7 (38.1-78.8)	52.6 ± 7.1 (38.1-77.9)	55.6 ± 6.9 (41.0-79.2)	51.6 ± 6.4 (38.1-75.4)
Height (cm)	154.3 ± 5.7 (142.1-171.0)				
Wt/Ht^2	21.2 ± 2.7 (16.4-30.8)	21.2 ± 2.6 (16.6-30.4)	22.1 ± 2.5 (17.4-29.6)	23.5 ± 2.5 (18.8-30.8)	21.7 ---
MUAC	26.0 ± 2.8 (20.6-36.2)	25.9 ± 2.8 (20.8-35.1)	25.4 ± 2.5 (20.4-33.8)	24.9 ± 2.3 (20.7-32.7)	24.6 ± 2.2 (20.2-30.7)
Sum_3FF	34.1 ± 14.4 (13.6-90.9)	35.0 ± 14.5 (13.4-104.0)	35.6 ± 13.9 (15.6-93.4)	32.7 ± 11.6 (16.4-82.1)	30.6 ± 9.5 (13.5-60.2)
Sum_6FF	78.4 ± 33.4 (33.0-188.1)	78.9 ± 31.6 (29.3-197.2)	81.6 ± 29.8 (41.3-197.7)	80.3 ± 29.0 (37.6-193.8)	75.7 ± 25.0 (32.8-167.7)
PFat	25.1 ± 5.8 (10.9-39.9)	25.5 ± 5.6 (11.0-41.8)	25.9 ± 5.2 (13.8-40.3)	24.9 ± 4.8 (15.3-38.5)	24.0 ± 4.5 (14.1-34.2)
Arm fat area	18.9 ± 9.1 (6.0-59.0)	18.9 ± 9.2 (6.6-61.0)	17.9 ± 7.8 (6.2-53.5)	16.1 ± 7.0 (16.6-48.4)	14.5 ± 5.4 (5.5-30.2)
Arm muscle area	35.8 ± 6.0 (22.7-53.1)	35.2 ± 5.5 (21.9-52.3)	33.8 ± 5.3 (17.0-54.0)	33.9 ± 4.5 (22.9-49.3)	34.1 ± 5.2 (21.4-47.2)

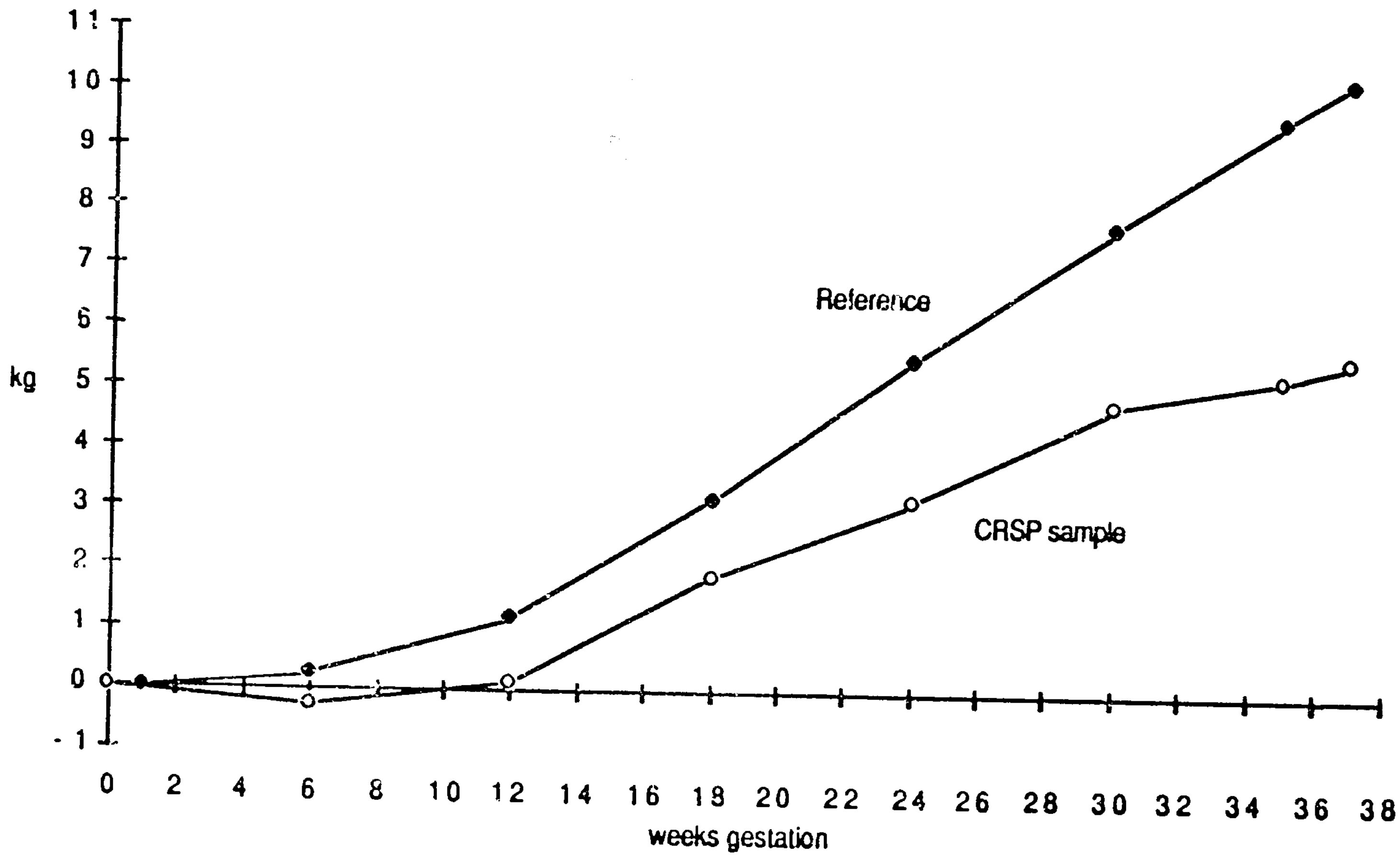


FIG. 23.1. Prenatal weight gain in the CRSP sample compared to reference weight gain (U.S. Department of Health, Education and Welfare, Children's Bureau).

A mean net postpartum weight gain of 1.4 ± 3.2 kg (-10.6 - 10.5 kg) above first trimester weight was seen at seven to ten days after delivery. This is about one third of the gain reported in countries such as the USA (7). Three obese women actually lost weight and 5% of the women were below pre-pregnancy weight by the end of pregnancy.

From the second to third trimester, there was a small increase in the sum of the fatfolds; but, in the eighth month, a decrease in all parameters of fat stores was observed (Table 23.4). The second to third trimesters is the time when pregnant women deposit most of their fat stores (3.4 to 4.0 kg) in "western" countries (6, 7). In the first two months of the third trimester, slight weight gain occurred concomitantly with a decrease in fat stores. This was followed by a mean weight loss of 0.22 kg during the last two weeks prior to delivery. The data suggest that the fetus continues to gain weight as the mother draws upon her own fat stores to supply needed energy. The decrease in maternal food intake in the third trimester, particularly during the last month of pregnancy, is no doubt a contributing factor. Simultaneous changes in weight, fatfolds, food intake, and available energy are presented in Fig. 23.2.

TABLE 23.4
Changes in weight, fat stores, and protein during pregnancy.

	n	Mean ± SD	Range
Weight (kg)			
Total pregnancy gain	61	6.4 ± 3.4	-5.0 - 14.0
2nd plus 3rd trimester gain	111	6.3 ± 3.4	-4.7 - 15.3
Postpartum net gain (8 days pp)	85	1.4 ± 3.2	-10.6 - 10.5
Diff wt trim. 2 to 3	111	3.1 ± 1.8	-1.4 - 8.9
Fat			
Diff Sum3FF (mm)*	78	-1.0 ± 8.2	-19.4 - 17.9
Diff % body fat*	78	-2.4 ± 3.5	-7.5 - 7.58
Diff Sum3FF trim 2 to 3†	111	-2.6 ± 5.1	-21.0 - 11.2
Arm Muscle Area (AMA) (cm^2)			
Diff AMA*	112	-1.9	

* Obtained by difference of the 3rd trimester mean minus prepregnancy mean.

† Obtained by difference of the 3rd trimester mean minus 2nd trimester mean.

Of the six measured fatfolds, all showed changes in a similar direction. The distal fatfolds (biceps and thigh, but not triceps) appeared to change less than the trunkal or proximate ones (abdominal, sub-scapular and suprailiac).
All fatfolds except biceps and thigh decreased in the third trimester and over the first two months after delivery (see Table 23.4 and 23.5).

Protein stores, as reflected by arm muscle area (AMA), decreased slightly in the second and third trimesters, with no return to pre-pregnant levels by six months postpartum. Arm muscle area will be compared with serum proteins, albumin, pre-albumin, and transferrin values during pregnancy and lactation at a future time.

Anthropometry Changes during Lactation

Mothers entered lactation with a mean net weight gain of 1.4 ± 3.2 kg, presumably due to fat stores, to help meet the demands of lactation as shown above. Mothers continued to lose weight for four to six weeks during lactation, at which time their weight began returning to pre-pregnancy levels (Table 23.5).

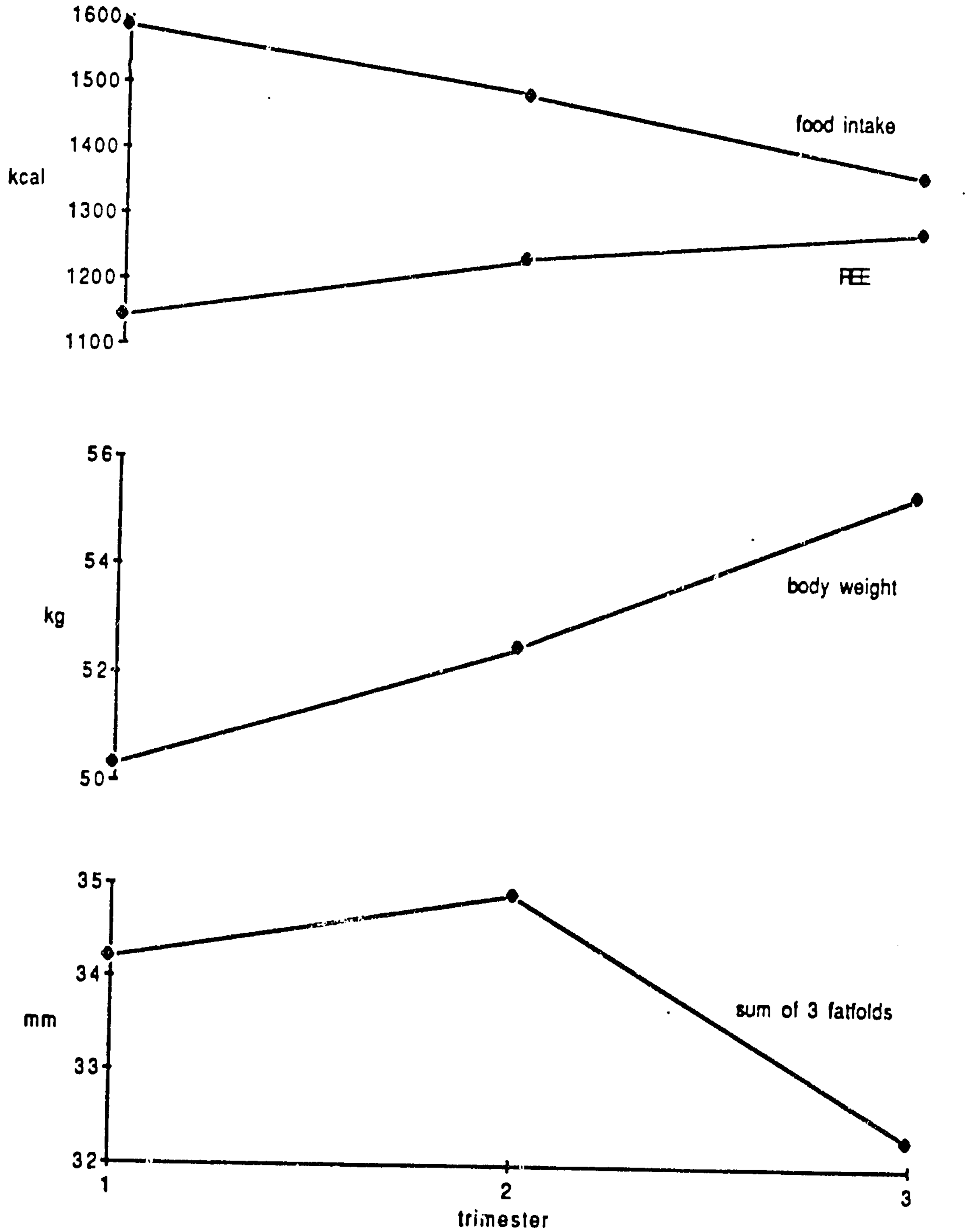


FIG. 23.2. Maternal food intake, REE, body weight and sum of three fatfolds by trimester of pregnancy.

Fat loss, as reflected by all fat parameters, continued into lactation until the third month of lactation, when fatfolds returned to pre-pregnancy values (Table 23.6). Muscle arm area remained slightly below the pre-pregnancy level through the sixth month of lactation. Energy intake during lactation, as mentioned above, was about 25% higher than in pregnancy, and some infants, beginning as early as one month of age, received considerable Kcal from supplements in addition to breast milk. These two factors may have decreased mothers' energy requirements, thus allowing them to recover body fat and body weight relatively early in lactation. RMR changes, as a possible adaptation in achieving energy balance, are discussed below.

TABLE 23.5
Anthropometry of lactating women by month of lactation: means ± SD and ranges.

Month	n	Weight (kg)	Sum3FF (mm)	MUAC (cm)
1	123	51.6 ± 6.5 (38.3 - 76.3)	30.8 ± 9.8 (13.4 - 60.7)	34.5 ± 5.4 (21.8 - 53.6)
2	95	50.9 ± 7.2 (38.7 - 80.0)	31.9 ± 11.9 (14.2 - 97.7)	-----
3	98	51.2 ± 6.9 (35.9 - 71.6)	35.5 ± 11.8 (14.2 - 82.4)	34.1 ± 4.9 (21.1 - 51.4)
4	103	50.9 ± 7.6 (38.1 - 82.3)	33.0 ± 13.0 (13.4 - 83.8)	-----
5	100	51.2 ± 7.3 (38.8 - 77.4)	35.7 ± 11.4 (14.9 - 67.5)	34.8 ± 5.1 (22.7 - 51.6)
6	105	50.7 ± 7.4 (37.9 - 82.5)	34.8 ± 14.4 (14.4 -105.7)	-----

TABLE 23.6
Maternal weight and fat loss in lactation from 0 to 2 months.

Parameter	Mean ± SD	Range
Weight (kg)	-1.6 ± 6.0	- 0.4 - (- 6.3)
Sum3FF (mm)	-2.9 ± 9.3	-24.5 - (-22.0)
Sum6FF (mm)	-1.61 ± 12.1	-25.4 - (-29.7)
% Body Fat	-1.04 ± 4.1	- 9.4 - (- 9.9)

It would be extremely helpful to use easily obtained anthropometric measures as surrogates for more complicated measures in following the course of pregnancy and maternal nutritional status. An examination of correlation coefficients between all anthropometric values reveals that MUAC is a good surrogate value for weight ($r = .80, p < .00001$), and head circumference as a surrogate for height ($r = .58, p < .00001$). These are easier to obtain than weight or height in a rural primary health care setting; but further validation is needed, and weight is still essential for helping to monitor fetal growth, in addition to fundal height.

Effects of Seasonality on Anthropometry and Food Intake during Pregnancy

Cohorts of pregnant women were constructed for analysis to detect, in a preliminary fashion, the influence of any seasonal effects (especially the drought) on pregnancy. Of particular interest are possible changes in body composition, weight, and food intake. Three-month periods were used and were found to coincide quite well with differing periods of rainfall, ambient temperature, and humidity. Pregnant women were assigned to cohorts based on the month in which their infants were born. Further analyses are needed to tease out seasonal effects versus pregnancy effects.

A brief summary of the cohort periods follows:

January to March-- This is usually a hot, dry, dusty season with low humidity and no rainfall.

April to June - This period includes the long spring rains, which usually start in mid-March and continue into June. The humidity rises, and toward the end of June, the temperature starts to cool off.

July to September-- These are the coldest months of the year. There may be some scattered light, short rains in August and September, but these are unreliable. The effects of the drought became apparent in this period.

October to December-- This is the period of the short rains which characteristically start in mid-October. Humidity, which builds up in late September, continues to do so into October. The short rains last several weeks. The temperature gradually rises toward December. The severe drought was the result of long and short rains being missed in 1983 and 1984. The height of the drought and resultant crop failure and food shortage hit the study area from late July 1984 to December 1984, with the worst effects in August to November. The rains returned in October 1984, but the harvest was not available until the Spring of 1985 and was generally below par because of a seed shortage and late planting.

Cohort Food Intake in Pregnancy and Lactation

Mean trimester intake by cohort was determined for the three pregnancy trimesters and three lactation periods (0 to 44 d, 45 - 134 d, and 135-182 d). The lowest 1st trimester mean daily Kcal intake was seen in the April - June 85 cohort whose 1st trimester was in July-September 1984 (Table 23.7). During the 2nd trimester, the lowest mean daily Kcal intakes were in the October - December 1984 and January - March 1985 cohorts.

The lowest 1st lactation period intake was seen in the October to December 1984 cohort, the lowest 2nd period intake was in the July - September 1984 cohort, and the lowest 3rd period intake was in the April - June 1984 cohort (Table 23.8). The lowest intakes coincided with the famine months.

TABLE 23.7
Mean daily kcal intake in 1st and 2nd trimesters by birth period cohorts.

Birth Period Cohort	n	Kcal/d	± SD	Range
		Mean 1st trimester intake		
July-Sept 84	25	1509	561	(180-2775)
Oct-Dec 84	25	1589	464	(611-2700)
Jan-Mar 85	21	1585	564	(577-2525)
Apr-Jun 85*	9	1308	296	(728-1706)
		Mean 2nd trimester intake		
Apr-Jun 85	9	1587	727	(517-2533)
July-Sept 84	34	1616	472	(855-2909)
Oct-Dec 84†	28	1147	386	(946-2643)
Jan-Mar 85†	26	1340	523	(721-2643)

* For infants born in Apr-Jun 85, the 1st trimester coincided with the famine (July-Sept 84).

† For infants born in Oct-Dec 85, the 2nd trimester coincided with the early months of the famine (July-Sept 84), and for infants born in Jan-Mar 85, the 2nd trimester coincided with the later famine months (Oct-Dec 84).

TABLE 23.8
Mean daily kcal intake per lactation period by cohort*

Birth Period Cohort	n	Kcal/d	± SD	Range
		Mean (1st lactation period intake: 0-45d)		
Apr-Jun 84	22	1918	496	(939-2919)
July-Sept 84	31	1625	144	(461-3701)
Oct-Dec 84	26	1550	674	(605-3118)
Jan-Mar 85	24	1894	612	(693-2961)
Apr-Jun 85	10	2054	653	(1114-2947)
		Mean (2nd lactation period intake: 46-135d)		
Apr-Jun 84	22	1869	500	(776-2673)
July-Sept 84	32	1537	456	(448-2521)
Oct-Dec 84	28	1904	446	(1108-2885)
Jan-Mar 85	24	1894	525	(979-3136)
Apr-June 85	10	1797	372	(1279-2338)
		Mean (3rd lactation period intake:136-180d)		
Apr-June 84	22	1570	616	(629-3103)
July-Aug 84	31	1711	519	(822-2838)
Oct-Dec 84	27	1746	386	(74-387)
Apr-Jun 85	10	1953	467	(1331-2799)

* Lactation during July-Dec 84 coincided with the famine.

Weight Gain by Cohort

For the cohorts passing through months of the famine during their 2nd and/or 3rd trimester of pregnancy, weight gain was less than that for other cohorts (Tables 23.9 and 23.10; Fig. 23.3). For the cohort passing through the famine during their 9th month of pregnancy, decreased weight gain was seen in the ninth month compared to other cohorts (Table 23.11). These decreases were not statistically significant, however.

Changes in fat stores (Sum3FF) of pregnant women are presented in Table 23.12. For those pregnant women whose 2nd trimester coincided with the famine, a decrease in fat is seen for the cohort born from January-June 85 (see Fig. 23.4).

In summary, the cohorts of pregnant women whose pregnancies and lactation periods coincided with the famine show evidence of decreased food intake, decreased weight gain and decreased fat gain, particularly when the 2nd and 3rd trimesters of pregnancy coincided with the food shortages. Although few of the decreases are statistically significant, the data are indicative of the drought's severity. A more detailed analysis of the true seasonal effect on pregnancy and lactation needs to be undertaken, as the severe food shortage may be obscuring the usual seasonal picture. Similar low pregnancy weight gains were seen in the Machakos study (8).

TABLE 23.9
Mean weight changes in the 2nd trimester of pregnancy, by cohort.

Birth Period Cohort	n	Mean (kg)	± SD	Range
July-Sept 84	35	2.9	1.9	-1.8 - 7.7
Oct-Dec 84	26	3.5	2.1	0.6 - 8.9
Jan-Mar 85*	25	2.9	1.5	0.5 - 6.2
Apr-June 85	10	3.7	1.7	1.1 - 5.7

* For infants born Jan-Mar 85, the 2nd to 3rd trimesters of pregnancy overlapped with the famine.

TABLE 23.10
Pregnancy weight changes in the 3rd trimester of pregnancy, by cohort.

Birth Period Cohort	n	Mean (kg)	±SD	Range
Apr-June 84	14	2.3	3.5	-5.4 - 11.1
July-Sept 84	20	3.1	2.3	0.4 - 9.2
Oct-Dec 84*	21	1.8	2.0	-1.1 - 5.1
Jan-Mar 85	17	2.7	2.1	0.0 - 7.3

* For infants born Oct-Dec 84, the ninth month coincided with the famine.

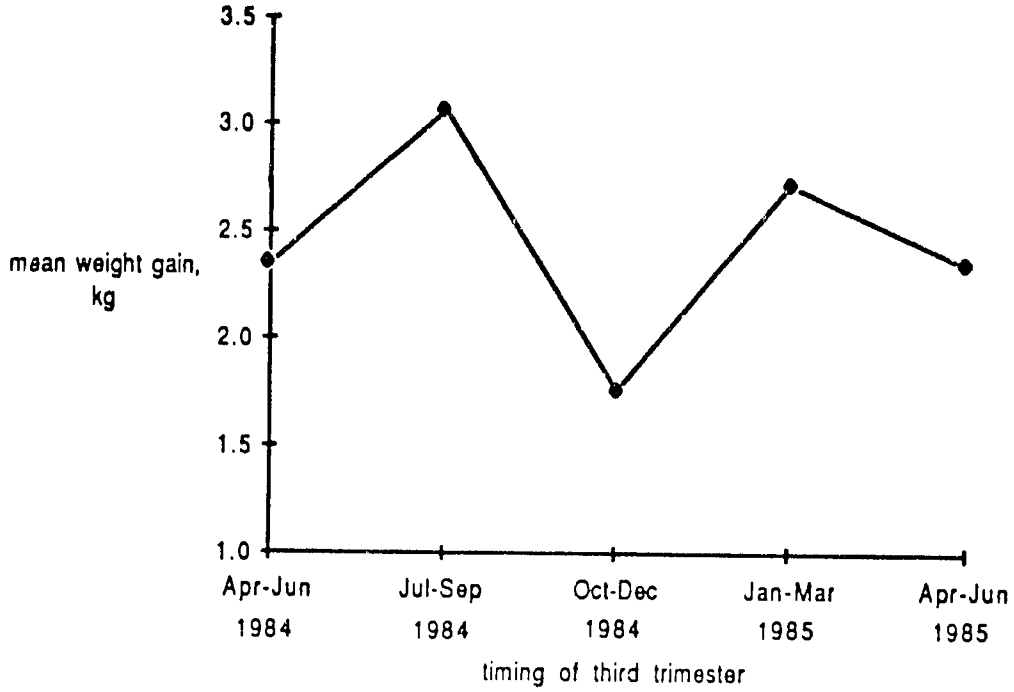


FIG. 23.3. Maternal weight gain from the beginning of the third trimester to 15 days before delivery by timing of the third trimester.

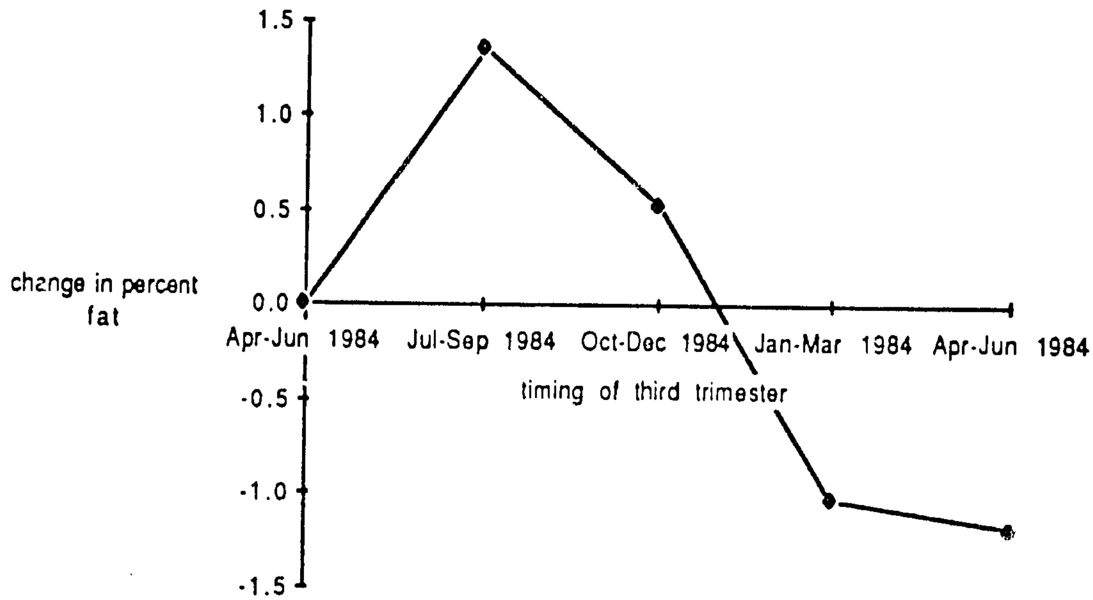


FIG 23.4. Change in mean maternal percent body fat during pregnancy by timing of the third trimester.

TABLE 23.11
Pregnancy weight change in the ninth month, by cohort.

Birth Period Cohort	n	Mean (kg)	±SD	Range
Apr-June 84	18	0.83	2.2	-4.6 - 7.3
July-Sept 84	21	0.99	1.3	-0.7 - 5.8
Oct-Dec 84*	22	0.31	1.4	-3.1 - 2.9
Jan-Mar 85	20	1.20	0.9	-0.5 - 2.6
Apr-Jun 85	7	0.82	0.8	0.0 - 1.9

* For infants born Oct-Dec 84, the ninth month coincided with the famine.

TABLE 23.12
Changes in sum of three fatfolds from the 2nd to the 3rd trimester, by cohort.

Birth Period Cohort	n	Mean (kg)	±SD	Range
July-Sept 84	74	2.7	8.3	-12.5 - 14.7
Oct-Dec 84*	26	0.7	8.9	-15.1 - 17.9
Jan-Mar 85†	25	-3.1	7.7	-19.4 - 10.2
April-June 85	10	-2.5	6.7	-11.7 - 11.3

* The 3nd trimester coincided with the famine.
† Part of the 2nd trimester coincided with the famine.

Resting Energy Expenditure

Resting Energy Expenditure (REE) measurements were obtained on 21 women within 90 days prior to conception. About 80-100 women (including the pre-pregnancy sample) were measured during pregnancy and lactation. Pregnant women were measured at approximately five months and eight months of pregnancy, and lactating women were measured at approximately one, three, and six months postpartum. REE values are presented in Table 23.13.

It is seen that REE rises above pre-pregnancy levels by only 2 Kcal/day in the first trimester, by 122 Kcal/day in the second trimester, and by 166 Kcal/day in the third trimester. This is an increase of about 11% in the second trimester and 15% in the third trimester above pre-pregnancy values. Expressed as Kcal/min, women had a mean REE of 0.78 Kcal/min/d in the first trimester, 0.86 Kcal/min/d in the second trimester, and 0.89 Kcal/min/d in the third trimester. In the USA, values of 1.01 and 1.5 Kcal/min/d are seen in early and late pregnancy, respectively (9).

During lactation the mean REE values dropped gradually and approached the pre-pregnancy values by the sixth month (from 1209 to 1151 Kcal/day). REE/kg/d throughout pregnancy was the same as for the pre-pregnancy period. REE for women in the first 45 days of lactation was 24 Kcal/kg/d, and then decreased slightly to 23.3 Kcal/kg/d (see Table 23.13).

By REE not increasing as much as might be "expected" during pregnancy, it is hypothesized that more energy becomes available for the growing fetus, placenta, and supporting structures, and also for helping to minimize the loss of maternal fat stores. The relationship of changes in REE to changes in weight, body fat, and protein stores needs to be examined.

TABLE 23.13
Pre-pregnancy, pregnancy, and lactation resting energy expenditure per day and per weight.

Period	n	Mean REE/day (Range)	Mean REE/wt (Range)
Pre-pregnancy*	21	1114 ±158 (792 - 1495)	23.8 ± 3.0 (16.7 - 31.0)
Pregnancy (by trimester)			
First	19	1116±158 (883 - 1503)	23.1±4.3 (16.0 - 33.6)
Second	63	1236 ± 201 (770 - 1709)	23.5 ± 3.9 (16.4 - 33.6)
Third	74	1280 ± 180 (881 - 1682)	23.7±3.2 (16.4 - 34.0)
Lactation (by period)			
First (0-45 days)	75	1209 ± 183 (817 - 1666)	24.0 ± 3.8 (14.6 - 33.9)
Second (46-135 days)	92	1185 ± 192 (776 - 1965)	23.3 ± 4.0 (13.2 - 38.3)
Third (136-180 days)	15	1151 ± 152 (845 - 1673)	23.6 ± 4.3 (17.1 - 31.8)

* Average of the 3 months prior to conception.

It is stated in the literature that an additional 36,000 kcal over an entire pregnancy, or 130 kcal/day, are needed for tissue maintenance (2). For the Kenyan women, additional kcals above pre-pregnancy values required for resting metabolism are as follows:

Trimester 1	2 kcal/day or 180 kcal
Trimester 2	122 kcal/day or 10,980 kcal
Trimester 3	166 kcal/day or 15,598 kcal

The total additional RMR kcals required are 26,598 kcal throughout pregnancy, or an average of 98 kcal/day, which is 74% of the above recommended values.

During lactation, the REE gradually decreased to near pre-pregnancy levels by the sixth month postpartum (Table 23.13).

Available energy (AE) in pregnancy is represented by total kcal energy intake/day minus the REE value/day measured concurrently for each trimester. The AE gives a truer picture of energy available for activity, infection, pregnancy weight gain, etc., than does kcal intake/day or kcal/kg/day. As REE decreases for a given level of kcal intake, available energy increases. A distribution of AE is presented in Table 23.14.

TABLE 23.14
Available energy (kcal/day) in pregnancy and lactation (kcal intake - kcal REE)

Period	n	Kcal/day Mean ± SD	Range
Pregnancy			
Pre-pregnancy	19	658 ± 486	-349 - 1574
First trimester	20	293 ± 451	-522 - 1110
Second trimester	63	173 ± 450	-945 - 1377
Third trimester	74	117 ± 501	-960 - 1266
Lactation Periods			
0 - 45 days	76	568 ± 673	-625 - 1738
46 - 135 days	95	633 ± 495	-404 - 1903
136 - 180 days	15	759 ± 414	-118 - 1376

Physical Activity

Quantitative descriptions of the time spent by pregnant, lactating, and non-pregnant/non-lactating women engaged in a variety of activities are available (Chapter 15). Unfortunately, the time allocation study was not implemented until the second year of the Main Study, in March 1985, after the majority of pregnancies had occurred. In the sample available, however, pregnant women spent about a third less time in the category "care of self and others," more than double the time in the "inactive" category, and about a sixth less time in "food preparation" and "cash labor" than non-pregnant women, some of whom were lactating (see Table 23.15).

TABLE 23.15
The time spent by pregnant women (0 to 9 months) and non-pregnant and lactating women (0 to 6 months) engaged in general level activities (expressed in minutes per day).*

General Activity	Pregnant Women (n=14) Minutes/Day	Non-pregnant and Lactating Women (n=155) Minutes/Day
Eating/Drinking	28.4	30.4
Food Preparation	78.2	91.1
Care of Self/Others	57.7	156.1
HH Labor	111.9	101.9
Food Production	115.5	103.3
Cash Labor	37.7	43.9
Inactive	120.8	51.2
Education	0.0	0.0
Recreation	0.0	0.0
Social	58.4	50.2
Other	46.6	32.0
Total	655.2	660.1

* Based on activities observed from 7:00 am to 6:00 pm, Mondays through Fridays, and 7.00 am to 12:30 pm on Saturdays.

Reducing energy expenditure by reducing physical activity is a method of adaption to conserve energy in the face of the increased energy demands of pregnancy and lactation. This is particularly important in the face of decreased pregnancy food intake, as observed in the Kenyan sample of pregnant women.

Health Status During Pregnancy

Anemia

Hypochromic, microcytic anemia was the most common form of anemia found in the pregnant women, with low mean hemoglobin and hematocrit values (Table 23.16). By way of comparison the hemoglobin and hematocrit values of non-pregnant and non-lactating women were 12.4 ± 1.7 gm [range = 6.6 - 16.9] and 37.2 ± 4.3% [range = 24.0 - 47.0], respectively). Hookworm and inadequate iron intake most likely contribute to the iron deficiency anemia.

Macrocytosis was seen in 6-8% of women and hypersegmented polymorphonuclear nuclei (4 lobes) were present in 4% of all women. These findings are indicative of folic acid deficiency. In situations of hemolysis with increased erythrocyte destruction and production (as in malaria), folic acid deficiency and anemia increases. Folic acid deficiency has been associated with prematurity and intrauterine growth retardation and could aggravate the detrimental effects of placental malaria on fetal growth.

Malaria

Thick blood smears revealed that 3-4% of all women were positive for malaria. Malaria is somewhat more common in the rainy season than the dry season and is endemic in the Embu district. Splenomegaly was present in 35% of all women. Spleen size suggestive of infection in malaria correlated negatively with weight gain data during pregnancy.

TABLE 23.16
Anemia related variables in pregnant women (all trimesters).

	Hg (n=104)	Hct (n=104)
Normal Values	>11 gm	34%
Mean ± SD	10.8 ± 1.6 gm	32.4 ± 4.2%
Range	6.5 - 14.2	20 - 41.0

Thyroid Enlargement

Goiter is seen mainly in women and school-age girls. Ten percent of pregnant women had grade 1+ goiter and 6% had grade 2+ goiter. The enlargement tends to recede only slightly by six months postpartum. There was no evidence of cretinism among the neonates nor cases of obvious hypothyroidism observed in the study area.

The presence of goiter in pregnant women showed positive low but statistically significant correlations with birth weight ($r = .19$, $p < .05$) and pregnancy weight gain ($r = .22$, $p < .05$). It may be that thyroid hypertrophy, an adaption to a relative lack of iodine, allows for more adequate levels of thyroxin in pregnancy and promotes better pregnancy weight gain and fetal growth than in women with no goiter formation in the face of iodine deficiency. Perhaps the low REE values in the women (and all TI's) are due to the marginal iodine deficiencies in the area. Body temperatures tended to run low or slightly below normal, which is seen in hypothyroidism as well as in food deprivation. Cassava, a goitrogen, is rarely eaten in the area, but cabbage is eaten not infrequently.

Acute Morbidity

A comparison of morbidity between pregnant and non-pregnant women was carried out. The only increased incidence seen was that of backache, which correlated positively with birthweight, heartburn, and other gastrointestinal complaints. One pregnant woman known to have rheumatic heart mitral disease developed congestive heart failure during pregnancy, but toxemia and hypertension were not seen.

ANALYTICAL APPROACH

Relationships between food intake variables and pregnancy outcomes (e.g., pregnancy weight gain [PWG], birth weight [BW]) and lactation were first evaluated by examining scatter diagrams. Since linear relationships were suggested by these graphs, they are summarized by correlation coefficients (r). The degree of linear relationship is assessed by the percent of variation in a given pregnancy outcome attributable to food intake or other variables. This is estimated by the square of the correlation coefficient.

Multiple Regression Analysis

The relationship between an outcome variable and a set of food intake variables is assessed by fitting an appropriate multiple regression equation. The coefficient of determination (R^2) serves as an estimate of the percent of variation in the pregnancy outcome attributable to food intake. When the regression equation is univariate (of the first order), it is simply the square of the multiple correlation coefficient between the pregnancy outcome variable and the food intake variable.

After the "effect" of food intake variables for each pregnancy outcome and lactation component is assessed, other sets of factors such as maternal pre-pregnancy or early pregnancy nutritional status, SES factors, disease, etc. are examined to determine their magnitude and relative order of importance. This is done by multiple regression analysis. Because of the large number of potentially relevant variables, an analysis for determining the "best subset" of variables for the multiple regression is performed using BMD (BMDP9R). Three grossly obese women (wt 75 kg) are omitted from the pregnancy analyses and examined separately.

For convenience, the food intake variables are referred to in all analyses as KCAL1, 2, 3, PROT1, 2, 3 etc., with the number indicating the trimester. ENERGY1, 2, and 3 refer to available energy as defined in Chapter 10. Lactation variables are designated by period of lactation (L1 = 0-45 days, L2 = 46 135 days, and L3 = 136-180 days) so as to maximize the sample size for REE studies. KCAL1, 2, 3, PROTL1, 2, 3, eg. are used to designate Kcal intake and protein intake by period of lactation. Net available energy of lactation (NAEL) was defined previously. Although data are available on all infant growth parameters, only length and weight are considered in the analyses with regard to lactation.

ANALYSIS OF MATERNAL INTAKE ON PREGNANCY OUTCOME

Analyses of Food Intake and Pregnancy Weight Gain

The research question addressed here is: "Does maternal energy intake during pregnancy affect weight gain during pregnancy?"

Weight gain during pregnancy is an important measure of the progress of pregnancy. It is related to the growth of the fetus, the placenta, supporting membranes, and maternal storage of fat for energy needs of late pregnancy and lactation. Since Kcal is a key food intake variable, the relationship between pre-pregnancy KCAL (PRKCAL) intake and PWG is also examined. Because body size is related to intake, PRKCAL/kg intake is also examined. Correlation coefficients between PRKCAL intake and weight gain variables are low but statistically significant (see Table 23.17), with only 10% of the variation in PWG attributed to pre-pregnancy energy intake.

TABLE 23.17
Correlation coefficients between pregnancy weight gain (PWG) and pre-pregnancy kcal intake.

Pre-Pregnancy Intake	n	r	p-value
KCAL/day vs. PWG	66	.31	<.01
KCAL/kg/day vs. PWG	59	.39	<.01

Third Trimester Food Intake and Pregnancy Weight Gain

Scatter diagrams between each of the third trimester food intake variables (KCAL3, PROT3, FAT3, CARB3, and available ENERGY3) and PWG suggest that there are weak positive relationships (Table 23.18; Figs. 23.5 and 23.6). For instance, the r between FAT3 and PWG is 0.31, suggesting that about 10% of the variation in pregnancy weight gain is attributed to 3rd trimester fat intake.

Data on PWG and the 3rd trimester food intake variables have been used to determine a first order regression equation of PWG on the five food intake variables. Its coefficient of determination is $R^2 = 0.11$, suggesting that only 11% of the variation in PWG is explained by the 3rd trimester food intake variables jointly. This is low and only slightly higher than what could be attributed to each food intake variable individually. This is because many of the third trimester food intake variables are highly correlated among themselves (r's vary from 0.51 to 0.99).

TABLE 23.18
Correlations between pregnancy weight gain and 3rd trimester food intake variables.

	KCAL3	PROT3	FAT3	CARB3	AVAIL ENERG3	p VALUE*
n=	(66)	(66)	(66)	(66)	(41)	
Weight Gain	0.24	0.30	0.31	0.21	0.21	<.08 -.01††
KCAL3		0.93	0.63	0.99	0.94	<.0000
PROT3			0.69	0.89	0.84	<.0000
FAT3				0.51	0.59	<.0000
CARB3					0.94	<.0000

* Range of p values computed for correlations in row

†† r = .21 has p value of <.08, all others p<.05 to .01

Multiple Regression Models for Pregnancy Weight Gain

The dependent or outcome variable is pregnancy weight gain (PWG). The following classes of variables were considered for inclusion in a multiple regression analysis, based on the results of simple correlation analysis. These were then subjected to the BMDP9R program for selection of the "best subset" (11):

a. Maternal Food Intake

Total KCAL of the 2nd plus the 3rd trimesters (TOTKCAL2)
KCAL/kg/d of 1st trimester (KCAL/KG/1)
Fat and protein of 3rd trimester (FAT3, PROT3)

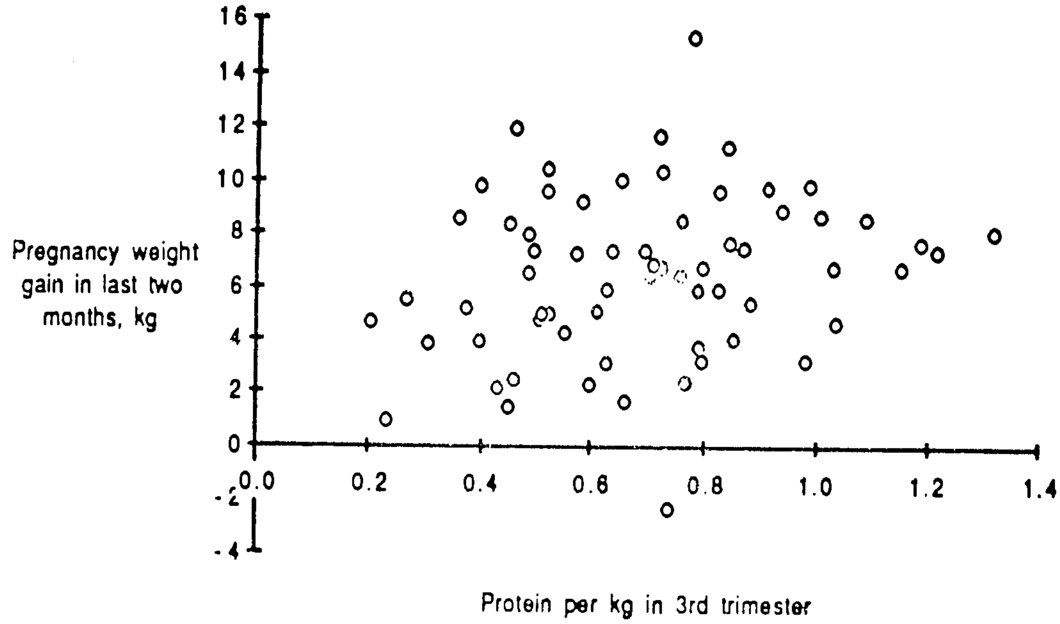
b. Maternal age and size early in pregnancy

Maternal age
Weight in 1st trimester (WT1) (same value as prepregnancy weight)
Sum of 3 fatfolds of 1st trimester (S3FF1) (same value as prepregnancy S3FF
Height (pre-pregnancy)
Change in S3FF between 2nd and 3rd trimesters (DS3FF23)
Weight change in pregnancy during 2nd plus 3rd trimester (DWT23)

c. Morbidity and disease

Morbidity - Significant illness index in 2nd trimester (SI2)
Significant illness index in 3rd trimester (SI3)
Thyroid size

d. Socioeconomic Status

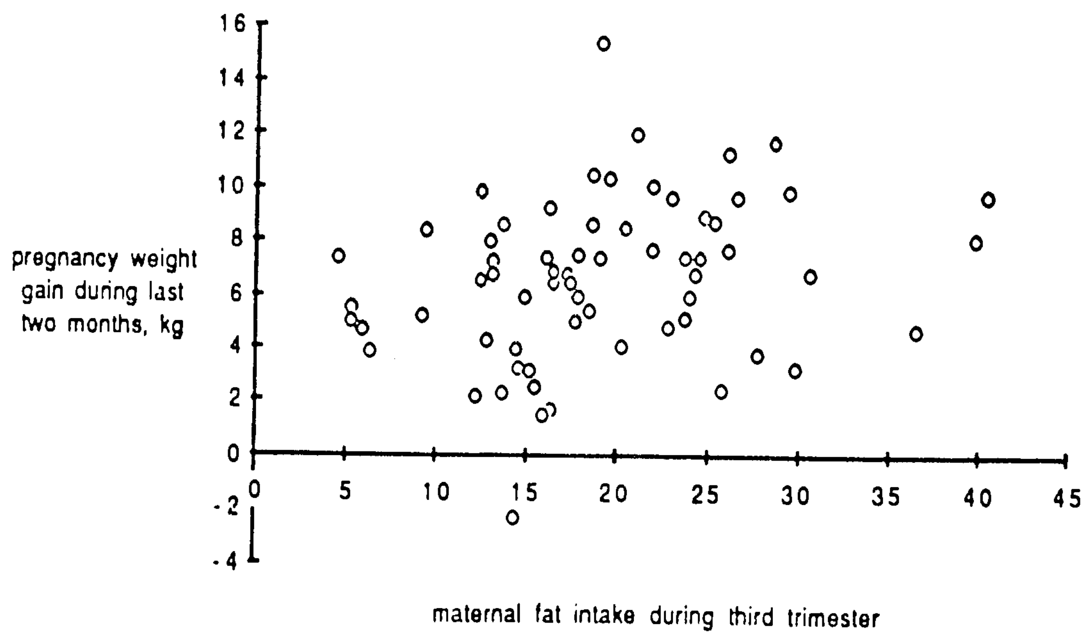


n = 69
r = .232
p = .055

Mean
X = .67711
Y = 6.1319

SD
.25846
3.4205

FIG. 23.5. Correlation between pregnancy weight gain in the last two months of pregnancy and maternal protein intake during the third trimester.



n = 69
r = .269
p = .025

Mean
X = 18.864
Y = 6.1319

SD
7.7645
3.4205

FIG. 23.6. Correlation between pregnancy weight gain during the last two months of pregnancy and maternal fat intake during the third trimester.

The best subset of variables for the prediction of pregnancy weight gain selected by the BMDP9R program is summarized in Table 23.19.

Other subsets with slightly higher R^2's could have been selected. For example, an alternative subset includes all the above plus KCAL/kg intake in the first trimester. In this latter subset, R^2 is .387. More variables could have been used, but by limiting the number of variables, more cases are available for analysis.

TABLE 23.19
The best subset of variables for prediction of pregnancy weight gain.

Variable	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
FAT3 Intake (preg)	.30	.012	.0817
DS3FF23 (preg)	.28	.019	.0715
SI2	-.30	.012	.0823
Thyroid size	.24	.037	.0555

n = 57 cases F stat = 7.57
R^2 = .37 p = .0001
CP = -1.78 (Mallow coeff. [11])

Thus, we see that fat intake, a reflection of the quality and energy density of the diet, appears to be more important than KCAL intake. The gain in fatfolds in trimester 2 (the time of laying down fat stores) contributes to PWG. Significant illness, particularly in the 2nd trimester of pregnancy, has a negative effect on PWG. The role of thyroid enlargement in enhancing PWG, perhaps through the production of more thyroxin, has been discussed previously.

<u>Summary</u>

Food intake has a weak but positive association with pregnancy weight gain (particularly in the 3rd trimester), and with total KCAL intake during pregnancy or during the 2nd plus 3rd trimester. Fat, protein, and available energy appear to exert an effect quite apart from KCAL intake. The correlations are generally low or medium (.20 to .40), but statistically significant (p <.05 to .001). A regression of all 3rd trimester food intake variables, as a group, with PWG, shows that only 11% of PWG is accounted for by food intake.

A multiple regression (best subset) points to the importance of fat intake in the 2nd trimester, low significant illness index, second trimester fat gain, and thyroid enlargement on PWG.

<u>Pregnancy Food Intake and Birthweight</u>

The research question addressed in this section is, "Does maternal energy intake during pregnancy affect the weight of the infant at birth?"

Birthweight is an excellent indicator of pregnancy outcome and a powerful determinant of perinatal, neonatal, and infant morbidity and mortality. Low birthweight is a leading cause of infant death and neonatal and long-term morbidity as well. Gestational age (GA) is equally important. It is important to know if a LBW infant was preterm with an appropriate weight for its GA, or experienced intra-uterine growth retardation (IUGR), since the prognosis of complications, long term sequelae and catch up growth differ. The IUGR infant is at a greater disadvantage than the preterm infant for catch up growth, provided the preterm infant survives. A difference of only 200-300 gm is significant for the infant's survival, particularly infants 2500 gm (12).

Although the WHO definition of a LBW infant is ≤ 2500 gm, the Nutrition CRSP Kenya Project data suggest that infants who are between the 3rd and 10th percentiles for BW (or 2500-2800 gm) are at considerable risk and represent a form of mild to moderate malnutrition. These infants have been found to have slightly increased morbidity and depressed immune responses and show poor catch up growth (particularly in length and head circumference), compared with neonates over 2800 gm (13). In the Kenya sample, 10.8% of infants were ≤ 2500 gm at birth, and 14.6% were between 2500 and 2800 gm.

Maternal Food Intake and Birthweight

The effects of total pregnancy Kcal intake (TOTKCAL), 2nd and 3rd trimester intake (TOTKCAL2), and 1st trimester food intake on birthweight (BW) are examined. Scatter diagrams suggest that the relationship between TOTKCAL intake and birthweight are linear (Figs. 23.7 and 23.8). The correlations are generally low and positive. Associations between 1st trimester food intake variables and BW also show positive low r's (Table 23.20), as are the ones between TOTKCAL2 and BW.

The maternal intake variables that correlate the most strongly with BW are TOTKCAL ($r = .38$, $p < .002$) and TOTKCAL2 ($r = .30$; $p < .001$). The percent of variation in BW attributable to food intake, estimated by the square of the correlation coefficient, is 14%. Four to 15% of the v[illegible]tion in BW is attributable to any single 1st trimester food intake variable.

TABLE 23.20
Significant correlations between birthweight and food intake during pregnancy.

Food Intake Variables		Correlation Coefficient (food intake vs. BW)	p value
<u>Trimester 1</u>	<u>n=84</u>		
KCAL/d		.29	<.005
KCAL/kg		.19	<.05
Protein (g)		.30	<.005
Protein/kg (g)		.27	<.01
Fat (g)		.31	<.005
Carbohydrate (g)		.25	<.02
Available energy	(n=62)	.39	<.005
<u>Trimester 3</u>	<u>n=122</u>		
KCAL		.20	<.02
KCAL/kg		.20	<.02
Protein (g)		.23	<.01
Fat (g)		.21	<.02
Carbohydrate (g)		.18	<.05
<u>Total pregnancy</u>	<u>n=77</u>		
TOTKCAL		.38	<.0005
TOTKCAL/KG		.20	<.05
TOTKCAL2 (2 plus 3 trimester)	(n=105)	.30	<.005

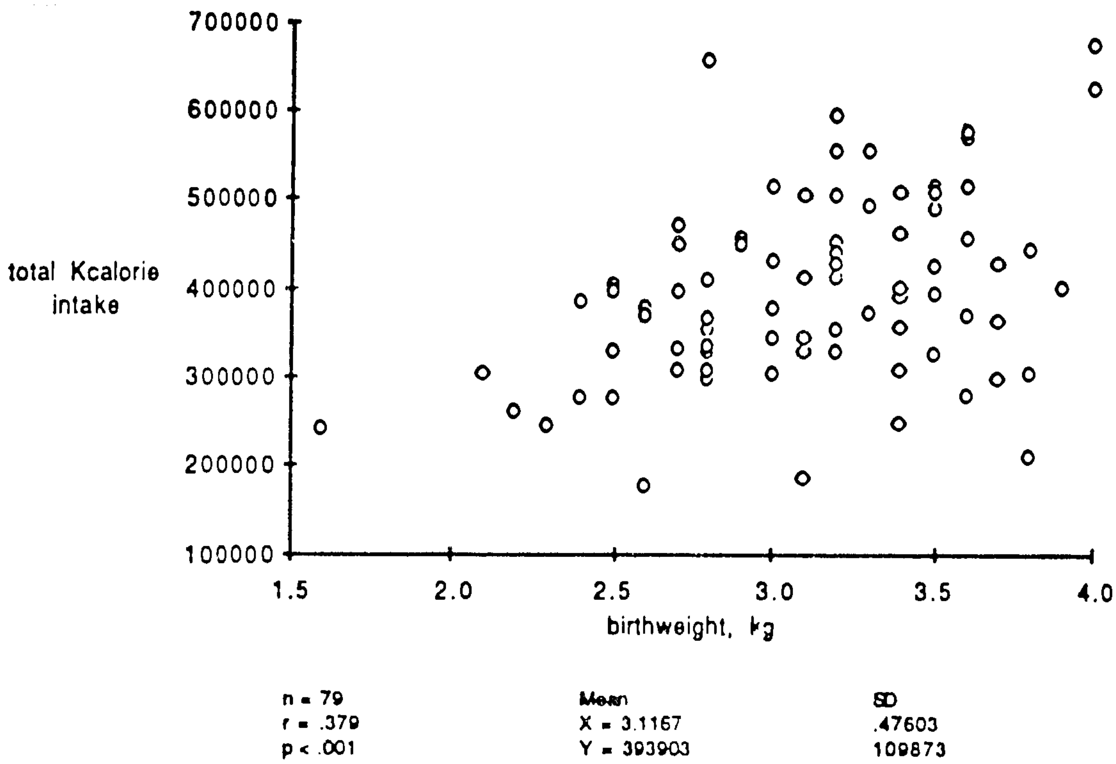


FIG. 23.7. Correlation between birthweight and total Kcalories consumed during pregnancy.

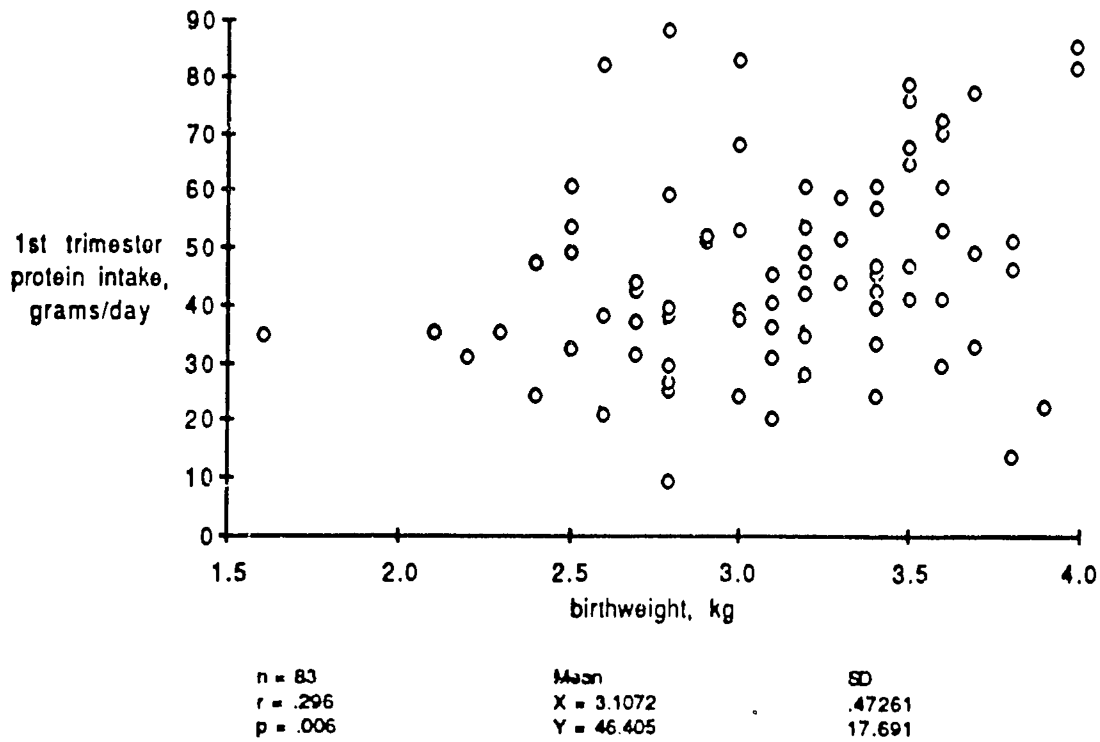


FIG. 23.8. Correlation between birthweight and first trimester maternal protein intake.

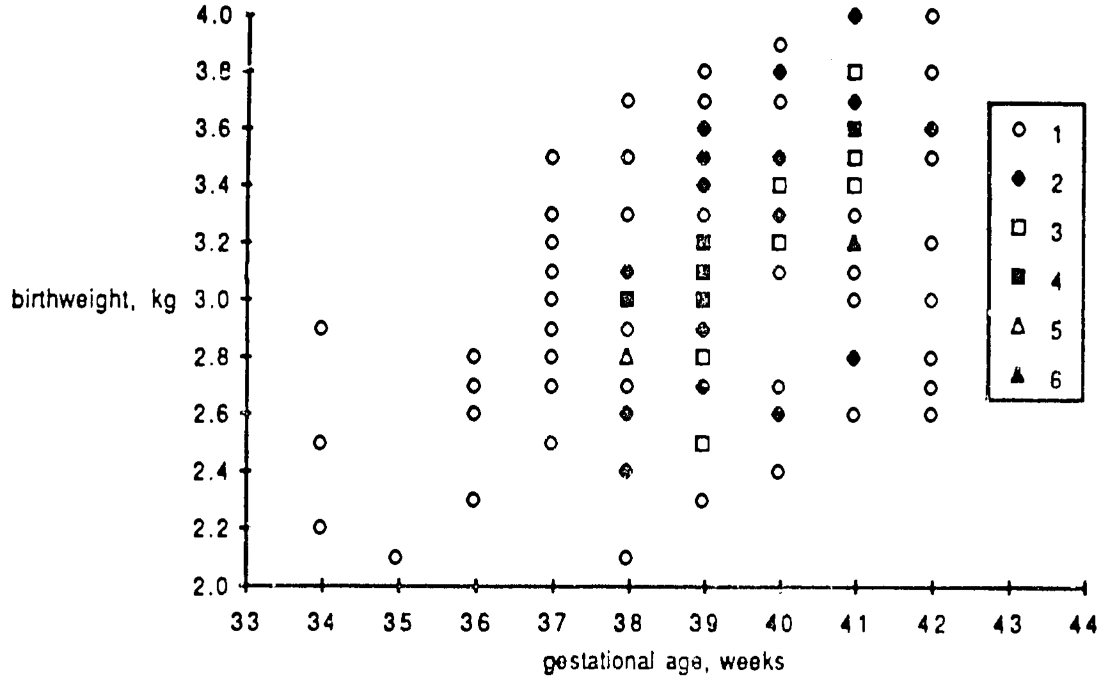
A large number of factors, in addition to food intake, correlate significantly with birthweight (see Table 23.21 and Figs. 23.9 and 23.10). The strongest relationship, as expected, is with gestational age. Maternal indicators of life-long nutritional status (head circumference and height) and more recent nutritional status (fat stores and weight upon entry into or early in pregnancy) are all positively related to BW, as is socioeconomic status. Significant illness, as already seen, relates negatively to BW.

TABLE 23.21
Significant correlations between birthweight and intervening variables.

		Correlation Coefficient (Intervening variables vs. BW)	p values
Intervening Variables	n=130		
Gestational Age		.60	<.0005
Maternal Age		.19	<.05
Maternal Pre-pregnancy Nutritional Status	n=82		
MUAC (mid upper arm circum.)		.32	<.002
Head Circumference		.36	<.001
Body Mass Index		.35	<.001
Pre-pregnancy weight		.34	<.001
Sum_3 Fatfolds		.29	<.005
Sum_6 Fatfolds		.39	<.001
Disease and Morbidity	n=127-130		
Significant Illness Index		-.24	<.01
Hematocrit		.17	<.06
Other Factors	n=127-130		
SES		.28	<.01
No. children < 6yr		.29	<.005
Females > 12yr		.24	<.01

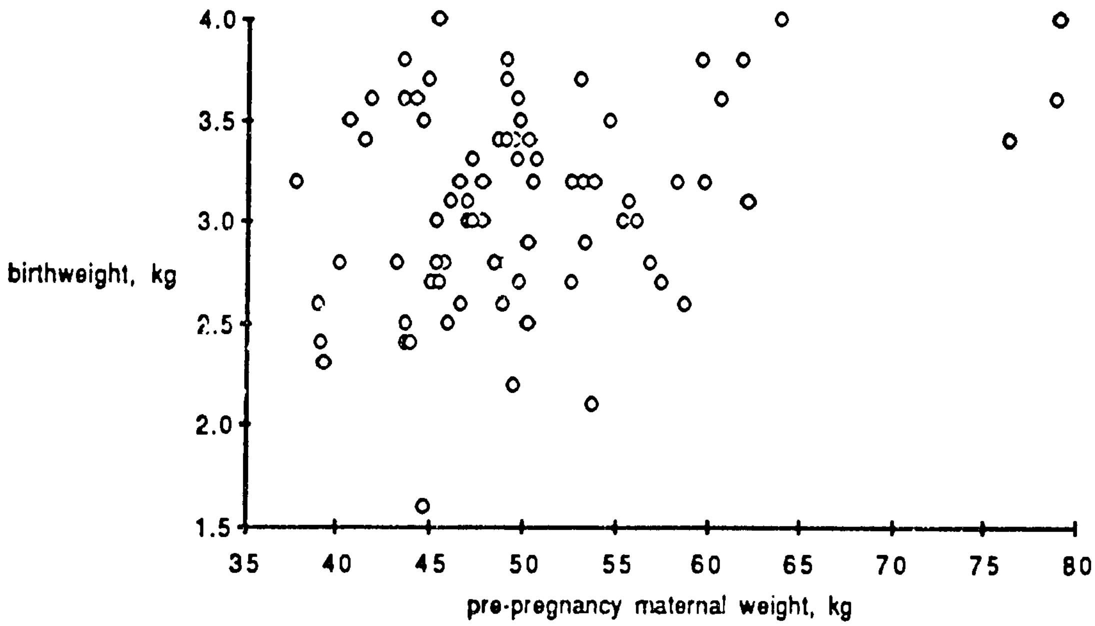
Multiple Regression Analysis of Birthweight

As for pregnancy weight gain, multiple regression analysis of the factors that predict birthweight are examined in addition to food intake variables. For selection of the best subset of variables to be used in the analysis of birthweight, BMDP9R was used. The variables considered for possible inclusion are:



n = 131	Mean	SD
r = .596	X = 39.15	2.096
p < .001	Y = 3.105	.476

FIG. 23.9. Correlation between birthweight and gestational age.



n = 82	Mean	SD
r = .327	X = 50.39	8.03
p = .003	Y = 3.11	.489

FIG. 23.10. Correlation between birthweight and pre-pregnancy maternal weight.

a. Maternal food intake

Total KCAL intake of the 2nd plus the 3rd trimesters (TOTKCAL2)
KCAL/kg/d in the 1st trimester (KCAL/kg 1)
Fat intake (gm/d) in the 3rd trimester (FAT3)
Protein intake (gm/d) in the 3rd trimester (PROT3)

b. Maternal age and size early in pregnancy

Maternal age
Weight in 1st trimester (WT1) same as prepregnancy weight
Sum of 3 fatfolds in 1st trimester (S3FF1)
Height (non-pregnant)
Change in sum of 3 fatfolds between 2nd and 3rd trimesters (D3FF23)
Change in percent body fat in 2nd and 3rd trimester (DFF23)
Weight gain in pregnancy from beginning of 2nd trimester to within 15 days of delivery (PE15)
Pregnancy weight gain between 2nd and 3rd trimester (DWT23)

c. Morbidity and disease

Significant illness index of 2nd trimester (SI2)
Significant illness index of 3rd trimester (SI3)
Hematocrit
Thyroid size
Stillbirth history

d. Household composition and SES

Number of children under 6 years
Socioeconomic status (SES)

Multiple Regression Model

The "best subset" of variables selected for prediction of birthweight is summarized in Table 23.22. The "best subset" accounts for 28% of the variation in birthweight. Variables contributing to the equation include, in descending order, TOTKCAL2, SI3, S3FF1, and KCAL/kg1.

TABLE 23.22
The best subset of variables used in the analysis of birthweight.

Variable	Standardized Regression Coefficient	p (2-tail)	Contribution to R^2
TOTKCAL2	.38	.003	.1357
KCAL1/kg	.20	.108	.0371
S3FF1	.24	.050	.0558
SI3	-.26	.042	.0606

n = 57 cases F stat = 4.99
R^2 = .278 p = .0018
CP = 1.17

<u>Summary</u>

Maternal food intake during pregnancy affects birth weight positively. Total Kcal intake over the entire pregnancy and over the second and third trimesters, and first trimester intake (especially Kcal, protein and fat) are particularly important. Pre-pregnancy Kcal intake is also of importance.

A number of intervening variables affect birth weight. Foremost is gestational age, followed by the mother's nutritional status upon entering pregnancy. Not only is recent nutritional status important, as represented by pre-pregnancy and 1st trimester weight and fat stores, but so to is her lifelong nutritional experience, as expressed by her height and head circumference. Women who have higher weights and greater fat stores give birth to larger infants. Socioeconomic status and all that it incorporates (e.g. better diet, literacy, food, housing, hygiene, and health care) is an important influence on the effect of food intake on birth weight. Finally, significant illness, particularly late in pregnancy, has a negative effect on birthweight.

<u>ANALYSIS OF EFFECTS OF MATERNAL INTAKE ON LACTATION</u>

The research question addressed here is: "Does maternal intake during lactation affect growth in the infant from zero to six months?" The effect of maternal intake on cognitive development and morbidity will be addressed at a later time.

The independent variables involved include the following: Kcal, fat, protein intake of the mother during pregnancy and lactation, and net available energy during lactation (NAEL defined above). The dependent variables are attained growth of weight and length at 6 months and the slopes (rate of growth) of infant weight and length. The infant data in the descriptive analyses are presented with both sexes combined to maximize the sample size.

A descriptive analysis based on correlation coefficients between maternal food intake during pregnancy, lactation food intake, and infant growth is presented before more complex analyses. Based on scatter plots, many of the relationships are linear, and therefore, correlation coefficients are appropriate. The effect of maternal intake during lactation on infant growth from 0 to 6 months is used as a "surrogate" for the relationship between maternal energy intake and lactation "performance".

Relationship Between Maternal Food Intake During Lactation And Infant Growth

Linear Growth

Maternal KCAL intake during the first four months of lactation correlates positively with all attained lengths from zero to six months of age (see Table 23.23). Maternal TOTKCAL intake during pregnancy and TOTKCAL2 (intake in the 2nd plus 3rd trimesters) also correlate positively with attained linear growth from zero to six months ($r = .28$ to $.38$).

TABLE 23.23
Correlation coefficients between maternal intake during lactation and infant length and slope of infant linear growth, (n = 81-120).*

Maternal Intake		Attained Infant Length (months) 1	2	3	4	5	6	Slope of Infant Linear Growth
KCAL	1	.23	.28	.19	.19			
	2	.21	.21	.20				
	3	.20	.19					-.24
	4		.19					-.19
	5							
	6		.20	.18				-.20
PROT	1	.20	.26		.21			
	2							
	3							
	4							
	5				-.20			
	6							
FAT	1	.24	.28	.23	.20	.18		
	2	.24	.23	.28	.20	.25		
	3	.21	.24	.21				-.19
	4	.20	.20			.18		
	5	.18	.18					
	6	.18	.23	.25		.26		

* Only statistically significant correlations are presented; $p < .05$.

However, the rate or slope of linear growth in the infant shows only negative correlations with maternal energy intake throughout lactation: A possible explanation may be that the larger women with large intakes have the largest infants. These infants, in turn, are seen to grow more slowly than the small infants.

Weight Gain in the Infant

The strongest positive correlations between maternal intake during lactation and attained infant weight are seen between: infant weight in the 2nd month with maternal kcal, protein, and fat intake throughout lactation; infant weight in the 3rd month with maternal protein intake; and infant weight in the 2nd through 5th months with maternal fat intake (see Table 23.24). There are no significant correlations between the rate or slope of infant weight gain with maternal energy intake variables.

TABLE 23.24

Correlations between maternal intake during lactation and infant weight and slope of infant weight gain (n = 81-120).

Maternal Intake		Attained Infant Weight (months) 1	2	3	4	5	6	Slope of Infant weight Gain
KCAL	1	.18	.27	.18				
	2		.21					
	3		.23	.18				
	4		.20		.19			
	5							
	6		.22					
PROT	1		.25					
	2							
	3		.23					
	4							
	5							
	6		.20					
FAT	1	.18						
	2		.24			.24	.20	
	3		.23					
	4		.25	.18	.19	.20	.21	.22
	5		.27	.19		.22		
	6	.18	.31	.21		.29		

* Only statistically significant correlations are presented; $p < .05$.

Infant Fat Stores

Maternal KCAL, protein, and fat intake during lactation correlate positively with nearly all infant attained monthly fatfold measures (see Table 23.25).

Net Available Energy

During lactation, both the absolute increase in maternal daily KCAL intake by 300 to 400 KCALS over pregnancy intake and the decrease in resting energy expenditure (REE) by 80 to 100 Kcal/d result in an increase in net available energy. Also, there is a 1.4 kg net postpartum weight gain in the mother which could furnish approximately 1.4 kg x 6500 Kcal/kg Kcals of energy available for lactation (10). This NAEL presumably would be used for maternal activity, lactation, and maternal weight or fat gain.

TABLE 23.25
Correlation coefficients between maternal intake during lactation and infant sum of fatfolds (n = 81-120).*

Maternal intake	mo.	Infant Sum of Fatfolds by Month: 1	2	3	4	5	6
KCAL	1						
	2	.20	.20				.20
	3	.18					
	4	.23	.25	.30	.29	.22	.28
	5	.23					
	6						
PROT	1						
	2	.21					.20
	3	.21					
	4	.29	.24	.29	.25	.17	.23
	5	.21					
	6						
FAT	1						
	2	.28	.27			.18	.27
	3	.25					
	4	.30	.31	.29	.29	.25	.24
	5	.20					
	6						

* Only statistically significant correlations are presented; $p < .05$.

Factors Other Than Maternal Intake Associated With Infant Growth

Gestational age (GA) and birth weight (BW) as well as infant length, head circumference, and fat stores at birth influence growth in the infant during the first 6 months of life.

Infant Linear Growth

The shorter the GA the steeper the slope for infant linear growth in the post-natal period. The same is true for the actual increment in length from 0 to 6 months. No effect of BW upon the slope of linear growth is found. There are positive and significant r's between GA and attained monthly length values from 0 to 6 months with a decrease over time, r = .37 to .20. Birth weight also shows very high associations with linear growth, again decreasing over time from zero to six months, r = .57 to .46. The birth length of the infant shows negative r's with the slope of linear growth, r = -.37. The shorter the infant at birth, the steeper is the slope of growth post-natally.

Infant Weight Gain

The influence of GA and BW on infant weight gain parallels the effect on linear growth. For GA and attained monthly weights from zero to five months, r = .43 to .25, the r values decrease over time but remain statistically significant ($p < .05$). For BW and attained monthly weights, r's equal .77 to .26, decreasing from zero to six months but still statistically significant. However, the actual increment in weight gained between 0 to 6 months shows no correlation with BW or GA. Arm circumference behaves much like weight in regard to GA and BW but with weaker correlations.

Infant Fat Stores

The relationships between the sum of fatfolds and BW and GA are positive and statistically significant during the 1st two months of age. However, the actual increment in sum of fatfolds shows no relation to GA or BW.

Infant Head Circumference

Head circumference is positively correlated with GA and BW. Correlation coefficients between monthly HC measurement and GA from zero to six months range from .40 to .12, and for BW from .68 to .44 in descending order. The actual increment in HC shows significantly negative r's with GA and birth weight, supporting the finding that babies with the smallest heads at birth show the greatest head growth during the first six months, assuming an adequate energy and nutrient supply and normal brain development.

Relationships of Maternal Anthropometric Status and Infant Growth

The anthropometric status of the mother before and during pregnancy and lactation exerts an effect on infant growth probably through shared genetic factors and/or environment. Paternal factors will be examined at a later date.

Maternal Weight and Height

Maternal pre-pregnancy weight, weight in all trimesters of pregnancy, postpartum net weight gain, and all maternal weights during lactation show consistently positive r's with monthly infant weights and the actual infant weight increment from zero to six months. No correlations were seen with the slope or rate of weight gain. The relationship between infant linear growth from zero to six months and pregnancy weight gain is also positive (see Table 23.26).

Maternal net postpartum weight gain has a positive association with increases in infant MUAC and infant fatfolds. The mother's body mass index during lactation, and infant attained monthly weights show consistently high correlations ($r = .80$) which are consistent with the above findings.

Maternal height correlates significantly with all infant monthly attained length measurements, as does weight (see Table 23.26).

Maternal Fat Stores

Maternal fat stores and infant weight gain, in general, show positive associations. All parameters of maternal fat stores (SumFF, percent body fat, and arm fat area) in pregnancy and lactation correlate positively with infant weight gain (Table 23.26). The highest r's are seen between maternal thigh and subscapular fatfolds in lactation and infant weight gain. Thigh fatfolds appear to be more responsive to energy changes during lactation than the other measured fatfolds.

Linear growth in the infants is correlated negatively with the abdomen, thigh, and suprailiac fatfolds in the mother during lactation, $r = -.17$ to -22. The mothers with the largest fatfolds have the larger infants, who have been found to have smaller increments and slope in linear growth than the smaller infants. Only during the 3rd to 6th month of lactation are there positive correlations between maternal fat stores with infant rate of linear growth. Arm fat area was found to be positively associated in pregnancy and lactation with attained length of the infant, $r = .25$ to .32, $p < .05$ - .001.

In the 2nd and 3rd trimesters of pregnancy, the SumFF and percent body fat correlated highly with infant monthly fat fold values ($r = .35$ to .38). The larger the gain in maternal fat stores in the second trimester of pregnancy, the greater the increase in fatfolds, and MUAC in the infants are seen from zero to six months of life. It would appear that maternal fat deposition in the second trimester of pregnancy and during lactation contributes to the success of lactation and is supportive of infant post-natal growth, probably through a positive effect on lactation.

TABLE 23.26
Relationship between maternal size and fat stores in pregnancy and lactation and infant growth (n = 81 - 120).*

		Maternal Weight Trimesters			Height	Sum of 6 Fatfolds Trimesters		
		1	2	3		1	2	3
PREGNANCY	MOS							
Infant Length	1	.40	.43	.41	.24	.27	.23	.20
	2	.43	.38	.35		.31	.31	.30
	3	.38	.27	.25	.26	.23	.26	.24
	4	.40	.36	.34	.24	.29	.32	.32
	5	.43	.35	.35		.32	.35	.33
	6	.39	.28	.29	.22	.32	.35	.36
Infant Length	1	.44	.43	.42	.20	.37	.31	.29
	2	.34	.34	.35		.20	.18	.18
	3	.23	.23	.26		.21	.19	.20
	4	.30	.29	.28		.22	.21	.24
	5	.33	.31	33		.24	.20	.22
	6	.43	.31	.29		.27	.25	.29
		Periods				Periods		
		1	2	3		1	2	3
LACTATION	MOS							
Infant Length	1	.40	.43	.41	-		.23	.22
	2	.43	.38	.35	-	.21	.22	.23
	3	.38	.27	.25	-			
	4	.40	.36	.34	-		.19	.23
	5	.43	.35	.35	-		.19	
	6	.39	.28	.29	-		.19	
Infant Length	1	.44	.43	.42	-	.30	.36	.32
	2	.34	.34	.35	-	.19	.27	.24
	3	.23	.23	.26	-	.22	.21	
	4	.30	.29	.28	-	.24	.30	.28
	5	.33	.31	.33	-	.26	.31	.28
	6	.43	.31	.29	-	.19	.25	.22

* Only statistically significant correlations are presented; $p < .05$.

Effects of Supplemental Infant Feeding On Infant and Mother

Intake of supplementary Kcals by infants was obtained by the usual quantitative methods for food intake (see Chapter 6). Supplemental foods consisted mainly of gruels, cow's milk, and thin soups. These were started from as early as one to three months of age.

An effect of supplemental feeding was sought, not only on infant growth and on breast feeding, but also on maternal anthropometric status during lactation. The questions for consideration are: Does early supplementation of the infant reduce the energy requirements for the lactating mother and allow her to restore her body mass and fat stores lost during the end of pregnancy and in the first 2 months of lactation? Does supplemental feeding result in a poorer weight gain and growth for the infant through an increased risk of illness, especially diarrheal disease, and also by depriving the infant of breast milk?

There are no statistically significant correlations noted between infant supplemental intake and weight gain. With slope of linear growth a negative correlation is seen at five months of age.

A weak but statistically significant correlation is seen only with attained monthly length values in the fifth month. It appears that the bigger the infant the more supplemental kcals they were fed. Slope of linear growth shows weak negative correlations with infant intake in months two and five (r's = -.17 to -.19; p < .05). With infant fatfolds, supplemental infant correlations are mainly negative and not significant.

During lactation, only in the first month of infancy, the more Kcal supplementation an infant received, the greater was the increase seen in maternal fatfolds. There are consistently high and positive r's between infant supplemental Kcal intake in the first month and maternal fatfold measurements (see Table 23.27). Therefore, the more supplementation the infant receives in the first month, the more fat the mother can accumulate, presumably due to the decreased demand for energy and breast milk by the infant.

Low negative correlations are seen between pregnancy fat gain (Sum3FF and percent body fat) and infant supplementation. The greater the fat storage during pregnancy, the less are supplemental foods given to the infant. It appears that it is the women who store the most fat in pregnancy that are best able to nurse their infants and therefore rely less on supplemental feedings (see Table 23.29). Although few negative correlations are statistically significant, negative associations are consistently found.

The less maternal available energy in all trimesters of pregnancy, the more likely the mother was to use supplemental feeding for her infant (r values of -.20 to -.72). Also, during all periods of lactation, the lower the NAEL the greater the amount of infant kcal supplementation. It was also noted that the greater the maternal energy intake during lactation the less supplemental feeding was given to the infant, r = -.38, -.23 in months three and five. The presumption is that more breast milk was being produced with less supplemental feeding felt to be needed.

Which mothers are more apt to use supplementation? It appears that mothers who had stillbirths in the past started supplemental feeding more often in the first month, (r = .30). The greater the total number of live births and pregnancies, the less likely was the mother to use supplemental foods (r = -.24 to -.23). Those infants of higher GA were more likely to have been given supplemental feeding in the second to fifth months of life (all r's presented are statistically significant, p < .05).

The literacy of the father and the mother, SES, and household sanitation scores are positively associated with the use of supplementary feeding of the infant. In considering household composition, the greater the number of children under 6 years in the household, the less likely was the mother to use supplementary infant feeding. In contrast, households with more than one female over 12 years were the more likely to supplement the infants.

As for the effects of illness, the more malaria reported or found in the mother the less likely she was to use supplemental infant feeding. Total significant illness and low grade illness indices in each of the pregnancy trimesters were associated with greater use of supplemental feeding in the infants.

The more significant illness the mother had during lactation, the less likely she was to use supplemental food. This suggests that the sick mother found breast feeding to require less effort and she was not likely to make the extra effort to give supplemental foods to the infant early in life. However, the more illness she experienced after three months, the more likely she was to supplement the baby. The reasons given by the majority of mothers for supplementing their infants were that they felt they did not have enough milk to satisfy the baby and that the baby was hungry.

TABLE 23.27
Correlation coefficients between infant supplementation and maternal lactation fat stores (n = 81-120).*

Maternal Fatfolds	Period	1st Month Infant Kcal Intake
S3FF	1	
	2	.27
	3	.37
S6FF	1	.23
	2	.28
	3	.34
Triceps	1	
	2	.30
	3	.37
Abdomen	1	.21
	2	.28
	3	.25
Thigh	1	.28
	2	.24
	3	.30

* Only 1st month of supplemental intake showed statistically significant correlations; $p < .05$.

TABLE 23.28
Correlation coefficients* of the relationship between maternal change in fat stores in pregnancy and infant supplemental feeding (n = 90-120).

Maternal fat stores	Infant Kcal Intake by Month 1	2	3	4	5	6
Change in S3FF	-.14	-.14	-.08	-.14	-.12	-.16
Change in % Fat	-.11	-.15	-.03	-.10	-.06	-.15
Change in SFF Postpartum	-.14	-.08	-.02	-.23†	-.12	-.12

* $p < .10$
† $p < .01$

The Effects of Infant Illness on Infant Growth

The number of days with fever in months zero to six show low negative r's with attained monthly length in the 1st through 3rd months of age (r's = -.17 to -.19, $p < .05$). Fever, in particular, is associated with poor linear growth. Diarrhea had a negative effect on the infant's fat stores in months five and six (see Table 23.29).

For weight, the heavier the babies were at one month, the more respiratory illness they experienced ($r = .22$). It has been documented in the literature that fat babies have increased respiratory infections. As for days of fever, a weak negative influence on infant's weight in months five and six was seen, ($r = -.18$; $p < .05$) (see Table 23.29). There are some significant negative correlations between infant growth variables and significant illness in the infants (see Table 23.30).

TABLE 23.29
Relationship between infant illness and infant size from 0 to 6 months.*

Variables	Month	Correlation Coefficient
Days of Respiratory Illness vs. Weight	1	.21
Days of Fever vs. Weight	5	-.18
Days of Malaria vs. Length	1	-.28
	2	-.17
	3	-.19
Splenomegaly vs. MUAC	2	-.18
	3	-.17
	4	-.21
	5	-.18
	6	-.19

* Only statistically significant correlations are presented; $p < .05$.

TABLE 23.30
Relationship between infant significant illness and infant size (n=120).*

Infant Growth	Mos	Infant SI by Month					
		1	2	3	4	5	6
S3FF	1						
	2		-.21				
	3		-.23				
	4		-.19				
	5		-.26		-.25		
	6						-.22
WT Slope							-.25
Fat Increment							-.25

* Only statistically significant correlations are presented; $p < .05$.

Summary

In summary, maternal food intake, both in pregnancy and lactation, does affect infant size and growth. Other very important factors are maternal nutritional status, maternal fat stores in pregnancy and lactation, and infant morbidity. The effect of supplemental feeding on infant growth is slightly negative and on the mother's fat stores is positive.

Multiple Regression Models for Infant Growth

The following classes of variables were considered for inclusion in a multiple regression analysis, based on the results of simple correlation analyses and the research questions. The BMDP9R program for the selection of the "best subsets" of variables to be included in the regression was used.

a. Maternal Food Intake

Pregnancy: TOTKCAL in 2nd plus 3rd trimesters.
Lactation: KCALL1 (maternal KCAL intake during the first lactation period), protein and fat each: 0-135d and 136-180d. The lactation intervals used are based on the fact that infants between 0-135 days are mostly breastfed, while between 136-180 days they receive a considerable amount of supplemental Kcals which probably makes them less dependent on maternal intake and breast milk.

b. Infant Characteristics

Birth weight, length, head circumference, and gestational age. Supplemental KCAL (daily mean intake) 0-3 months and 4-6 months

c. Maternal Anthropometric Characteristics

Pregnancy : Weight change between 2nd to 3rd trimester.
Lactation : Postpartum net weight gain (8-10 days pp).
Change in Sum3FF between 0-6 months (D S3FF).
Change in weight between 0-6 months (D WtL).

d. Morbidity

Maternal total Significant Illness index (tot SI) in lactation at 0 to 6 months) Infant total Significant Illness index (tot ISI) from 0 to 6 months of age.

e. Infant Length

Attained infant length at six months
Slope of infant linear growth

f. Infant Weight

Attained infant length at six months
Slope of infant weight gain

Multiple Regression Model for Attained Infant Length at 6 Months Using the "Best Subset" of Variables.

The "best subset" of variables obtained for analysis of attained infant length at 6 months of age using a sample of 68 cases is summarized in Table 23.31.

With 68 cases included, the R^2 was found to be 0.41. Birth weight exerts the strongest effect, accounting for approximately one-third of the variation in length at 30 months. Gain in maternal weight and fatfolds during the 2nd trimester of pregnancy explain a small but significant amount of the variation, respectively. Infant supplemental Kcal intake has a small negative effect.

Although TOTKCAL2 intake in pregnancy (2nd plus 3rd trimester) and fat intake in the 5th and 6th months of lactation were not included among the selected variables, they were included among the next best subsets. The effects of other food intake components are negligible.

TABLE 23.31
"Best subset" of variables for attained infant length at 6 months (n=68).

Variables	Standard Regression Coefficient	p value	Contribution to R^2
Infant supplemental kcal 1-3 months	-.19	.000	.0353
Birth weight	.59	.056	.3340
Maternal fat change S3FF (pregnancy)	.23	.000	.0476
Maternal change WT (lactation)	.24	.022	.0517

CP = -2.03 $R^2 = 0.41$
F stat = 11.1 $p < .001$

Multiple Regression Model for Slope of Linear Growth Using the "Best Subset" Variables.

As shown earlier, all maternal food intake variables correlate negatively with the rate or slope of linear growth. Negative and statistically significant r's are also seen with infant supplemental Kcal and gestational age.

The "best subset" of variables selected by program BMDP9R using a sample of 75 cases is summarized in Table 23.33. With 75 cases included the R^2 is 0.24. The contribution of maternal food intake variables to the variation in slope of linear growth is modest, with maternal fat intake exerting a positive effect and maternal Kcal intake a negative effect. Gestational age exerts the strongest effect (negative) on the slope of linear growth, and gain in maternal fat in the 2nd trimester of pregnancy has a positive effect.

It was observed that the more mature infants have a lower rate of linear growth than the more mature infants. The negative effect of maternal Kcal intake may merely reflect that it is the larger mothers with larger infants that have higher Kcal intakes rather than mothers with smaller infants.

TABLE 23.32
"Best subset" of variables for slope of linear growth (n=75).

Variables	Standard Regression Coefficient	p value	Contribution to R^2
Maternal KCAL intake in 1st and 2nd lactation pd (0-4 1/2 months)	-.21	.000	.0319
Maternal fat intake in 2nd lactation pd (1 1/2 - 4 1/2 months)	.28	.034	.0522
Gestational Age	-.34	.005	.0946
Postpartum wt (8-10d)	-.19	.110	.0301
Maternal change S3FF23 pregnancy	.23	.039	.0494

CP = -0.09 F stat = 3.64
R2 = 0.24 p(2-tail) < 0.005

Multiple Regression Model for Attained Infant Weight at 6 Months Using the "Best Subset" Variables.

The "best subset" of variables selected for attained infant weight at 6 months of age from a sample of 69 cases contains four variables. These are summarized in Table 23.33. Birthweight and maternal weight gain in lactation exerts the largest effect on the variation of infant weight at 6 months

This best subset model includes 4 variables, none of which are food intake variables. The next best subset which includes food intake variables and still satisfies the criteria of the smallest CP and highest R^2 includes all of the above variables plus maternal fat intake from 1 1/2 to 4 1/2 months of lactation. The R^2 is 0.27 and CP 1.37. Maternal fat intake in lactation adds very little to the R^2.

Multiple Regression Model for Slope of Infant Weight Gain Using Best Subset Variables

The "best subset" of variables for slope of infant weight gain using a sample of 75 cases is summarized in Table 23.34. The contribution of maternal intake, whether in pregnancy or lactation, is negligible and these variables are not included in the best subset.

Infant supplemental Kcal intake has a negative effect on the variation in slope of weight gain. Mothers' weight change in lactation and SES each account for a small contribution to the variation.

TABLE 23.33
"Best subset" of variables for attained infant weight at 6 months (n=69).

Variables	Standard Regression Coefficient	p value	Contribution to R^2
Birth Weight	.28	.000	.0712
Maternal wt gain 2nd preg. trim (D WT 23)	.17	.015	.0283
Maternal wt change in lactation (DWTL)	.38	.001	.1394
SES	.18	.11	.0310

CP = -.14 F stat = 5.8
$R^2 = 0.27$ p(2-tail)< 0.0005

TABLE 23.34
"Best subset" of variables for slope of infant weight gain (n=75).

Variables	Standard Regression Coefficient	p value	Contribution to R^2
Infant Supplemental KCAL intake in months 1-3. (KCAL 13)	-.19	.09	.0350
Maternal weight change in lactation (DWTL)	.32	.005	.0992
Socioeconomic status	.19	.087	.0362

CP = -6.19 F Stat = 4.15
$R^2 = 0.15$ p(2-tail) < 0.01

Summary

The effects of maternal intake on infant growth by multiple regression analysis are very modest. Gestational age is a negative factor in regard to the slope of linear growth - the less mature the infant, the greater the rate of linear growth. As for attained infant weight at 6 months, maternal weight gain during lactation and SES are important factors. Maternal wt gain in lactation and SES are also determinants of slope of weight gain, but infant supplemental KCAL has a negative effect on weight gain when considered together with other variables.

CONCLUSIONS REGARDING THE EFFECT OF MATERNAL FOOD INTAKE ON PREGNANCY OUTCOME AND INFANT GROWTH

The Kenya sample of women enter pregnancy with generally low body weights, short stature and less body fat than found in Egyptian, urban Kenyan and U.S. women. Weight for height is between 90-93% of the medium and wasting is not common. In contrast to the recommended increase of 75,000 to 80,000 kcal during pregnancy, energy intake decreases during pregnancy compared to intake among non-pregnant women and continues to decline with each successive trimester. This situation was further complicated by the drought of 1984, although 3rd trimester decline is also seen in the non-famine year. Voluntary limitation of intake in the 3rd trimester is often seen in Kenya. Pregnancy weight gain is less than half of the recommended pregnancy weight gain of 12.5 kg. The resting energy expenditure increases only slightly during pregnancy.

Despite all of the above, the mean birth weight of the newborn is 3.1 kg, about 300 to 400 grams less than European and American infants, with 10% of infants small for date and 9% pre-term. The number of infants with birthweights between 2500 and 2800 gms is sizable (14%). Maternal fat storage in the 2nd trimester of pregnancy and the net pregnancy gain in weight are less than half of that seen in well-nourished populations. Also in the Embu sample, fat loss is seen in the 3rd trimester and weight loss is seen in the 9th month of pregnancy among a large percentage of the women. The effects of the severe drought accentuated these phenomena, and careful analyses will have to be carried out.

Maternal food intake during pregnancy (particularly Total Kcal and fat intake) explains less than 20% of the variation in the relationship between pregnancy weight gain and birth weight. A consistent finding is that maternal size (height and head circumference) is a major determinant of pregnancy outcome, as are prepregnancy energy reserves (W/H, fatfolds, etc.). These findings have implications for intervention - particularly long term intervention. The data indicate that serious consideration should be given to designing interventions for females that monitor their growth throughout their lifespan (particularly during weaning, toddler years, and the school years), so that by the time they reach the reproductive years they will enter pregnancy in optimal nutritional condition. This type of strategy could prove to be the most productive approach for improving pregnancy outcome.

A similar picture of low intake and weight gain with near normal or normal birth weights has been seen in the Machakos Studies (9) and The Gambia (11). The recommendation that women ingest 80,000 KCALS over the course of pregnancy and gain 10 to 12 kg seems unrealistic and may not be appropriate. The data, although in the early stages of analysis, shed some insight into adaptations by the study women in the face of decreasing energy intake and increasing energy needs during pregnancy. One adaptation, revealed by the time allocation studies, is that physical activity is reduced by 50% compared to non-pregnant women. Another suggested adaptation is that the resting energy expenditure increases only very slightly and is only a fraction of the increase seen in women studied in the U.S. This type of adaptation was reported in The Gambia and elsewhere. The main effect of the drought (and the subsequent period of famine-like conditions) in 1984 was decreases in weight and fat gain during the 2nd trimester and the 9th month, as well as greater fat loss in the 3rd trimester of pregnancy. Also, for the women whose last trimester coincided with the famine, the percent delivering infants with birth weights between 2500 and 2800 grams doubled (from 14 to 28%).

The slightly stronger relationships between food intake and pregnancy weight gain and birth weight in the presence of goiter suggest the possibility that women who develop goiter might be better compensated than those who do not. This will be further examined with thyroid hormone levels using a subsample. Goiter is common among female schoolers and women, but less common among men. Iodized salt is rarely used in this area; its use would be highly recommended in any case.

The "Margin of Safety" and Possible Sequelae of Poor Weight Gain and Intake

The fact that women can produce infants of near normal birth weight in the face of low energy intake and low weight gain has been confirmed in several studies. The question is - are there any negative consequences to this situation?

The 2nd trimester and 3rd trimester fat stores increase very little, with fat actually lost late in pregnancy. In part, the women who lose fat have higher BW infants. It is as if the mother dips into her own reserves for needed energy. Also, activity decreases. The effect of the presence of a pregnant woman in the household needs to be examined particularly upon morbidity, child care, and food production. Decreased activity within the household may adversely affect the household and may be one of the costs of pregnancy.

Another area of concern is the fact that study newborns are 300 to 400 gms lighter than the offspring of well-nourished women. Each 100 to 200 gms of decreased birthweight has been seen to increase the risk of morbidity (12). Three low birthweight infants (out of 133 infants) did die within the first week of life during the course of the study. This yields a perinatal death rate of 23 per 1000 live births (North America is 10-14/1000 live births).

One last area of concern evidenced by the data is that by 4 to 5 months, infants are beginning to decrease their rate of linear growth and their rate of weight gain.

Effects of Maternal Food Intake During Pregnancy and Lactation on Infant Growth

As with pregnancy weight gain, maternal food intake plays a definite but modest role in infant growth. Using infant growth as a surrogate for lactation performance is complicated in the Embu setting because of the early KCAL supplementation that is given to infants (starting as early as one month of age) which tends to weaken any relationship between maternal intake and infant growth.

The factors that stand out more than maternal food intake in regard to infant size are maternal nutritional status, birthweight, and gestational age. Maternal height, weight, head circumference, and fatfolds in pregnancy and lactation show positive correlations with all attained infant weights and lengths at 6 months. However, the rate of growth is consistently slower for the larger and more mature infants. The smallest and the least mature infants grow more rapidly than the larger infants, particularly in length.

Illness is seen to play a negative role in infant growth. Those infants with a high incidence of significant illness, particularly with fever and diarrhea, grow and gain less well than infants with less illness. Infection is catabolic and diverts energy from growth.

One set of findings with implications for intervention programs and policies involves maternal fat and weight gain status during lactation. Those women who maintain or increase their body weight and/or fat stores are better able to support their infant's growth than those losing weight or fat during lactation. A recommendation can be made to institute a monitoring system to follow lactating women for weight loss and fat loss. These women could be monitored by weight and arm circumference (which correlates highly with triceps fatfolds) when their infants are brought for growth monitoring. Women found losing weight or arm circumference could be supplemented and/or given special nutritional attention.

Returning to the issue of supplemental infant feeding, this practice appears to be quite widespread in the area. In fact, according to a Central Bureau of Statistics report, formula feeding in Embu District is among the highest in Kenya (15). The Embu study area mothers actually use little commercial formula but mainly cow's milk and maize gruels. The illness incidence was no higher in the supplemental infants than non-supplemental groups. When combined with other variables in a multivariate model supplemented feeding had a slight negative effect on growth. The infant receiving supplemental feedings may be deprived of breast milk. The dilemma is that the practice of early supplementation appears to be well established. The Ministry of Health's policy is to promote breastfeeding until 4 to 6 months. This is a sound policy but further research is needed about what is being given for supplementation and how it is prepared. This would help assure timely and safe supplementation.

Despite the limited in-depth data analyses to date, findings are already emerging with important program and policy implications. Caution of course is needed until further analysis confirms and expands these findings.

REFERENCES

1. WHO, FAO. Joint Expert Committee. Energy and protein requirements. WHO Technical Report Series No. 724. Geneva, 1985.

2. Worthington-Roberts B.S., Vermeersch J., Williams S.R. Nutrition in pregnancy and lactation. C.V. Mosby Company, London, 1981.

3. Hamil P.V.V., Drisa T.A., Johnson C.L., Rea R.B., Roche A.F, Moore W.N. Physical Growth: National Center for Health Statistics Percentiles. Am. J. Clin. Nutr. 32: 607-629, 1979.

4. Durnin J.V.G.A., Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16-72 years. Br J Nutr 32: 77-97, 1974.

5. Gurney J.M., Jelliffe D.B. Arm anthropometry in nutritional assessment: nomogram for rapid calculations of muscle-circumference and cross-sectional muscle and fat areas. Am J Clin Nutr; 26:912, 1973.

6. Metcalf J., Klein E.M., Nichols B.L. Proceedings of a workshop on the nutrition of the child: maternal nutritional states and fetal outcome, Houston. Am J Clin Nutr; 34: 653-817, 1981.

7. Thomson A.M., Hytten F.E. Nutrition during pregnancy. World Review of Nutrition and Dietetics; 16: 22, 1973.

8. van Ginneken J.K., Muller A.S. Maternal and Child Health in Rural Kenya: an epidemiological study. Croom Helm, London, 1984.

9. Nagy L.E., King J.C. Post parandial energy expenditure and RQ during early and late pregnancy. Am J Clin Nutr, 1984; 40:1258-1263.

10. Manning-Dalton V.C., Allen L.H. The effects of lactation on energy and protein consumption, postpartum weight change and body composition of well nourished North American women. Nutrition Research; 31: 213-308, 1983.

11. Afifi A.A., Clark V. Variable selection in regression analysis. In: Computer-Aided Multivariate Analysis. Lifetime Learning Publications, Belmont, CA., 1984.

12. Tafari N. Low birthweight: an overview. Advances in International Maternal and Child Health, Vol. 1, edited by D.B. Jelliffe and E.F.P. Jelliffe, pp. 105-127, 1981.

13. Neumann C.G , Stiehm E.R., Zahradnick J, et al. Immune function in intrauterine growth retardation. Nutrition Research, 1984; 4: 399-419.

14. Whitehead R.G. Factors influencing lactation performance in rural Gambian mothers. The Lancet, July 22, 1978.

15. Republic of Kenya. Third rural child nutrition survey, 1982. Central Bureau of Statistics, Ministry of Finance and Planning, December 1983, Nairobi, Kenya.

Chapter 24

EFFECTS OF FOOD INTAKE ON TODDLER COGNITION AND BEHAVIOR

The original Nutrition CRSP research question focussed on the effect of food intake on the cognitive function and behavior in children 18 to 30 months of age. This question has been broadened to also assess the contributions made by illness and rearing conditions on the individual differences noted on standardized measures at 24 and 30 months and in behaviors observed in the home during the last period of observation.

To answer this question, two other questions must also be addressed in the analysis carried out on the toddler data:

1. Based on the child-rearing observations carried out every two months, how were toddlers reared and how consistent were rearing patterns?

2. How did children develop, in terms of their behavior observed in the home and their scores on standardized assessments, and how consistent were individual differences from 15 to 30 months?

BACKGROUND

The data used to address the research questions mentioned above came from both home observations and standardized assessments (see chapter 11). The following rearing variables were considered: physical care, holding, touching, talking to the child, social interaction, responsiveness to child vocalizations, and responsiveness to child distress. In order to assess the consistency in individual patterns of rearing, the data were divided into blocks representing observations during five age periods, 15-18 months (a few toddlers were enrolled into the study early before the age of 18 months), 18-21 months, 21-24 months, 24-27 months, and 27-30 months. Correlations were calculated between the frequency of each behavior pattern from one period to the next.

There was strong consistency in the individual differences in the extent to which toddlers were held, talked to and their vocalizations responded to. There was consistency in the duration of social interactions only in the first six months of observations. There was no consistency from one period to the next in the extent to which an individual toddler was physically cared for or touched and only stability from 18 to 27 months in responsiveness to distress. As might be expected, it was found that the rearing conditions in which individual differences remained stable over time were the ones most highly associated with the child's behavior and development (see Appendix H, Table H.3).

Toddler behavior and development was assessed with the Bayley Scale and several of the Uzgiris-Hunt Scales at 18, 24, and 30 months of age, and a play observation carried out at the end of the Bayley administration at 30 months. The Bayley Behavior Record was completed at the end of each testing. Home observations were used to assess toddlers' affect and object play. The frequency of smiling, crying, and talking was recorded during the home observation. In addition, the number of intervals in which object play occurred was noted, with play differentiated into simple play, functional play, and symbolic play. Continuity in development as measured by the Bayley Scale was strong; the correlations from one test period to the next were r = .55 for samples of 96 to 101 children. There was no continuity in object permanence items of the Uzgiris Hunt Scale.

In the other Uzgiris Hunt Scales, there was moderate continuity from one period to the next (the Imitation and Schemes Scales were only used at 18 and 24 months). A factor analysis of the eight behavior ratings used at all three testings provided one to two factors at each session. One factor represents attention span while the other includes all other behaviors with fearfulness negatively correlated with the other ratings. For this reason, three behavioral ratings have been used, attention span, fearfulness, and test behavior (the sum of the other ratings). There is no continuity in attentiveness, moderate continuity in fearfulness, and significant continuity in the global rating of test taking behavior. However, this variable is strongly associated with the Bayley Score (r = .62) so it is unlikely to furnish additional information.

Toddlers' behavioral patterns observed in the home showed some areas of consistent individual differences in the frequency of talking, symbolic play, and smiling. There was no stability in individual differences in simple, functional, or total play or in the frequency of crying. Correlations were computed using the total score on the Bayley Scale administered at 30 months of age with the means for the seven home rearing variables. The mean age of the child at the time of the home observations was partialled out of the correlations between rearing variables and Bayley Score. This analysis showed that the following rearing variables were associated with Bayley Score: Talking, Social Interaction, Verbal Responsiveness, and Child being held (a negative association).

The remainder of this chapter presents preliminary findings regarding the associations between toddler food intake, health conditions, physical stature and cognitive development. Additional reports of toddler cognitive analyses are in Appendix H.

ASSOCIATIONS BETWEEN FOOD INTAKE AND SUBSEQUENT BAYLEY SCORES

Descriptions of the food intake variables and Bayley scores are presented in Chapter 6 and 11. Pearson correlations were computed between five food measures (Kcal, protein, fat, carbohydrates, and iron consumed in the period from 18 to 24 months, and 24 to 30 months) and three Bayley scores (the total items passed on the Bayley Mental Scale administered at 24 and 30 months and on the Bayley Motor Scale administered at 30 months). The results are shown in Table 24.1.

ASSOCIATIONS BETWEEN FOOD INTAKE FROM 18 TO 24 MONTHS OF AGE AND 24-MONTH BAYLEY MENTAL SCORES

There is a significant association between the mean daily fat intake by the toddlers between 18 to 24 months of age and their total score on the Bayley Mental Scale. The 24 month Bayley mental score can be subdivided into those items measuring verbal abilities and those items measuring non-verbal cognitive and perceptual abilities. Only fat intake has any relation to Bayley Verbal scores at 24 months (r = .20). However, all food intake variables are associated with Bayley Performance scores at 24 months; r's range from .20 to .25. Thus, there are significant associations between food intake of the toddlers from 18 to 24 months of age and their skills, particularly nonverbal abilities, at 24 months of age. The significant positive correlation of iron intake and the performance score at 24 months ($r = .21$; $p < .05$) is of interest as iron deficiency is important in cognitive performance (1). Serum ferritin will be of interest in future analyses.

TABLE 24.1
Correlations between nutritional factors and Bayley Scores at 24 and 30 months of age.*

Food Intake	24 months Bayley Mental	30 months Bayley Mental	30 months Bayley Motor
18-24 months (n=99)			
Kcal	-	-	-
Protein	-	-	-
Fat	.24	-	-
Carbohydrates	-	-	-
Iron	-	-	-
24-30 months (n=105)			
Kcal	-	.19	.23
Protein	-	-	-
Fat	.28	.24	-
Carbohydrates	-	-	.23
Iron	-	-	-

* All correlations shown are significant, $p < .001$.

ASSOCIATIONS BETWEEN FOOD INTAKE FROM 18 TO 24 AND 24 TO 30 MONTHS OF AGE AND 30-MONTH BAYLEY MENTAL AND MOTOR SCORES

Food intake between 18 to 24 months is not associated with Bayley Mental Score at 30 months, and this is true for both Bayley Verbal Score and Bayley Performance score. Food intake between 18 to 24 months is also not associated with Bayley Motor score at 30 months.

Food intake between 24 to 30 months is correlated with Bayley Mental Score at 30 months. The amount of fat eaten by the toddlers is related to their subsequent abilities as are the total Kcal. Fat intake is associated with both verbal and performance subtests of the Bayley Mental Scale, whereas Kcal intake is only associated with the score on the verbal items. Motor skills are related to previous food intake as well. Two nutritional variables, Kcal and carbohydrates, are associated with Bayley Motor score at 30 months of age.

The fat in the diet may be a marker of SES. The correlation coefficient between fat intake and SES is (.37; $p < .005$). Also, SES and literacy of the father correlate significantly ($r = .31$).

While there is no direct association between food intake at 18 to 24 months and subsequent functioning at 30 months there is an indirect effect. Children that consume more fat are longer in size and may be eating more than smaller children. The possibility exists that more verbal children can demand more and receive more food than a less verbal child. This effect of the child on the nutritional environment is also found in the Egypt data. There appears to be a link so that toddlers who are fed more fat develop more skills at 24 months which may help them continue to be better fed in the next six months, and which may be mediated by high SES, size and parental literacy.

ASSOCIATIONS BETWEEN ILLNESS AND SUBSEQUENT BAYLEY SCORES

The description of illness measures is provided in Chapter 8. Pearson product moment correlations were computed between two illness measures (low grade illnesses and severe illness indices) and the three Bayley scores.

There are only a few significant correlations between illness and outcome. Toddlers who had more low grade and severe illnesses between 18 to 24 months of age had lower Bayley Mental scores at 30 months (r's = -.27 and -.25, respectively). There was also a negative association between low grade illness in this age period and Bayley Motor Score at 30 months (r = -.20). Illness during this period had very little immediate impact on development except that verbal skills at 24 months were negatively associated with severe illness in the previous six months (r = -.19) (see Table 24.2).

Illness during the period from 24 to 30 months had no association with mental or motor development. Thus, toddlers who suffered from a large number of mild and severe illnesses during the 18 to 24 month period were no less advanced developmentally six months later. It is not clear why early illness had so little immediate effect nor why the 24 to 30 month period was so unimportant in terms of the effects of illness on mental and motor development. The continuity in health conditions must be thoroughly researched. This is clearly an area where more refined analyses are needed to clarify interpretations of the results.

ASSOCIATIONS BETWEEN PHYSICAL STATURE AND SUBSEQUENT BAYLEY SCORES

The description of anthropometric measures is presented in Chapter 7. Pearson product moment correlations were computed between two anthropometric measures (height and weight) and the three Bayley scores (Table 24.3).

TABLE 24.2
Correlations between illness indices and Bayley score at 30 months of age.*

Illness 18-24 months	n	30 months Bayley Mental	30 months Bayley Motor
Low grade	105	-.27	-.20
Significant	105	-.25	--

* All correlations shown are significant, p < .02.

TABLE 24.3
Correlations between physical stature and Bayley scores at 24 and 30 months of age.*

Physical Stature	n	24 months Bayley Mental (Total)	30 months Bayley Mental (Total)	30 months Bayley Motor
18-24 months	99			
Length		.24	.22	.25
Weight		--	.31	.31
24-30 months	105			
Length		.30	.28	.27
Weight		.21	.29	.31

* All correlations shown are significant, $p < .05$.

There are significant associations between physical, cognitive, and motor development at all ages. As indicated in Table 24.3 toddlers who are taller and heavier at any age score better on all the 24 and 30 months measures. These associations hold for both verbal and performance subtests. Toddlers who have advanced cognitive skills at 24 months of age are taller and heavier in the next age period, perhaps because they were initially taller and heavier. There are generally high correlations between weight and height in one period with weight and height in subsequent periods ($r = .70 - .80$). Thus, there is an association between development in the physical, cognitive and motor spheres in this group of toddlers.

ASSOCIATIONS BETWEEN FAMILY STATUS AND BAYLEY SCORES

Family status was measured in two different ways, with assessments of socioeconomic status (Chapter 13) and parental literacy (Chapter 18). Pearson product moment correlations were computed between three family status measures (SES, paternal reading score, and maternal reading score) with the three Bayley scores (see Table 24.4).

There are significant associations between SES scores and Bayley performance scores and total Bayley scores at 24 months, but not between SES and either Bayley score at 30 months. The association is stronger with the performance items at 24 months then with the verbal items. Paternal reading ability is associated with the toddler's skills at all ages while maternal reading ability is not associated with toddler score at any age. The association at 24 months is stronger between paternal literacy and toddler performance skills than between paternal literacy and toddler verbal skills but is similar for both sets of skills at 30 months. Wide differences in maternal literacy would be of interest here.

TABLE 24.4
Correlations between family variables and Bayley scores at 24 and 30 months of age.*

Family Status	24 months Bayley Mental (Total) (n=99)	30 months Bayley Mental (Total) (n=103)	30 months Bayley Motor n=103
SES	.26	--	--
Father's reading score	.24	.24	.24
Mother's reading score	--	--	--

* All correlations shown are significant, p < .05.

The pattern of associations is much like that reported for fat intake. We do not know yet whether more literate fathers have children who consumed more fat. This is most likely the case, because of the significant correlation between fat intake and SES (.37;p <.001) and male literacy with SES (r = .31 < .001).

To investigate the relationship between the cognitive function of the parents and the cognitive development of the toddler, correlations were computed between the scores of the mothers and fathers on the Raven's Progressive Matrices and verbal cognitive measures, and the toddlers total Bayley score at 30 months (see Table 24.5). Positive correlations were observed between the mothers scores on the Raven Matrices and the verbal measures, and the toddlers total Bayley score at 30 months (r's = .21 and .24, respectively).

Further analyses should be conducted to determine whether development is more a function of food intake or the educational backgrounds of the parents.

ASSOCIATIONS BETWEEN HOME REARING CONDITIONS AND SUBSEQUENT BAYLEY SCORES

This issue is dealt with at great length in the manuscript "Home Environment and the Development of Embu Toddlers" (excerpts in Appendix H). Home rearing conditions, particularly those that reflect verbal and social interactions, are associated with subsequent developmental scores. The home conditions seem to affect development beyond the contribution of paternal literacy which also correlates with the toddler scores.

Two hierarchical multiple regressions were performed -- one in which the seven rearing variables were entered first, and then the eight food variables (without iron) with the Bayley Mental Score at 30 months as the dependent variable. The food intake variables do not add significantly to the variance after the rearing variables are entered. On the other hand, when the nutritional variables are entered first, these variables account for 8% of the variance and the rearing variables accounted for an additional 17% of the variance in the Bayley Mental Score at 30 months and added significantly to the regression after food intake (p < .02).

TABLE 24.5
Correlations between adult cognitive measures and toddlers total Bayley scores at 30 months of age.*

Adult Cognitive Measure	n	30 months Total Bayley
Father's Raven score	103	.14
Father's Verbal score	103	.07
Mother's Raven score	105	.21
Mother's Verbal score	105	.24

* $p < .01$.

Thus, child-rearing seems more important for mental development at 30 months than the way that the children are fed although this may not be true for mental development at 24 months or motor development at 30 months. Further analysis is planned at UCLA using the same kinds of regressions. The toddlers development seems to be more a function of home rearing conditions than of the nutritional intake factors. The toddlers who consumed more fat in their diet may be talked to more, held less and experience less significant illness.

The contributions of illness over and above nutritional and home rearing factors has not been investigated. With the previous data set, using stepwise multiple regression and no ordering of variables, the following factors entered into the regressions: severe illness from 18 to 24 months, fat intake from 24 to 30 months, social interaction, toddler held (negative), and responsiveness to verbal interaction. Thus, toddlers' experiences in a number of domains seem to have contributed to mental development at 30 months. However, it is not clear that these contributions are independent. Moreover, we need to construct a longitudinal progression from 15 to 30 months. This should be done with some form of regression analysis, probably path analysis.

SUMMARY

In conclusion, the competence of these Kenyan toddlers appears to be shaped by the manner in which they are reared, the adequacy of their food intake, and the extent to which they are healthy in the period from 18 to 24 months of age.

REFERENCE

1. Pollit E., Leibel R.L., Greenfield D.B. Iron Deficiency and Cognitive Test Performance. Nutrition and Behavior 1983; 1:137-46.

Chapter 25

THE EFFECT OF FOOD INTAKE ON TODDLER HEALTH AND GROWTH

The toddler group, aged 18 to 30 months, is known for its vulnerability to infection and malnutrition (1). They are either weaned or in the process of being weaned and have lost the protection and nutrition offered by breast milk. The toddler diet can be bulky, difficult to digest and at times ill-suited to a rapidly growing child. Known as the transitional child, the toddler, because of his/her mobility and physical separation from the mother, is often exposed to an unsanitary micro-environment and increased contact with others thus raising the incidence of infection.

In the Kenya study population, we have seen that the toddlers show varying degrees of stunting in about 25% of the group. Their low weight for age can be attributed largely to this stunting rather than to wasting. Infection rates are high and respiratory disease is the most common type of illness. No deaths were seen in this group. Most are weaned except for about 25% who still receive a small amount of breast milk. Total kcal intake, iron, and animal protein (but not total protein) intake were found to be low.

PREVIOUS TODDLER ANALYSES

In June 1985, the CRSP statisticians adapted an auto-regression model for the toddler analysis based on preliminary data. For that analysis the year was divided into a three month "baseline" period (ages 18.0 - 20.9 months) and nine monthly periods. For uniformity, each month was assumed to be exactly 30 days.

Summary of Autoregression Analysis

Results of the autoregression analysis showed that anthropometric status was strongly predicted by previous anthropometry, and that morbidity and intake are also best predicted by prior illness and nutrition, respectively, but to a much lesser degree. Other variables explained only small portions of the remaining variance.

One interpretation of the above findings was that the events which interacted to affect the status of these toddlers were more or less a series of continuous events over a 12-month period. By breaking the year into a series of short periods, one does not see anything but deviations due to measurement error, inadequate sampling, or just normal growth spurts and lags. Additionally, there were several factors not included in this model which may have major significance in an analysis of this type (for example, age and seasonality).

Suggestions for dealing with these shortcomings were made. The 30-day periods could be lengthened to 60, 90, or even 180 days. These longer periods would include several measurements and their means would tend to "smooth" out measurement errors and attenuate the occasional sampling of true but extremely atypical values. Similarly, a lag of one month seems much too short when assessing the effects of intake on linear growth; therefore, lags of three or more months were suggested.

Seasonality is another important factor and should be included. Since toddlers reached 18 months of age over a period of approximately 6-9 months, the baseline months occur in quite different seasons. This could have an effect on the analysis.

Perhaps the most important weakness in the auto-regression model was that it did not account for the age of the child (i.e. it assumed that the effects of illness and intake on growth were the same at 21 months as they are at 30 months). Because of these problems other approaches were tried.

PRESENT ANALYSIS

The primary purpose of this set of analyses is to determine the relationship between food intake, growth, and morbidity. At this point, no single analytic model is offered but rather an attempt is being made to bring out relationships between independent and dependent variables and numerous intervening or co-variables. There are two main research questions:

1. Does food intake in toddlers affect their growth? -- both weight and length.

2. Does food intake affect morbidity in toddlers? -- frequency, severity and duration.

CORRELATIONS FOR FOOD INTAKE AND THE INTERVENING VARIABLES WITH TODDLER GROWTH

Descriptions of the interrelationships between the independent, dependent, and intervening variables are based on simple correlational analyses. The dependent variables are the toddler growth measures (attained length, attained weight, head circumference, fatfolds, and slope of weight and length gain.). The food intake variables have been defined above and the intervening variables are morbidity, parental size, socioeconomic status, literacy, sanitation and hygiene, and household composition. This will serve as a background to the analytic section. These relationships are presented as correlation coefficients.

Data for food intake, growth, and morbidity are presented by four periods, each 3 months long, representing toddler age periods: 1 = 18-20.99 months; 2 = 21-23.99 months; 3 = 24 -26.99 months; and 4 = 27-29.99 months. Values are averaged for each of these periods. For convenience, age groups are represented in months as 18-21, 21-24, 24-27, and 27-30. Maternal food intake and weight are also presented by these four periods.

Dependent Toddler Growth Variables

This section will use linear regression analyses to examine the effect of food intake on toddler growth.

Attained Length

Kcal and fat intake in all periods correlate significantly with concurrent measurements of attained length (see Table 25.1) in each period and with length in subsequent periods. Also, length in preceding periods is related to Kcal in succeeding periods.

With protein intake, the strongest correlations are seen with length in the 1st, 2nd, and 4th periods. Even stronger correlations are seen with protein from animal sources with significant r values from .20 to .39. Animal protein intake in all periods correlates significantly with current measures of attained length and with length in the subsequent periods. As with kcal intake, length is related to intake in preceding periods. Significant positive correlation coefficients are seen between kcal and protein intake from 21 to 24 months, animal protein from 18 to 24 months, and fat intake from 24 to 30 months, with slope of linear growth. As for maternal intake and toddler's length, the pattern is similar to that found with toddler intake, particularly for maternal fat intake (see Table 25.2).

TABLE 25.1
Correlations* between toddler food intake variables and attained body length and slope of linear growth (n=98-111)

Toddler Food Intake Variables	Periods	Attained mean length during each period				Slope of length, all periods
		1	2	3	4	
Kcals/d	1	.20	.16	.09	.16	
	2	.18	.19	.16	.22	
	3	.20	.30	.29	.32	.19
	4	.23	.28	.24	.28	
Total Protein (g/d)	1	.17	.14	.10	.14	
	2	.16	.14	.12	.15	
	3	.08	.17	.16	.20	.16
	4	.17	.19	.13	.14	
Animal Protein (g/d)	1	.37	.35	.34	.38	.16
	2	.23	.15	.14	.19	
	3	.30	.29	.31	.35	.15
	4	.19	.20	.14	.19	
Fat (g/d)	1	.33	.29	.27	.30	
	2	.19	.18	.16	.22	
	3	.32	.36	.36	.43	.28
	4	.21	.26	.24	.31	.25
Carbohydrates (g/d)	1	.12	.09	.02	.09	
	2	.14	.16	.13	.17	
	3	.15	.26	.23	.25	
	4	.21	.25	.21	.24	

* Correlation Coefficients ≥.165 are statistically significant at p.< 05; .15 - .16 borderline

TABLE 25.2

Correlations* between maternal food intake variables and toddler attained body weight and length and slope of length (n=98-111)

Maternal (Mat) food Intake Variable	Period	Attained Weight (kg) 1	2	3	4	Attained Length (cm) 1	2	3	4	Slope of length, all periods
MatKCALS/day	1	.11	.14	.16	.16	.15	.21	.19	.16	
	2	.15	.16	.23	.24	-.01	.07	.10	.14	.30
	3	.26	.29	.32	.31	.15	.27	.31	.36	.44
	4	.29	.29	.28	.28	.16	.23	.21	.36	.22
MatFAT g/day	1	.22	.26	.27	.26	.27	.31	.30	.31	
	2	.17	.23	.26	.27	.08	.14	.16	.23	.21
	3	.28	.33	.34	.35	.21	.29	.32	.39	.40
	4	.26	.29	.29	.28	.17	.26	.24	.32	.22
MatIRON mg/day	1	.06	.10	.11	.11	.05	.10	.07	.06	
	2	.05	.07	.18	.17	-.03	.05	.10	.11	.31
	3	.20	.25	.27	.25	.07	.19	.22	.27	.41
	4	.23	.26	.26	.25	.17	.23	.23	.26	.23

* Correlation coefficients ≥.165 are statistically significant at $p < .05$; .15 - .16 borderline

Attained Weight

The pattern of correlations between attained weight in each period and food intake are quite similar to those seen with length. However, animal protein shows far fewer significant relationships to weight and appears to play a greater role in linear growth (see Table 25.3).

With kcals, carbohydrates, and fat intake, r's of a slightly lesser magnitude than for length are seen both for concurrent weight and for weight in subsequent periods. Also, intake is related to weight in preceding periods. Protein intake in period one (18 to 21 months) correlates with weight in all periods as does protein intake in period four (27-30 months). Animal protein intake in period one correlates with weight in all periods. Slope of weight gain shows no significant correlation with food intake variables.

Maternal intake behaves as does toddler intake showing similar correlations with weight measures, particularly maternal fat intake (see Table 25.2).

Head Circumference and Fatfolds

Fewer significant r's are found between food intake and head circumference. Kcal intake, mainly during 24 to 30 months, is associated with head circumference. Total protein and animal protein show positive associations in the 18 to 21 month old group. Fat and carbohydrate intake are positive in the 3rd period (see Table 25.4).

With sum of fatfolds the positive r's are seen only with maternal kcal and animal protein intake. With toddler intake, particularly fat and animal protein, all r's are statistically significant, but negative.

Intervening Variables

Morbidity

Attained length measures are affected by significant illness (SI) in the 18-21 month-old with low negative r's for LN1 and LN4.

Attained weight in period 2 shows a negative relationship with SI, particularly SI in the 1st period. Also, the higher the weight in period 2 the lower the SI in periods 3 and 4, suggesting that the smaller children develop more illnesses (see Table 25.5).

TABLE 25.3
Correlation* between toddler food intake variables and attained body weight. (n=98-111)

Food Intake Variables	Periods	Attained mean weight during periods 1-4: 1	2	3	4
Kcal/day	1	.18	.18	.15	.15
	2	.14	.21	.18	.18
	3	.23	.26	.27	.27
	4	.29	.26	.27	.30
Protein (g/day)	1	.21	.18	.16	.14
	2	.11	.17	.15	.14
	3	.17	.18	.18	.16
	4	.24	.21	.20	.21
Animal protein (g/day)	1	.15	.18	.26	.17
	2	.07	.04	.04	.02
	3	.16	.15	.13	.11
	4	.10	.13	.10	.08
Fat (g/day)	1	.16	.16	.21	.14
	2	.03	.07	.03	.02
	3	.26	.28	.26	.24
	4	.16	.18	.21	.18
Carbohydrates (g/day)	1	.15	.15	.10	.13
	2	.15	.22	.19	.21
	3	.19	.22	.24	.25
	4	.28	.24	.25	.29

* Correlation coefficients ≥ .165 are statistically significant at $p < .05$; .15 - .16 borderline

Fat stores (sum of fatfolds) throughout 18 to 30 months of age are adversely affected by SI in the younger toddlers. Not only does the thinner child in period 1 develop more SI, but SI in period 2 is associated with a reduction in fatfolds in all other periods.

As for the effect of specific types of illness, fever of long duration has a negative effect on fat stores in children 21 to 27 months old. Also, duration of fever, diarrhea, and respiratory disease correlates negatively with head circumference in the 18 to 24 month olds. It appears that children with small head circumference are more prone to illnesses (fever, diarrhea, and respiratory) of long duration. Children with small head circumference are also the shorter children.

TABLE 25.4

Correlations* between toddler food intake variables and attained head circumference. (n=98-111)

Toddler Food Intake Variables	Periods	Head Circumference 1	2	3	4
Kcal/day	1	.15	.17	.14	.18
	2	.09	.12	.13	.19
	3	.27	.32	.33	.34
	4	.14	.20	.20	.19
Protein (g/day)	1	.17	.19	.16	.20
	2	.14	.15	.17	20
	3	.23	.29	.29	.30
	4	.07	.10	.10	.11
Animal prot (g/day)	1	.17	.18	.18	.19
	2	.09	.03	.02	.00
	3	.14	.11	.12	.10
	4	-.03	-.05	-.06	-.06
Fat (g/day)	1	.15	.15	.14	.16
	2	.00	-.03	-.04	-.05
	3	.26	.26	.29	.27
	4	.10	.11	.14	.11
Carbohydrates (g/day)	1	.13	.16	.12	.15
	2	.09	.13	.15	.23
	3	.22	.27	.28	.30
	4	.14	.21	.20	.20
Iron (mg/day)	1	.16	.17	.12	.14
	2	.12	.14	.16	20
	3	.13	.21	.19	.20
	4	.04	.07	.09	.10

* Correlation coefficients ≥.165 are statistically significant at $p < .05$; .15 - .16 borderline

TABLE 25.5
Correlations* between toddler size and growth variables and significant illness. (n=98-111)

Toddler Growth Variables	Periods	Significant Illness Index† 1	2	3	4	Tot. Significant Illness Index Periods 1 - 4
Weight (kg)	1	-.15	-.07	-.10	-.10	
	2	-.19	-.14	-.08	-.11	
	3	-.14	-.06	-.20	-.12	
	4	-.09	-.06	-.17	-.09	-.16
Weight Slope		.04	.10	-.23	.04	
Length (cm)	1	-.14	-.06	-.12	-.07	
	2	-.16	-.09	-.05	-.05	
	3	-.16	-.08	-.11	-.05	
	4	-.17	-.12	-.11	-.06	-.21
Length slope		-.10	-.16	-.18	.01	-.19
Sum of Fatfolds‡ (mm)	1	-.10	-.18	-.13	-.01	
	2	-.10	-.18	-.13	-.01	
	3	-.06	-.05	-.23	-.03	
	4	-.02	-.08	-.21	-.07	
Head (cm)	1	-.02	-.05	-.10	-.22	
	2	-.08	-.12	-.04	-.19	
	3	-.08	-.11	-.05	-.19	
	4	-.08	-.14	-.05	-.19	

* Correlation coefficients ≥.165 statistically significant at p<.05; .15 - .16 borderline

† Significant illness index (SI) equals days of SI plus weighting factors for severity, activity, etc. (see chapter 8 and Appendix D) SI is for a designated period, e.g. 1 period (3 months).

‡ Triceps, biceps, subscapular fatfolds.

Finally, as seen in our data and reported by others (2), the "fattest" toddlers from 18 to 24 months have the most respiratory infections. Correlations between sum of fatfolds in periods 1 and 2 have positive r's with both average duration and days of respiratory illness (see Table 25.6).

Anemia (Hg < 10 gm/dl) shows negative effects upon slope of linear growth (r = -.28) and weight gain (r = -.18). Hematocrit levels with positive relationships with all LN measures in periods 1 and 2 support the finding of a negative effect of anemia on growth.

Parental Size

Maternal and toddler weight are closely related. For all concurrent measures of weight and for succeeding and preceding periods, maternal and toddler weights show positive associations. Maternal weight and toddler slope of weight gain are also positively related.

TABLE 25.6

Correlations* between toddler attained size variables and measures of illness. (n=98-110)

Toddler Growth Variable	Period	Mean duration days per period			Total no. days per period		
		Fever	Diarrhea	Resp	Fever	Diarrhea	Resp
Weight (kg)	1	.02	-.01	.08	-.01	-.02	.03
	2	.03	-.03	.14	-.04	-.02	.06
	3	.00	-.07	.09	-.04	-.06	.05
	4	.03	-.09	.08	.01	-.07	.02
Sum of Fatfolds†	1	-.13	.09	.29	-.07	.06	.28
	2	-.19	.10	.22	-.13	.10	.25
	3	-.17	.02	.10	-.08	-.01	.14
	4	-.13	.03	.09	-.03	.01	08
Head circum. (cm)	1	-.16	.04	-.06	-.05	-.02	-.05
	2	-.02	-.07	-.11	.00	-.12	-.17
	3	-.01	-.04	-.08	.02	-.11	-.10
	4	.03	-.03	.07	.02	-.09	-.07

* Correlation Coefficients ≥.165 statistically significant at $p<.05$; .15 - .16 borderline

† Triceps, biceps, subscapular.

In regard to toddler length, maternal weight and height also show positive relationships to toddler length in all age periods. Father's height is also related to toddler growth (see Table 25.7).

Socioeconomic status

SES shows a positive effect on toddler weight from 24 to 30 months as it does length and head circumference for all age periods (see Table 25.8).

Literacy

Literacy, which is related to SES, is also examined. The father's ability to read is positively associated with the infant's head circumference and fatfolds in the older toddlers (24 to 30 months). Weight is also positively affected by father's literacy throughout all age periods. Maternal literacy does not appear to affect any of the growth parameters (see Table 25.8).

Sanitation and Hygiene Score (SAHY)

The SAHY score shows positive relationships to weight measures in all age periods. The correlation with attained length is strongest in the fourth age period (see Table 25.8). SAHY and SES are positively correlated with each other.

TABLE 25.7
Correlations* between parental height and weight and toddler attained length and weight by age periods. (n=98-110)

Parental Variable	Periods	Attained Weight 1	2	3	4	Attained Length 1	2	3	4
Maternal weight (kg)	1	.12	.15	.20	.18	.17	.17	.14	.17
	2	.16	.22	.26	.24	.22	.23	.20	.21
	3	.26	.32	.35	.33	.32	.31	.28	.28
	4	.22	.28	.31	.31	.25	.25	.23	.24
Maternal height (cm)		.09	.15	.21	.18	.23	.26	.25	.22
Paternal height (cm)		.14	.12	.13	.08	.24	.22	.24	.21

* Correlation coefficient ≥.165 statistically significant at p.< 05, .15 - .16 borderline

TABLE 25.8
Correlations* between SES, sanitation and hygiene, and father's literacy scores on attained toddler size. (n=98-110)

Toddler Size Variable	Period	SES HH Score	Sanitation and Hygiene HH Score	Father's Literacy Score
Weight (kg)	1	.17	.18	.19
	2	.17	.17	.26
	3	.21	.15	.26
	4	.21	.22	.25
Length (cm)	1	.25	.06	.21
	2	.20	.08	.26
	3	.23	.08	.26
	4	.27	.17	.27
Head Circumference (cm)	1	.21	.08	.06
	2	.15	.04	.15
	3	.17	.08	.19
	4	.20	.08	.19
Sum of Fatfolds†	1	.00	.11	.02
	2	-.06	.05	.09
	3	.05	.04	.06
	4	.03	.08	.08

* Correlation Coefficient ≥.165 statistically significant at p.< 05; .15 - .16 borderline
† Triceps, biceps, subscapular.

Household Composition

The number of household members does not appear to affect growth as much as the composition of the household (see Table 25.9). The number of infants less than 18 months of age shows negative r's with toddler length. This is also true for the number of children under 6 years old. Weight, length, and head circumference demonstrate positive relationships with the number of females over 12 years of age.

The size and composition of the household was found also to affect food intake. No effect was seen on kcal intake. The larger the household, the less total protein and iron that was ingested by toddlers at ages 27 to 30 months. For example, the correlation between household size and protein intake during the fourth toddler age period was -.24. The more children under 6 years old in a household, the less animal protein and fat were eaten by the toddlers (see Table 25.10). Animal protein intake was negatively affected by the presence of infants younger than 18 months. Of interest is the finding that the more infants under 18 months in the household, the less Kcals, fat and iron were eaten by the mother in all periods. Thus, the presence of infants under 18 months may adversely affect not only the intake of the toddler but also the mother -- which could in turn have a negative impact on the health and welfare of the toddler.

In summary, food intake in the toddler and mother is positively related to growth in toddlers as are maternal size, SES, sanitation and father's literacy. Morbidity, particularly significant illness, and household composition appear to have negative affects on toddler growth.

TABLE 25.9
Correlation* between household composition and attained toddler size. (n=98-110)

		Infants < 18 months	Children < 6 years	Females > 12 years	Household size
Weight (kg)	1	.04	.01	.21	.04
	2	-.02	-.05	.13	-.05
	3	-.05	-.07	.15	.01
	4	-.04	-.04	.15	.00
Length (cm)	1	-.07	-.10	.17	.08
	2	-.14	-.18	.11	.09
	3	-.16	-.16	.15	-.03
	4	-.12	-.16	.15	-.05

* Correlation coefficients ≥.165 statistically significant at p.<05; .15 - .16 borderline

TABLE 25.10
Correlation* between household composition and toddler food intake variables. (n=97-110)

Toddler food Intake Variables	Period	Infants < 18 mos	Children < 6 years	Females >12 years	Household size
KCAL/day	1	.14	.03	.03	.05
	2	.13	.04	-.07	-.01
	3	-.04	-.13	.00	-.03
	4	.07	-.05	.01	-.11
PROTEIN (g/day)	1	.07	-.09	.02	.05
	2	.14	.03	-.08	.00
	3	.08	-.03	.01	.04
	4	.08	.01	-.17	-.24
ANIMAL PROTEIN (g/day)	1	-.05	-.24	.03	-.24
	2	.04	-.07	.07	.03
	3	.04	.01	.11	-.06
	4	-.17	-.14	.00	-.09
FAT (g/day)	1	-.02	-.20	.09	.14
	2	-.02	-.12	.08	-.02
	3	-.04	-.13	.13	-.05
	4	-.08	-.08	.12	.01
IRON (mg/day)	1	.13	.03	-.08	-.11
	2	.16	.07	-.17	-.04
	3	.11	-.04	-.06	.01
	4	.24	.14	-.19	-.20

* Correlation coefficients ≥.165 statistically significant at p.<05; .15 - .16 borderline

MULTIPLE REGRESSION MODEL USED IN ANALYSIS OF THE EFFECT OF FOOD INTAKE ON TODDLER GROWTH

Regression of food intake components and growth was conducted using the following independent variables:

Food intake: variables are divided into two periods:

Period A = daily mean intake for mos 18 - 24.
Period B = daily mean intake for mos 24 - 30.

The ten specific food intake variables are Kcal/kg (A and B), total protein/kg (A and B), animal protein/kg (A and B), fat/kg (A and B) and iron/kg (A and B).

There are six dependent growth outcome variables used in the analyses. They are:

1. Weight increment (change in weight between 18 and 30 months)
2. Length increment (change in length between 18 and 30 months)
3. Attained length at 30 months
4. Attained weight at 30 months

5. Slope of length (rate of linear growth from 18 to 30 months)
6. Slope of weight (rate of weight gain from 18 to 30 months)

Multiple regression analyses were performed for each of the six dependent growth variables using the forced entry of all ten food intake variables. The results of those analyses are presented in Table 25.11.

Attained length at 30 months gave the only significant R^2 value. Within the subset of intake variables for this specific analysis, only animal protein per Kg (A) was significant. Table 25.12 gives the correlations between the ten food intake variables. There are some very strong correlations among the independent variables that need to be considered when examining the results of multiple regression analyses.

TABLE 25.11
Multiple regression analyses on growth outcome variables using the subset of food intake variables.

Growth variable	Multiple R^2	p value
Weight increment	.0583	.9407
Length increment	.1703	.2427
Attained length at 30 mos	.2317	.0208
Attained weight at 30 mos	.1313	.3387
Slope of length	.1225	.3020
Slope of weight	.1204	.3172

TABLE 25.12
Correlation* matrix for the toddler food intake variables.

	KCALKGA	KCALKGB	FATKGA	FATKGB	PROTKGA	PROTKGB
KCALKGA	1.00					
KCALKGB	.48	1.00				
FATKGA	.63	.38	1.00			
FATKGB	.32	.46	.61	1.00		
PROTKGA	.91	.44	.66	.35	1.00	
PROTKGB	.45	.88	.25	.37	.49	1.00
APROTKGA	.46	.28	.92	.65	.53	.19
APROTKGB	.14	.09	.43	.67	.18	.16
IRONKGA	.75	.32	.13	-.04	.74	.43
IRONKGB	.38	.78	.07	.06	.40	.89

	APROTKGA	APROTKGB	IRONKGA	IRONKGB
APROTKGA	1.00			
APROTKGB	.55	1.00		
IRONKGA	-.04	-.10	1.00	
IRONKGB	-.03	-.21	.48	1.00

* Correlation coefficients all stat. sig. at p<.05 - .0000

MULTIPLE REGRESSION ANALYSES USED TO DETERMINE THE BEST SUBSET OF VARIABLES FOR EXPLAINING TODDLER GROWTH

In addition to the effect of food intake on growth, we are interested in other factors which impact the outcome measures. A better understanding of the relative importance of food intake and those other factors which affect growth, positively or negatively, is important from a programmatic as well as a biologic point of view.

The multiple regression model is used to analyze weight and length outcomes. Aside from food intake, we have seen that beginning size, sex, and season are important determinants of growth outcomes. Genetic or shared environmental factors are also important (maternal weight and height as well as father's height). Mother's intake is an important factor in toddler growth as well as her ability to care for the child (not yet tested). Factors such as morbidity, SES (combination of household possessions, land, education, and social standing), sanitation, and the size and composition of the household are some of the more important intervening variables.

Toddler Growth

Six toddler growth outcomes were included as dependent variables in the multiple regression analyses.

1. Initial length at 18 months of age
2. Attained length at 30 months of age
3. Slope of linear growth (rate of linear growth between 18 and 30 months)
4. Initial weight at 18 months of age
5. Attained weight at 30 months of age
6. Slope of weight gain (rate of weight gain between 18 and 30 months)

Because previous size of toddler (as was learned from the auto-regression models) plays so great an influence on the attained growth of the toddlers at 30 months, it was felt important to examine factors responsible for the weight and length of the toddler upon entry into the study at 18 months of age. Although no food intake and illness data were collected before 18 months on the toddlers, other factors related to the growth of the toddler were collected. Variables measured were household size, SES, sanitation and hygiene score, household composition, parental height and weight, and the sex and birthdate of the child.

Initial Length

Length at 18 months shows statistically significant correlation coefficients with SES, reading level of the father, mother's and father's height, and the sex of the toddler. Selection of the best subset of variables was performed using the BMDP9R program. The best subset selected included the following variables: T1 (sex of the toddler), SES, mother's height, and father's height. The next best subset of 5 variables adds to the above four, either birthdate (season effect), number of females in the household older than 12 years (in addition to the mother) or the number of children less than 6 years old. These add very little to the R^2. The best subset is summarized in Table 25.13.

TABLE 25.13
Results of the multiple regression for the best subset of variables for toddler's initial length.

Variable	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
T.I. (sex of toddler)*	-.17	.084	.0277
SES	.26	.008	.0678
Mother's height	.20	.038	.0400
Father's height	.24	.014	.0576

* Male designated as 41 and female as 42 in analyses

n = 93 cases   F stat = 5.58   CP = 2.72

p < .0005 R^2 = .2023

SES, maternal and paternal height, and sex each contribute 6.8, 4.0 and 5.8 and 2.8%, respectively, to the variation in toddler length at 18 months.

Attained Length at 30 Months

The multiple regression model which employed the best subset of variables used 81 cases with a resulting R^2 of .835. The variables selected are length at 18 months, maternal fat intake, season, and household size. Choosing a five variable best subset increases R^2 to .839 and adds fat intake per kg during period B to the equation. The best subset is summarized in Table 25.14.

Length at 30 months is explained largely by length at 18 months. Maternal fat intake is a reflection of the quality of the family diet and may have implications for the mother's ability to carry out child care (not analyzed as yet). A seasonal effect is seen in that children reaching 18 months after April 1984 (higher value for birthdate, Julian-days used) were younger during the drought and may have been protected by breast-feeding or preferential feeding. The negative influence of household size may imply less child care, attention, etc, for the toddler.

Factors which were seen to correlate significantly with length but do not enter the equation are maternal height, SES, fat and protein intake. Total significant illness had a negative effect on length.

TABLE 25.14
Results of the multiple regression for the best subset of variables for toddler's attained length at 30 months.

Variables	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
Length	.87	.000	.7047
Maternal fat intake	.17	.001	.0257
Season	.08	.085	.0062
Household size	-.08	.072	.0068

n = 81 cases   F stat = 102.71

R^2 = .835   p = .0000

CP = 5.77

Slope of Linear Growth

For the rate of linear growth between 18 and 30 months, fat/kg (B) accounted for 12.3% of the variation. In addition to food intake, other factors were examined using the multiple regression model selecting the best subset of variables.

The best subset of variables selected, using 95 cases, resulted in an R^2 of .2697. The seven variables included maternal fat intake, season, household size, fat/kg (B), protein/kg (B), iron/kg (B) and total days of diarrhea form 18 to 24 months. A summary of the regression is presented in Table 25.15.

Thus, for slope of linear growth, 27% of the variation is explained by the above variables. Fat intake and seasonality play important roles. The children who reached 18 months of age after April 1984 appear to do better with regard to length. Household size and total days of diarrhea per 3 month period have negative effects on the rate of linear growth. The large negative effect of protein (which appears in other analyses of growth) is due perhaps to a "statistical artifact" resulting from the use of multiple regression analyses. Simple correlations of protein intake and growth are positive; protein also shows high positive correlations with kcal intake.

TABLE 25.15
Results of the multiple regression for the best subset of variables for toddlers slope of linear growth.

Variable	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
Maternal fat intake	.25	.018	.0486
Season	.27	.005	.0701
Household size	-.14	.124	.0201
Fat/kg (B)	.38	.006	.0653
Protein/kg (B)	-.63	.025	.0430
Iron/kg (B)	.45	.077	.0267
Days diarrhea (A)	-.18	.054	.0317

n = 96 cases — F stat = 4.64
R^2 = .2697 — p = .0002
CP = 4.01

Summary of Linear Growth Analyses

The most powerful determinant of attained length at 30 months is length at 18 months, which is largely determined by parental height (maternal more than paternal), SES, and the sex of the child. After accounting for initial length, other variables such as fat, Kcals, animal protein, and iron intake--particularly in the 24-30 month period--explain the largest percent of variation for attained length. Other negative factors which were not included in the best subset are significant illness, days of diarrhea and protein intake. Parental size, season and maternal intake are also important determinants.

For slope of linear growth, fat intake accounts for the highest percent of the variation (other than the negative effect of protein intake). Maternal fat intake and seasonality are also important. The larger the household, the slower the rate of linear growth, implying possibly less food and maternal care and more exposure to illness for the toddler. The negative regression coefficient for protein intake (per kg) is surprising. Protein intake in period 3 showed only a weak positive (but significant) correlation with slope of linear growth using simple correlational analysis.

Initial Weight

Weight at 18 months shows statistically significant correlation coefficients with sex of the child, father's reading level ($p < .06$), and maternal height. These are the factors that affected toddler weight before 18 months, thus, influencing the attained weight at 18 months.

Using 93 cases, an R^2 value of .232 was obtained with a subset of eight variables. The subset contained the following variables: sex of the toddler, household size, SES, father's literacy, mother's literacy, the number of females older than 12 years (in addition to the mother), maternal weight and father's height. Negative effects were contributed by the father's height and household size. The best subset is summarized in Table 25.16.

The sex of the child, the number of females in the household older than 12 years, and literacy explain most of the variation of weight at 18 months. A negative effect is exerted by household size. The more people in the household, the less food and maternal care may be available to the child.

TABLE 25.16
Results of the multiple regression for best subset of variables for toddlers initial weight.

Variable	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
T.I. (sex of toddler)*	-.28	.005	.0746
HH. size	-.30	.047	.0373
SES	.20	.096	.0260
Father's literacy	.34	.047	.0370
Mother's literacy	-.30	.080	.0286
No. female 12 yrs old	.29	.036	.0415
Maternal weight	.16	.132	.0211
Father's height	.15	.138	.0205

* Males designated as 41 and females designated as 42 in analysis

n = 93 cases F stat = 3.18

CP = 3.77 p = .0034

R^2 = .232

Attained Weight at 30 Months

Using 86 cases, an R^2 value of .778 was obtained. The best subset includes the following variables: weight at 18 months, length at 18 months, maternal fat intake, and fat/kg (B). Maternal height and maternal literacy were added to yield the next two best subsets (R^2 = .782 and .781, respectively). The best subset is summarized in Table 25.17.

Again, the preponderance of the variation in attained weight at 30 months is explained by the child's weight at 18 months. Fat intake appears to be a key food intake component. Aside from its importance as an excellent energy source, it has a high correlation with SES.

TABLE 25.17
Results of the multiple regression for the best subset of variables for toddlers' attained weight at 30 months.

Variables	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
Weight 18 mos	.69	.000	.2122
Length 18 mos	.16	.036	.0125
Maternal fat intake	.17	.008	.0201
Fat/kg B	.14	.018	.0160

n = 86 cases
R^2 = .778
CP = 5.44

F stat = 71.1
p = .0000

Slope of Weight Gain

As was seen earlier, iron and total protein intake both account for about 12% of the variation in the slope of weight gain. Using 96 cases, the best subset of six variables yielded an R^2 of .197. The variables include: iron/kg (B), protein/kg (B), length at 18 months, weight at 18 months, maternal fat intake and days of diarrhea. The results are summarized in Table 25.18.

The slope of weight gain is negatively influenced by the weight at 18 mos. The smaller the child initially, the steeper the slope of weight gain. Iron intake exerts a significantly large effect on rate of weight gain, perhaps mediated through hemoglobin levels. Protein intake exerts a large negative effect and maternal intake exerts a positive effect. Days of diarrhea has an expectedly negative effect on the rate of weight gain.

Simple correlations of protein intake with other variables were examined to try to understand their consistently negative effect on growth. These are summarized in Table 25.19.

TABLE 25.18
Results of the multiple regression for the best subset of variables for toddler slope of weight gain.

Variable	Standardized Regression Coefficient	p (2 tail)	Contribution to R^2
Initial Weight	-.31	.028	.0449
Initial Length	.31	.024	.0478
Maternal fat intake	.29	.008	.0654
Total Prot/Kg (B)	-.73	.001	.1056
Iron/kg (B)	.76	.001	.1070
Days of diarrhea (A)	-.16	.096	.0255

n = 96 cases
CP = -2.44
R^2 = .1972

F stat = 3.64
p = .0028

TABLE 25.19
Correlations* between protein intake/kg during period B (24-30 months) and other variables (n = 11).

Variable	r
SES	-.18
Kcal/kg B	.88
Fat A	.27
Fat B	.40
Prot/kg A	.49
Animal Prot	.19
Iron	.45

* All r values statistically significant ($p < .05$)

Summary of Weight Analyses

Food intake in the toddler affects its attained weight and weight gain but to a lesser extent than for length. By the time the toddler is 18 months, the effects of sex, SES, literacy of the father, maternal and paternal size have been expressed. For example, males are heavier than females. The larger the household size the smaller the child's weight, presumably due to less food per child and perhaps less child care. In support of this, the more females over 12 years old in the household, the heavier was the 18 month old toddler. Maternal intake also appears to be important in the determination of toddler weight.

SUMMARY OF TODDLER GROWTH

Food intake definitely has an effect on both linear growth and weight gain in toddlers but particularly on linear growth. This has been demonstrated by simple correlation analysis and multiple regression analysis. Food intake components of particular importance appear to be Kcals, fat, animal protein, and iron. The fat and animal protein both correlate with SES and may be markers for SES. Maternal food intake, particularly fat intake, also appears as an important positive factor for growth, not only as an indication of a good household SES but it may also influence the child care practices (not yet analyzed).

Of the negative influences on growth, significant illness and days of diarrhea appear most important. Household size also plays a role, the larger the household, the smaller the toddler.

The most potent determinant of growth during the toddler period, appears to be the child's size on entry into the study, explaining a major part of the variation of the attained size at 30 months. Food intake becomes the most predictive variable after initial size is accounted for. Growth is a multi-factorial process and many intervening variables contribute to the outcome.

The data suggest that the quality of the toddler diet is important. The positive associations between fat and animal protein is attained, and slope of growth demonstrate the importance of these components and their positive association with SES. A high SES score implies a higher material standard of living, more literate parents, presumably more food, and more health care.

THE EFFECT OF FOOD INTAKE ON TODDLER MORBIDITY

The research question addressed here is: Does food intake in toddlers 18 to 30 months of age affect their morbidity experience with regard to: low grade illness (LG); significant illness (SI); mean duration per episode and total days of illness due to diarrhea, respiratory disease, and fever?

The independent variables involved in this analysis are the same subset of ten food intake variables described in the previous section on food intake and toddler growth. The dependent morbidity outcome variables have been fully described in Chapter 8, and are summarized below.

Intervening variables are the same variables as used in the analysis of toddler growth with the addition of maternal illness, specifically the maternal total LG illness index and the SI index during the time the toddler is 18 to 30 months of age. The percent T-lymphocytes in toddlers was also added as an intervening variable, despite the small sample size.

Morbidity Variables

Low grade illness index - This index includes, in general, common colds, nonfebrile illness such as skin and eye infections, diarrhea with under 5 stools per day with no dehydration or vomiting, and minor trauma. The low grade illness index approximates days of illness.

Low grade illness is designated by:

LGA = total LG illness index from 18 to 24 months
LGB = total LG illness index from 24 to 30 months

Significant Illness Index - This category includes febrile illness, lower respiratory infections, malaria, tonsillitis, pharyngitis with fever, etc. This category includes illnesses that were designated as severe according to pre-existing criteria (see Appendix D). The SI index incorporates duration, a weighting factor, and accounts for decrease in activity and food intake by semiquantitative scaling. The food intake factor is removed whenever SI is used for analysis that includes the effect of food intake on morbidity.

Significant illness is designated by

SIA = total SI index[2] from 18 to 24 months
SIB = total SI index from 24 to 30 months

A third category of extremely severe illness (SSI) covers diagnoses of immediately life threatening critical illnesses such as meningitis, massive trauma, coma, dehydration with shock, etc. These were not seen in the study children of any age and rarely in the adults.

Specific disease outcomes considered are days and mean duration per episode of diarrhea, fever and respiratory infections.

Other variables used are the target individual identification number for sex, male toddler (41) and female toddler (42). Seasonality is also considered, children who reach 18 months of age before mid-April 1984 (BD1) and those who become 18 after mid-April 1984 (BD2). Children born later experienced the severe drought at an earlier age. Literacy, SES, and sanitation and hygiene scores have been described in Chapters 18, 13, and 14, respectively.

CORRELATIONS FOR FOOD INTAKE AND THE INTERVENING VARIABLES WITH TODDLER MORBIDITY

Food Intake

The main food intake variables that correlate with low grade illness are Kcal during 21-24 months, total protein durir 21-24 months, animal protein during 27-30 months, fat during 27-30 months, and carbohydrates during 21-24 months. See Table 25.20. These correlations are all positive and weak. Significant illness correlates negatively with total Kcal intake within the 21-24 month period. Again these correlations are weak (p . <025). See Table 25.20.

A possible explanation for positive rather than negative correlations between food intake components and LGI is that the better fed children are the more active ones and mingle with other children to a greater extent than less active children. The former are exposed to more illness, the bulk of which is LG illness. Host factors, such as food intake, may be more important a factor for incidence in SI.

TABLE 25.20
Correlation* of toddler food intake with toddler low grade and significant illness indices. (n = 103-111).

Toddler Intake Variable	Periods	Low Grade Index† 1	2	3	4	Significant Illness Index† 1	2	3	4
KCALS/ day	1	-.06	.01	.03	.01	-.03	-.01	.19	-.05
	2	.02	.17	.25	.19	-.22	-.21	-.06	-.21
	3	-.18	-.07	-.07	.09	-.08	-.08	-.05	-.10
	4	-.09	-.04	.02	.04	-.08	.03	.18	.01
PROTEIN (g/day)	1	-.08	.05	.03	.04	-.08	.03	.18	.01
	2	.08	.19	.19	[illegible]	-.14	-.17	-.03	-.18
	3	-.12	-.05	-.02	.08	.00	-.14	.06	-.11
	4	.02	.04	.02	.14	.00	.03	.13	-.01
ANIMAL PROTEIN (g/day)	1	-.02	.04	-.07	.02	-.12	-.01	-.06	-.12
	2	-.03	.12	.06	.07	-.09	-.02	-.02	-.13
	3	-.17	.01	.02	.07	-.07	-.09	-.10	-.13
	4	-.01	.11	.23	.17	-.09	-.10	.04	.10
FAT (g/day)	1	-.04	.02	.00	.02	-.07	.02	.07	-.08
	2	-.11	.11	.10	.11	-.17	-.08	.02	-.13
	3	-.22	-.03	.04	.07	-.17	-.08	.04	-.12
	4	-.04	-.03	.28	.13	-.17	-.18	.08	-.10
CARBO-HYDRATE (g/day)	1	-.05	.01	.04	.01	.00	-.03	.19	-.05
	2	.05	.15	.27	.19	-.20	-.21	-.08	-.19
	3	-.13	-.17	-.19	.08	-.05	-.06	-.08	-.07
	4	-.10	-.05	-.07	-.01	-.01	-.07	.09	-.17

* Correlation coefficients ≥.165 statistically significant at p.<05; .15 - .16 borderline; .12 - .14 NS

† Indices defined in Chapter 8 and Appendix D. Indices are basically number of days per designated period of illness modified by weighting factors, taking into account severity, effect on activity, etc.

A few significant positive correlations are seen with regard to duration of respiratory illness and food intake. They are protein 2 and 4 (p <.005 and p<.02, respectively) and carbohydrate 2 (p<.005). See Table 25.21. Percent T-lymphocytes show positive correlations with all food intake variables (primarily during the 21-24 month period).

TABLE 25.21
Correlation* of toddler food intake with mean duration, total days of illness per period, and percent T-lymphocytes (n = 98-111).

Toddler Intake Variable	Period	Mean Duration per Period			Total Days per Period			% T-Lymphocytes
		Fev	Dia	Res	Fev	Dia	Res	
KCAL/day	1	-.02	.03	-.01	.04	.00	-.03	.16
	2	-.12	.00	.30	-.27	.00	.21	.25
	3	.08	-.07	.03	.00	-.11	-.04	.32
	4	-.04	.14	-.15	-.01	.16	.05	.08
PROTEIN (g/day)	1	.00	.08	.02	.07	.02	-.01	.09
	2	-.13	.04	.27	-.20	-.01	.17	.32
	3	.08	-.05	.06	.04	-.11	.01	.35
	4	.02	.19	.19	.06.	23	.11	.07
ANIMAL PROTEIN (g/day)	1	-.13	.06	-.03	-.11	.00	-.01	.08
	2	-.13	.08	.03	-.13	-.02	-.01	.26
	3	.03	.07	-.01	-.02	-.03	-.07	.02
	4	-.10	.04	.17	-.04	.17	.16	.04
FAT (g/day)	1	-.06	.07	-.02	-.04	.02	.02	.14
	2	-.12	.03	.08	-.18	-.04	.00	.27
	3	.00	.02	.00	-.04	-.08	-.07	.15
	4	-.12	.01	.14	-.08	-.02	.12	.02
CARBO-HYDRATES (g/day)	1	-.01	.01	-.01	.05	-.01	-.04	.10
	2	-.09	-.02	.32	-.26	.02	.26	.18
	3	.10	-.09	.04	.01	-.10	-.02	.32
	4	-.02	.15	.11	.00	.17	.00	.12

* Correlations coefficients ≥.165 statistically significant at p<.05; .15 - .16 borderline

Maternal Illness

Maternal low grade illness shows strong positive correlations with toddler low grade illness. There is a particularly strong relationship for respiratory illness. This is not surprising given the relative ease of communicability of respiratory illness and the close interaction of mother and child. See Table 25.22. Maternal SI shows a negative significant correlation with toddler SI for period three (p <.025). Beyond this there are no significant relations between maternal SI and toddler SI.

SES, Literacy, and Sanitation Score

The SES index does not show any significant correlations with toddler morbidity. Paternal literacy shows low positive correlations with low grade illness in period three and the duration of respiratory illness (see Table 25.22). Paternal literacy also gives a weak negative correlation with significant illness in period two. Low negative correlations are seen between maternal literacy and duration of respiratory infection ($p<.05$) and diarrhea (borderline significance).

Sanitation and Hygiene (SAHY)

SAHY gives a weak negative correlation with toddler LG in period one ($p<.025$). Other than this there are no significant correlations between the SAHY score and any of the toddler morbidity variables (see Table 25.22).

TABLE 25.22
Correlations* between toddler morbidity and household characteristics (n = 103-111).

Toddler Morbidity Variable	Period	SES Score	SAHY Score	Father's Literacy Score	Mother's Literacy Score	Maternal LGI Index	Maternal SI Index
LG Index	1	.04	-.21	.06		.39	.14
	2	.08	-.14	.15		.50	.01
	3	.16	-.08	.19		.47	.00
	4	.00	-.01	-.02		.37	-.03
SI Index	1	-.03	-.14	-.14		-.04	12
	2	-.03	-.12	-.18		-.01	.14
	3	.02	.10	.04		-.16	-.21
	4	-.08	-.15	-.16		.03	.13
DUR† FEV		-.05	.03	-.13		-.10	-.05
DUR DIA		-.06	.03	-.12	-.15	-.07	-.15
DUR RESP		-.02	-.07	.23	-.20	.63	-.04
DAYS‡ FEV		.00	-.01	-.15		-.12	.02
DAYS DIA		-.06	-.01	.01		.24	-.01
DAYS RESP		.07	-.07	.15		.57	-.01

* Correlation Coefficients ≥.165 statistically significant at $p<.05$.
† Mean duration (days) per episode.
‡ Total number days from 18 to 30 months.

MULTIPLE REGRESSION MODELS FOR MORBIDITY OUTCOMES

Multiple regression analysis was undertaken to investigate the effect of food intake on morbidity outcomes in the toddlers as well as other determinants of morbidity. An understanding of the factors that influence morbidity is important not only from biologic and epidemiologic points of view, but also from an intervention and programmatic perspective.

A number of variables of possible relevance to toddler morbidity were collected by the Nutrition CRSP project. As many of these as possible are included in the analyses of morbidity. The majority of the variables used for analysis of growth are used for the morbidity study. The household sanitation and hygiene score and the household size appear to be important as does morbidity in the mother. The presence of low grade or significant illness at age 18 months turns out to be an important predictor of later illness. The addition of % T-lymphocytes, although it correlates with many parameters of growth and food intake, because of the small sample size does not contribute very much to the multiple regression. Household morbidity, may be an important variable in future analyses. Data on water contamination, crowding, and other household factors are also potentially useful explanatory variables in the study of morbidity.

MULTIPLE REGRESSION ANALYSES USED TO DETERMINE THE BEST SUBSET OF VARIABLES FOR EXPLAINING TODDLER MORBIDITY

Low Grade Illness Index in the 18-24 Months Old Toddler (LGA)

Analysis of LGI index was conducted on 84 cases The best subset contained only one variable, the household sanitation/hygiene score, which accounts for 39.8% of the variation in LGA illness in toddlers 18 to 24 months of age (see Table 25.23). Alternative best subsets included the sanitation/hygiene score, followed by either weight at 18 months or maternal fat intake as the second variable. The sanitation hygiene score accounts for factors of crowding, personal use of soap and water, housing conditions, water contamination, etc.

TABLE 25.23
Results of the multiple regression for the best subset of variables for toddler low grade illness index from 18 to 24 months.

Variable	Standardized Regression Coefficient	p value	Contribution to R^2
Sanitation/hygiene score	-.20	-1.84	.3975

n = 84 CP = -.88, R^2 = .89
F stat = 3.39 p < .0001

Low Grade Illness Index in the 24-30 Months Old Toddler (LGB)

Multiple regression analysis was conducted to obtain the best subset to account for the variation in LG illness in the toddler aged 24 to 30 months. The best subset is presented in Table 25.24.

TABLE 25.24
Results of the multiple regression for the best subset of variables for toddler low grade illness index from 24 to 30 months.

Variable	Standardized Regression Coefficient	p (2-tail)	Contribution to R^2
TI (sex)	.15	.099	.0211
Mat fat intake	.15	.132	.0175
Mat LGI index	.33	.002	.0805
LGI Index (18 months)	.33	.002	.0809
Fat/kg B	.33	.006	.0594
Animal Prot/kg A	-.23	.025	.0396

n = 82; CP = 1.79; R^2 = .434; F stat = 9.60; p < .0000

The illness experience of the child at 18 months and the LG illness experience of the mother appear to be important factors. There is a lag effect seen with LG illness at 24 to 30 months with animal protein intake in the preceding 6 months. The association of fat intake and LG illness index in the child has already been noted.

Significant Illness in 18 to 24 Month Old Toddlers

Food intake components showed no significant relationship with significant illness when these were considered as a group. Some simple correlation coefficients, however, were statistically significant (See Table 25.20). As food intake variables showed no significant relationship in the regression model, other factors accounting for the variation in SI in 18 to 24 month old toddlers were sought.

Analysis of 80 cases yielded an R^2 of .174. The best subset included the following variables: season, child's weight at 18 months (negative effect), and Kcal intake at 18 to 24 months (see Table 25.25).

The less the child weighs at 18 months and the less Kcal it ingests (per kg), the more SI it experiences in the following months. Seasonal effect shows that the earlier the child turned 18 months (by April 1984) the more significant illness it experienced. These children would have been about 20 to 24 months old during the cold season and at the start of the severe drought.

TABLE 25.25
Results of the multiple regression for the best subset of variables for toddler significant illness index A (18-24 months).

Variable	Standardized Regression Coefficient	p (2-tail)	Contribution to R^2
Season	-.35	.001	.1226
Kcal/kg A	-.17	.110	.0271
Wt 18 mos.	-.22	.038	.0460

n = 84 cases; CP = -.616; R^2 = .174; F stat = 5.6; p (tail) = .002

Significant Illness in 24 to 30 Month-Old Toddlers

Analysis of 82 cases yielded an R^2 of .093. The best subset included the amount of significant illness at 18 months, and the length of the child at 18 months (yielding a negative effect on SI). Results are presented in Table 25.26. The next best subset includes animal protein intake in the preceding 6 months (negative effect on SI), increasing the R^2 to .11.

TABLE 25.26
Results of the multiple regression for the best subset of variables for toddler significant illness index B (24-30 mos).

Variable	Standardized Regression Coefficient	p(2-tail)	Contribution to R^2
SI index at 18 mos	.24	.03	.0558
Length at 18 mos	-.18	.09	.0330

n = 82; CP = -6.28; R^2 = .093; F stat = 4.05; $p < .0211$

These results indicate that the SI index at 18 months influences future SI. Thus, whatever conditions preceded significant illness continue to adversely affect the child. Also, the shorter the child at 18 months, the more SI is experienced in the following months.

Factors Associated with Respiratory Disease

Acute respiratory disease is the most commonly occurring illness reported. Associated factors were examined. Multiple regression analyses to obtain the best subset of variables for days and mean duration per episode of respiratory disease yield very similar results (see Table 25.27).

Female toddlers have more days and longer episodes of respiratory disease compared to males. Also there appears to be a strong seasonal effect. The toddlers who turned 18 months after April 1984 experienced longer episodes and more days of respiratory disease than the older children who turned 18 months before that time. The younger children went through both the colder months and the drought at the ages of about 20 to 24 months compared to those aged 24 months or more in the older group. The inclusion of length at 18 months in the best subset is unexpected, and may indicate that the length does not necessarily reflect current nutritional status.

The negative association of animal protein intake with respiratory illness may imply that not only the quality of the diet but higher SES and improved sanitation and hygiene are positively correlated with animal protein intake (shown earlier) and less respiratory illness.

TABLE 25.27
Results of multiple regressions using the best subset variables for total days with that for mean duration per episode of respiratory disease.

	Total Days		Mean duration per episode	
	Standard Regression Coefficient	p(2 tail)	Standard Regression Coefficient	p(2tail)
Sex (M = 1, F = 2)	.29	.009	.27	.013
Season	.23	.035	.34	.001
Maternal Intake (Kcal)	.18	.086		
Animal protein Kg A	-.23	.045	-.18	.105
Iron A	.18	.070	.23	.033
Length 18 mos	.24	.058	.23	.038

n	=	82 cases	n	=	82 cases
R^2	=	.2126	R^2	=	.20
CP	=	-1.03	CP	=	-1.23
F stat	=	4.00	F stat	=	3.15
P	=	.0024	P	<	.008

SUMMARY OF TODDLER MORBIDITY

In general, food intake has a limited influence on morbidity in the toddler. The influence is greatest for both low grade and significant illness in the toddler aged 24 to 30 months. The better the intake the less the detected morbidity. Fat and animal protein intake and Kcal/kg intake appear to be important factors. The strong positive association of these food intake components with SES has been pointed out earlier. SES will have to be controlled for in future analyses to see if the impact of fat and animal protein intake is still as strong. Low grade illness is at times positively correlated with food intake. As was pointed out, it is likely that the better fed child may be more active, interact with more people, and be exposed to more low grade illnesses in the environment.

The most important factors in toddler morbidity are season, sex, and the toddler's morbidity experience at 18 months; this may imply a continuation of adverse factors that continue to result in high levels of morbidity or the harmful effects of morbidity on the nutritional status of the child.

Maternal illness, particularly low grade, is a strong factor in toddler's illness, particularly low grade. Maternal intake seems to be protective against significant illness. The future analyses of the maternal caregiving data set and its association with maternal intake should be of great value.

In general, children who entered the drought and cold months of July-September encountered illnesses, particularly respiratory diseases, more so than other children. Household morbidity data should be of great value for the future analysis of toddler morbidity.

In conclusion, environmental factors, infection, and quantity and quality of the diet all influence the growth in the toddler. Food intake appears to play a less important but definite role in the morbidity of the toddler. For both growth and morbidity, pre-existing or "baseline" status at 18 months is a potent determinant of the outcome measure. Longitudinal data from pregnancy, birth, and infancy are critical to a full understanding of the toddler's health and nutritional status.

REFERENCES

1. Williams C.D., Baumslag N., Jelliffe D.B. Mother and Child Health, Delivering the Services. New York: Oxford University Press, 1985.

2. Hutchinson-Smith B. The Relationship between the Weight Gain of an Infant and Lower Respiratory Infection: Med Officer, 1970; 123:257.

Chapter 26

POLICY IMPLICATIONS OF THE FINDINGS

This chapter will present a brief discussion of the policy implications of the Kenya Nutrition CRSP Project. The discussion will focus on the project's potential contributions to policy formation; it should be noted, however, that this is a very preliminary discussion. The bulk of the data analysis remains to be done, and as that analysis is carried out the policy potential of the Nutrition CRSP Project will be greatly expanded. What is presented here is only an introduction to that potential.

THE BASIC POLICY QUESTION REGARDING FOOD INTAKE

The central policy issue with regard to food intake is as Reutlinger states, "whether the average energy intake of sub-populations known to have low intakes should be augmented through public intervention."(1) The determinations for making this judgement are the benefits and costs associated with increasing energy intake and functional performance for the targeted population. Standards for energy requirements do exist, but their relationship to productive performance has not been well established. Additionally, energy requirement standards are usually based on country averages which obscure requirement variations among different segments of the population.(1) This has generated problems with the calculation of benefits and costs with regard to food supplementation policies and programs. Population stratifiers such as age, socioeconomic status, morbidity risk, and energy expenditure levels have not been applied to determine group specific energy requirements needed to achieve a satisfactory level of performance. Therefore, there is substantial need for the refinement of the input-output correlations for specific segments of the population. These refinements will facilitate the development of policies which can better direct scarce resources to the sites where they can have the optimum impact.

It should be noted that the allocation of resources through policy formation is often a subjective political decision. Causative factors may or may not be considered manipulatable, depending upon the political orientation of the decision-maker. (2) The objective of this study is to provide rational support for decisions which will best serve the development of the nation in such a way so as to promote the highest possible standard of life for all.

POLICY SIGNIFICANCE OF THE NUTRITION CRSP DATASET

The Nutrition CRSP Project offers a wealth of information that can be used in the development of intervention strategies and policies directed at issues of food security and nutrition. The nature of that information, however, must be fully understood in order to appreciate its significance.

The first concern with respect to policy formation is the level at which the information has been gathered. That is, was the issue addressed from the perspective of the individual, the household, the community, the nation, or some other level? With regard to the Kenya Nutrition CRSP Project, the primary levels of concern were the individual and the household. The Kenya Nutrition CRSP Project, therefore, best facilitates the development of policy that deals with food issues at these levels. For example, the project has a great deal to say about the quantity and timing of food intake during pregnancy and its affect on the newborn. Such information could impact on the design of special feeding programs for expectant mothers or the development of more accurate risk profiles for women so that potential problems can be identified early and dealt with at a minimum cost to the health service.

The Nutrition CRSP Project also collected information on the household as a unit. (A discussion of the definition of household is presented in Chapter 5). Since the household is the major rural productive unit in most developing countries, it is essential to focus policy on the survivability of this unit. The CRSP data allows for correlations to be drawn between various household characteristics and food intake, shedding light on which factors contribute best to household survival.

Another major concern with regard to policy significance is the exact problem under study and the degree to which that problem is prevalent in other parts of the world. The Nutrition CRSP Project is concerned with the functional consequences of individuals and households that experience mild to moderate malnutrition. Mild to moderate malnutrition has been credited with having greater impact on development efforts than more extreme forms of malnutrition (3, 4). Furthermore, it affects a vast proportion of the world's population and touches on nearly all developing countries, giving great weight to the findings of the Nutrition CRSP Project and their impact on policy. Enhanced functional performance is central to any development concept, and any factor which has significant impact on that performance is a viable target for policy attention.

The Nutrition CRSP Project seeks to provide insight into the relations which affect food intake as well as the consequences of reduced intake. Its contribution to policy development can, therefore, be found in the richness of its dataset (providing tremendous potential for future analysis) as well as its current findings. The analytical basis of the research was to consider food intake as the independent variable. This allows for an understanding of the adverse consequences of reduced intake and an identification of specific sites where intervention can generate positive results. The Nutrition CRSP Project did not test intervention strategies, but it does provide an analytical basis for determining which strategies would be most appropriate for a situation such as that found in Embu. This is an extremely important contribution as it lays the groundwork for future tests of programmatic interventions.

SPECIFIC POLICY IMPLICATIONS FOR THE NUTRITION CRSP PROJECT

The Nutrition CRSP Project has produced a wealth of data and information gathering procedures that will be most helpful to the formation of policies and intervention strategies. Presented below is a brief summary of some of the findings.

The project developed food value tables specific to Kenya. This will facilitate further research and an accurate appraisal of the benefits derived from various foods, thus allowing nutrition policy to focus more specifically on foods of maximum benefit.

The development of measurement protocols for variables which are important to food policy researchers was a primary activity for the project. The project tested numerous methods for measuring important variables. The result has been to eliminate inappropriate methods and further refine viable ones. This will facilitate future investigations that test intervention strategies and the development of useful monitoring systems.

The project provides valuable insights into the development of a nutritional status monitoring system that would provide leaders and policy makers with current information concerning the nutritional status of the community. This is best seen with regard to the famine. The analysis of project data reveals which indicators are most sensitive to food disruptions and how they can be applied in order to detect problems before they generate severe consequences. Another example of this type of contribution is anthropometric measures for pregnant women. The study found that mid-upper arm circumference and head circumference were good surrogate measures for weight and height, respectively. Since these measures are easier to obtain than weight and height, they can serve as useful monitoring instruments in rural settings such as Embu.

A wealth of data was collected with regard to the 1984 drought and subsequent food shortage. These data will permit investigations into what survival strategies are most successful in dealing with severe food shortages. This information also sheds light on which approaches were unsuccessful and what the long-term impact is for various household coping strategies. As these data are reviewed, they will provide valuable insights into the design of interventions and policies that can reduce a family's vulnerability to famine and strengthen their capacity to adopt positive responses.

The Nutrition CRSP Project also explored the roles of various household members and which ones constitute the optimal targets for assistance. As an example, it has been seen that lead females play a critical role in many of the intra-family food decisions. This points to the need for greater policy attention to be placed on strengthening the woman's capacity to make these decisions. This type of analysis of the CRSP data allows for the direction of interventions to those individuals who play the most critical role in resolving a particular problem. Thus, policy intervention approaches can be fine-tuned so that they maximize their impact.

An initial review of the data on pregnancy outcome indicates the importance of the mother's condition before she becomes pregnant. The better nourished a woman is when she enters pregnancy, the better able she is to derive benefit from her food intake and the greater the birthweight of the baby. This suggests that more emphasis be placed on early intervention to get the best possible outcome. Results also confirm the relationship of morbidity and socioeconomic status with pregnancy weight gain and birthweight. These seem to imply that broad based development efforts which address the quality of life for all individuals may best serve the needs of the mother.

The data indicate that productive interventions should address the nutritional condition of the mother from the time of her childhood. This means that food interventions which come after the mother has become pregnant might not have the desired level of impact. While such interventions are necessary, more comprehensive approaches could produce more lasting and substantial changes.

Project findings can facilitate the identification of high risk groups. Infants are seen to drop off the standard growth curves at around 3 months of age. As decreases in body weight are correlated with increases in the risk of disease, attention should be focused on these children at an early stage. Mothers who lose fat and weight during lactation were associated with children who also lose weight and present lower rates of linear growth and weight gain. A monitoring system to identify these mothers could serve as a valuable method of identifying infants who are at risk. These women could be monitored by weight and arm circumference (which correlates highly with triceps fatfolds). This points out the need to examine mothers as well as children at monthly growth monitoring clinics.

Study findings also indicate that the infants most dependent on breastfeeding for their gr[illegible] those who have a gestational age less than 38 weeks and a low birthweight, head circumference, and lengt[illegible] at b[illegible] [illegible]here is also a correlation with SES and male literacy. These children are at a higher risk for future problems and should be monitored closely. An associated issue is that of infant supplementation. Findings indicate that supplementation starts very early. It is not entirely clear at this time what the consequences are for the infant who is supplemented, and more research needs to be conducted on this subject. It would be supportive of government policy to better understand the significance and consequence of supplementation practices.

The full policy significance of the Nutrition CRSP Study has yet to be realized. The wealth of the data set contains valuable insights as policy questions are posed. While the literature currently provides insight into the problems of malnutrition, intervention strategies will be well served by information which can identify relationships that permit the maximum benefit to be derived from the resources directed toward the resolution of those problems. To that end the CRSP data set can be very helpful.

REFERENCES

1. Reutlinger S. Policy implications of research on energy intake and activity levels with reference to the debate on the energy adequacy of existing diets in developing countries. In Energy Intake and Activity: Current Topics in Nutrition and Disease, volume 11, edited by Ernesto Pollitt and Peggy Amante. New York: Alan R. Liss, Inc., 1984, pp. 377-394.

2. Orlans H. "On knowledge, policy, practice and fate" in Translation of Scientific and Nutrition Findings to Social Policy, a symposium presented by the American Institute of Nutrition at the 63rd annual meeting of the Federation of American Societies for Experimental Biology, Dallas, Texas, April 2, 1979. Federation Proceedings vol. 38, no. 12: pp. 2553-2556.

3. Berg A. The Nutrition Factor, Brookings, 1973.

4. Reutlinger and Selowsky, Malnutrition and Poverty: Magnitude and Policy Options. International Bank of Reconstruction and Development, 1976.

Appendix A

ADDITIONAL PROJECT OUTPUTS

INSTITUTION BUILDING

A primary objective of the Nutrition CRSP Project was to facilitate the development of institutional capabilities within Kenya that would enable local groups to address food and health issues. The main methods for achieving this objective are the continued education and employment of Kenyans, and the encouragement of further research and programmatic interventions in the Embu area.

Further Education and Employment of Kenyans

The Nutrition CRSP Kenyan Project provided considerable nutrition, health and other training for Kenyans throughout the period of field research. Among the Kenyan senior staff, the physicians, social scientist, psychologist, nutritionist, lab technicians, data manager and accountant all gained invaluable experience and expertise through their participation in the project. All are now employed by the University of Nairobi or by other research institutions, or are continuing their education and training. It is particularly noteworthy that two former Kenyan staff members have received United Nations University Fellowships and are currently enrolled in the Master of Public Health program at the UCLA School of Public Health. Mr. Erastus K. Njeru, the data manager, is studying biostatistics and Mr. Duncan Ngare, the social scientist, is studying behavioral science. Mr. Njeru's training as a biostatistician will be extremely valuable to research activities in Kenya; he has been guaranteed employment by the University of Nairobi upon his return. Mr. Ngare will be resuming his position with the Kenyan Medical Research Institute as a medical sociologist. Both have been working with the CRSP data in the development of the final report and will continue to work with the data upon their return to Kenya.

Mrs. Charity Njiru, a CRSP staff nutritionist, and six former field staff have been employed by Meals for Millions/Freedom from Hunger Foundation to work on their applied nutrition program in Embu. About a quarter of the Nutrition CRSP Project Kenyan junior staff have obtained positions related to their CRSP training (data entry, field nutrition, mapping, microcomputer operation, field research, laboratory work (RMR) and nursing positions). Another quarter have continued in their education: nursing school, electronics school, computer training, and teacher training.

Further Research and Programmatic Interventions

Dr. A.A. Kielmann, director of the Master's program in Applied Nutrition at the University of Nairobi, College of Agriculture, is now planning to use the CRSP study area as the field training site for his program. This will be done in conjunction with the activities of Meals for Millions.

The area has also attracted student research as a result of the project. Dr. Waswa, a physician in the M.P.H. program at the University of Nairobi, did his thesis field work in the study area on a geriatric population.

Meals for Millions/Freedom from Hunger Foundation has targeted the area for an applied nutrition program. They have utilized CRSP Project data in the planning of that project and are currently involved in project implementation. Their interest in the Embu site was a direct consequence of the Nutrition CRSP Project.

In January of 1987 the Ford Foundation funded a follow-up study for the Embu area with the University of Nairobi as the lead institution. The study will follow households that experienced the acute food shortages of 1984 so as to provide an additional year's data on the recovery period. This will provide more information on the impact of the drought and subsequent food shortage and develop a monitoring system based on household food availability, food intake, anthropometry, crop production, market surveys and rainfall. This will increase the ability of government officials and community leaders to detect food availability problems before they pose serious threats to the community. This study is making use of the data collection methods established by the Nutrition CRSP Project as well as the trained enumerators and supervisors that the project produced.

CONFERENCES AND PRESENTATIONS

The following presentations have been given concerning the Kenyan Nutrition CRSP Project;

1. American Society for Clinical Nutrition; Nutrition and Health Impact of Famine on a Rural Kenyan Community; April 30, 1987; San Diego, California; Dr. Charlotte G. Neumann, Dr. E. Carter and S. Weinberg.

   Abstract:
   The unexpected occurrence of severe drought and subsequent famine in rural Kenya in 1984 at the site of a longitudinal study on marginal malnutrition furnished a unique opportunity to document health and nutrition consequences and household coping mechanisms in response to extreme food shortage. Food intake, anthropometry, morbidity, and agricultural activities, were monitored on a monthly basis on 270 households prior to, during and after the famine. Food intake was greatly reduced with zero intake reported on some days. There was a shift in diet to increased amounts of commercially processed maize flour, wild plants and insects as maize and bean harvests failed. Pregnant women experienced reduced weight gain, some having no weight gain or weight loss and a higher percent of newborns weighed under 2800 grams. The percent of severely malnourished children rose from 3 to 15% in some age groups and the community had little or no household or community stores of food and relied heavily on drought vulnerable crops or maize and beans. Early warning signs, monitoring and famine strategies have emerged from this experience.

2. American Anthropological Association; Anthropology and Nutrition: The Nutritional CRSP Kenya Project; December 2-7, 1986; Philadelphia; Michael J. Paolisso, Ph.D.

   Abstract:
   The Kenyan Nutrition CRSP Project offers a wealth of anthropological data for analysis. The data topics include socioeconomic status, sanitation and hygiene, time allocation, household economics, household agricultural production, and energy expenditure. The structure of the project facilitates the testing of numerous hypotheses of interest to anthropologists and provides a basis for new insights into the social, economic and cultural aspects of life in Kenya.

3. American Anthropological Association; Emergence of a food emergency: Embu District, Kenya; November 1987; Chicago; Dorothy J. Cattle, PhD; Michael Baksh, PhD; Eric Carter, M.D.; and Charlotte Neumann, M.D.

Abstract:
Temporary environmental conditions can precipitate major health and social stresses. By mid-1984, drought was evident in Embu District in east-central Kenya. A nutrition research project in the area documented the emergence of the subsequent severe food shortage. Through its ongoing data collection, the project was able to monitor biological, nutritional, and behavioral responses to the shortage. In addition to such responses, this paper describes the various household strategies used to cope with the worsening situation and the roles of local leaders and the project in offsetting the impact of the food shortage.

PUBLICATIONS

Due to an agreement on publications, no articles have been published at the time of the writing of the report. Several papers, however, are planned for publication. A brief summary follows.

1. "Impact of the 1984 drought on food intake, nutritional status and household response in Embu District, Kenya;" Neumann, C.G.; Bwibo, N.O.; Carter, E.; Weinberg, S.; Jansen, A.A.; Cattle, D.; Ngare, D.; Baksh, M.; Paolisso, M.; Coulson, A.H.; to be published in Drought in Kenya: Lessons from 1984; published by Lynne Rienner, 1988; edited by T. Downing et. al.

   Abstract:
   In 1984, drought and a subsequent famine struck Embu District of Eastern Province, Kenya. The impact and responses to this famine were carefully documented due to the presence of a nutrition research project in the area. Impact was measured in terms of food intake, nutritional status and pregnancy outcome. Household and community responses were observed during the course of the nutrition research and the ensuing emergency food relief program. This paper describes the impact of that famine and the coping responses that were employed by the households and communities to deal with severe food shortages.

2. "The Program and the Field: Social Science in the Nutrition CRSP;" Dorothy J. Cattle; Bringing People In: Social Research in International Agricultural Development; edited by C. McCorkle.

   Abstract:
   This chapter describes the institutional development of the Nutrition CRSP in response to recommendations by the Academy of Sciences concerning world hunger and malnutrition issues. The process of planning the strategy and guidelines for the nutrition research is briefly reviewed. The major social science issues in, and contributions to, the pre-field phase of the Nutrition CRSP are considered under three headings: the nutrition focus, design, and concepts. Some of the initial in-field procedures for implementation of the Nutrition CRSP Kenya Project are given. The chapter identifies the social issues raised, and program expectations about social research. Within this CRSP research framework, in-field concerns about local participation are discussed.

3. "Home environment and the development of Kenyan toddlers;" Sigman, M.; Neumann, C.; Carter, E.; Cattle, D.; D'Souza, S.; Bwibo, Nimrod; submitted to Child Development.

   Abstract:
   The rearing conditions experienced by 110 children, growing up in a rural Kenyan community, were observed when the children were between 15 and 30 months of age during two-hour observations carried out every other month. The children's cognitive development was assessed with revised versions of the Bayley and Uzgiris-Hunt scales at 18, 24, and 30 months of age. Children who were talked to more frequently, whose vocalizations were responded to more, and who were more engaged

in sustained social interactions passed more of the Bayley Mental Scale items at 24 and 30 months of age than children who were less involved in verbal and social interactions during the previous home observations. Durations of smiling and crying during the last home observations were also related to previous home rearing conditions. Children who were carried and held a great deal developed less well. The influence of the home rearing conditions was largely independent of the children's earlier cognitive and affective characteristics. Both home rearing conditions and the level of paternal literacy were independently associated with the cognitive and verbal development of these Kenyan toddlers at 30 months of age.

4. "Risk Factors for Diarrhea Among Young Children in Rural Kenya." Thomas, J.C. Ph.D dissertation, University of California, Los Angeles. 1987.

Abstract:
Diarrhea is the primary cause of death among children less than five years of age in developing countries. Nutrient loss attributable to diarrhea is one of the major factors contributing to malnutrition. Though death from dehydration resulting from diarrhea is preventable, little is know about preventing the occurrence of diarrhea. This study examines the role of factors of the child and the child's environment as risks for diarrhea among children less than 36 months old in rural Kenya. A cross-sectional study of 357 chilren was performed in the context of a six month prospective study of 249 children. These larger studies are accompanied by in-depth, systematic observations of a subsample of 38 households. A seasonal variation of diarrhea was identified in association with the temperature, humidity, and wi d. No evidence was found to indicate that the child's nutritional status affected the risk of diarrhea. There ar conflicting results on the risk posed by exposure to domestic animals. The effects of latrines and various water sources were minor compared to social factors of the child's environment, including the mother's level of education, her knowledge of the causes and prevention of diarrhea, physical contact with the child, and child caretaking practices. The resources for addressing these factors of the social environment are available within the local community. The findings regarding the risk factors and methods of this study have implications for public health efforts to prevent diarrhea and for future community-based studies of clinical diarrhea.

Appendix B

FOOD TO NUTRIENT CONVERSION SYSTEM

OVERVIEW

Development of a food to nutrient conversion system for the Nutrition CRSP Kenya Project was carried out as a cooperative effort between the Kenya Project staff and the Nutritional Sciences Department at the University of California, Berkeley. The actual computer conversion was performed at Berkeley, using field data supplied by UCLA, and the results were sent to UCLA. Meetings between the staffs at both universities were held on several occasions during this process. A hand-calculated conversion was performed earlier in Kenya in order to perform preliminary analyses.

The system development was a multi-step process, involving development of a nutrient data base, calculation of the nutrient values of household recipes, development of nutrient values for standard recipes, and calculation of nutrient totals for individuals and households. Quality control checks were performed at each step. A brief summary of each step is presented below. A flowchart, "Creation of Kenya Project nutrient intake files" (Figure B.1), presents an overview of the files used at each step.

DEVELOPMENT OF A NUTRIENT DATA BASE FOR KENYAN FOOD ITEMS

The Kenya Project field nutritionist developed a list of foods and dishes consumed by the survey population and assigned codes to these items. Approximately one-third of the codes refer to food items, and the remainder refer to mixed dishes (recipes). The food item codes were used in two ways: to record the ingredients in household dishes; and to record the consumption of non-dish foods (snacks and non-household foods) by individuals. The nutrient base contains five nutrients for each food item: energy, protein, fat, carbohydrate, and iron. Nutrient values are per 100 grams of the food item. Sources of nutrient values included: laboratory analyses of food items, USDA Handbook 8 (1-2), FAO values for foods in Africa (3), Platt (4), and McCance and Widdowson (5). When a published value could not be found, a value was assigned from a similar food. The final food item nutrient data base contains 180 food items, including eight hotel foods (generally, foods commercially prepared).

CALCULATION OF NUTRIENT VALUES FOR HOUSEHOLD RECIPES

Every time a dish (recipe) was prepared during a day of observation, the ingredients were weighed and recorded on a meal preparation form (No 114). If a dish was prepared while the enumerator was absent, the weight of each ingredient was estimated (recalled). Each dish was assigned a unique code for that household. There are 157 types of dishes. Recipes can appear as ingredients in other recipes that were prepared later in the observation period. Standard recipes (see next section) can also appear as ingredients. Records with "-8" in the data fields were used to indicate that a household was scheduled for a visit that day, but the visit could not be made (in some cases, because no one was home;

in other cases, when field personnel were not available to make the visit). Dish codes of 9900 were used to indicate that the household was visited, but no food was prepared that day.

An initial computer edit check was performed in Berkeley, on the meal preparation records, to eliminate quality control records (containing a "9" in the year field), duplicate records, and records with missing household number, date, or dish code.

A SAS program was used to search the nutrient data base for the nutrient content of each ingredient in a dish, multiply the nutrient values by the weight of the ingredient, provide for the recomputation of each dish to allow for the use of previously prepared dishes as ingredients in the current dish, sum the nutrient values for all ingredients, and adjust the nutrient totals by the final weight of the cooked dish. The "nesting" of dishes and ingredients may occur up to two levels. A file (form 121) has been written which contains the nutrient values for 100 grams of each household dish.

DEVELOPMENT OF A STANDARD RECIPE NUTRIENT DATA BASE

When a respondent reported consumption of a dish for which no recipe was available (e.g., it was consumed at another house), a standard recipe code was used on the 116 form. There are 157 standard recipe codes, corresponding to the 157 household dish codes.

A SAS program was used to calculate nutrient values for standard recipes, based on the median values for corresponding household dishes. Only those dishes for which all ingredients had been weighed (rather than recalled) were used for this calculation (dishes from January and February, 1984, were also omitted, as these early reports might have been atypical). To address concerns that the composition of recipes might change with time, particularly during the famine, median energy values were examined for ten commonly consumed dishes at three time points (June, 1984, prior to the drought; December, 1984, during the drought; and June/July, 1985 after the drought). Variation was less than 12 kcal per 100 grams for nine of the dishes, and 41 kcal/100g for the remaining dish (plain ugali). Thus, there was no consistent variation over the time of the drought, and the decision was made to use an overall median value for each standard recipe.

CALCULATION OF INDIVIDUAL NUTRIENT TOTALS

The amount of a food item or dish consumed by an individual was recorded on form 116. A meal code was associated with each entry, indicating meal number for dishes, and either snack or non-household for food items. Snacks are any non-dish food which originated in the home (and can be consumed any time during the day). Non-household food items originated outside the home, including relief foods, (but may be consumed in the home) and also may be consumed at any time.

Records with "-8" in the data fields were used to indicate that the target individual was not present on that day. A meal code of "0" was used to indicate that the target individual had no intake on that day.

An initial edit check was performed on the 116 records to eliminate quality control records and records with a missing household number, date, or dish/food item code.

A SAS program was used to calculate nutrient totals for each individual. This program accesses the nutrient data base (for food items), the standard recipe nutrient data base (for standard recipes), and the household recipe nutrient values (for dishes). The corresponding nutrient values per 100 grams are multiplied by the portion size specified in the 116 form, and totalled for each individual. Three total values are calculated for each nutrient: dish nutrients, snack nutrients, and non-household nutrients. Target individuals can have non-zero values for all three totals. Non-target individuals have values only for snack and non-household nutrients. These totals are written on a file as form No. 120.

Two indicator variables are also contained on this file: 1) if the nutrient values could not be found for a food or dish (due to some type of mismatch), a missing-food indicator is set; 2) if a child had been breastfed at least once during the day, a breastfed indicator is set.

CALCULATION OF HOUSEHOLD NUTRIENT TOTALS

The total amount of a dish consumed by a household was recorded on the household dish intake summary (form No. 115), as was the amount consumed by guests.

Total daily household nutrient intake was defined as the sum of:

1. The nutrient content of all dishes consumed by the household (minus any amount consumed by guests).

2. The nutrient content of all snacks consumed by targets and non-targets.

3. The nutrient content of all non-household food consumed by targets and non-targets.

Household nutrient intake was calculated by a SAS program which accessed the household dish intake records and multiplied the amount consumed (minus the amount consumed by guests) times the nutrient values in the dish nutrient file (form No. 121). To this was added nutrient values for snacks and non-household foods (on the individual nutrient intake file, form No. 120). These totals were entered on a household nutrient intake file, form No. 122.

QUALITY CONTROL

Recipes which contained an ingredient for which no nutrient values existed were flagged and listed. This type of mismatch occurred when a food item was not on the nutrient data base, or when a recipe used as an ingredient did not have a 114 form. This mismatch listing was sent to the field nutritionist in Kenya, who corrected all mismatches (after referring to the original field data forms) and returned the corrected forms to Berkeley. The corrections were key-entered in Berkeley and applied to the recipe data files.

The yield was calculated for each recipe as the cooked weight divided by the sum of the weights of the raw ingredients. Yields should not exceed 100%, but it was decided that high yields normally indicate missing water as an ingredient, and would not be considered an error (since the nutrient value is not affected by water). Yields under 50% were common, since many dishes are cooked for long periods in uncovered containers. Thus, a range check on yield was not performed.

Energy values greater than 350 kcal/100 grams were considered unlikely for most dishes. Thus, a listing was made of all dishes exceeding this limit, and the source of the high values was determined. For some food items, a high energy density was to be expected (e.g., for chapati), while for others, the values were deemed unreasonable. If the source of the error was obvious (incorrect codes or amounts), the errors were corrected. In most cases, the cooked dish weight appears incorrect, and a standard yield factor for the specific dish, derived from the standard recipe file, was applied.

All dish summary records (form No. 114) were scanned for dates that did not appear in pairs (since food intake was normally collected on two consecutive days). A listing of non-aired dates indicated that the source of error was usually an incorrectly entered year (1984 vs. 1985). These corrections were made.

Individual food intake items which did not have entries on the nutrient data base, standard recipes which were not on the standard recipe nutrient data base, and dishes which were not on the household recipe nutrient data base were printed. An individual diet which had missing nutrient values was flagged. A listing of these mismatches was made, and the source of the error investigated. Most errors were due to a transposition of numbers, and the correct code was determined by examining the dishes prepared in the household that day or the snacks consumed by other household members. When possible, these errors were corrected.

VALIDATION WITH ANALYTIC VALUES

The nutrient content of several mixed dishes was analyzed by Medallion Laboratories. The field nutritionist collected from one to three samples each of twelve typical dishes. The analytic values are compared to the corresponding standard recipes and presented in Table B.1. The largest percent difference was 22%, for plain ugali, with the standard recipe higher than the analytic value. The largest energy difference was for chapati (34 kcal/100 g.); again, the standard recipe was higher than the analytic value. In general, the analyzed and calculated values were within 15 kcal/100 g. of each other. The analytic value was higher for four dishes, the standard recipe was higher for six dishes, and the values were identical for one dish. The analyzed composite for porridge included plain porridge and porridge with milk and sugar. As expected, the standard recipe for the former was lower than the analyzed value, while the standard recipe for the latter was higher.

TABLE B.1
Comparison of calculated and analyzed nutrient values for selected dishes.

Dish Name	Dish Code	Standard Dish* PRO g/100g	FAT g/100g	CHO g/100g	Kcal	N‡	Laboratory Analysis† PRO g/100g	FAT g/100g	CHO g/100g	Kcal	KCAL DIFF§
Chapati - fried (flour, water, fat)	3820	8.2	5.6	59.5	336	37	6.3	9.1	49.0	302	11%
Githeri - boiled (maize, beans, water)	2510	5.1	1.6	29.6	147	1760	6.3	1.4	31.1	163	-10%
Githeri - fried (boiled w/fat, onions)	2520	4.5	1.9	25.9	135	1208	4.2	1.8	24.2	130	4%
Githeri - fried with vegetables	2540	4.3	1.8	24.3	126	483	4.5	1.9	25.9	138	-9%
Gitwero - banana bean	3050	1.2	.1	17.5	70	227	.7	.1	13.6	58	21%
Gitwero - banana/bean fried	3080	3.0	1.1	20.5	98	25	5.0	.6	21.2	110	-11%
Gitwero - banana/potato fried	3060	1.2	1.4	17.1	82	219	1.0	1.7	15.8	82	0%
Porridge (flour, water**)	2360	.9	.5	7.7	38	684	1.1	.4	9.2	45	-16%
Porridge (flour, water sugar milk**)	2390	1.2	.9	10.1	53	96	1.1	.4	9.2	45	18%
Ugali - plain (flour, water)	3510	3.3	1.7	27.6	134	1243	2.1	1.3	26.2	125	7%
Ugali - plain with beans	3950	5.2	1.6	30.3	152	12	3.4	1.0	25.5	125	22%
Ugali - plain with vegetables	3520	3.3	1.3	22.3	109	47	2.3	1.2	23.3	113	-4%
Ugali - plain with vegetables,beans	3530	4.3	1.1	25.0	127	10	3.6	1.2	24.8	125	2%

* Standard dishes: standard dish nutrient values were obtained by taking the median of all weighed dishes (as opposed to recalls) for a given dish type.

† Analyses performed by Medallion Laboratories, Minneapolis, MN.

‡ "N" is the recorded number of weighed dishes from which median values were calculated.

§ KCAL DIFF is the difference between the standard dish kcals and the analysis kcals expressed as a percentage of the analysis kcals.

** The porridge sample sent to the lab was a combination of the two different types of porridge noted above. The analysis value for the combined sample is reported above for both types.

REFERENCES

1. United States Department of Agriculture, Agricultural Research Services. Composition of foods, Agriculture Handbook No. 8. Washington, DC. 1963.

2. United States Department of Agriculture, Agricultural Research Services. Composition of foods, Agriculture Handbook Nos. 8-1 through 8-12. Washington, DC. 1976-1984.

3. United States Department of Health, Education, and Welfare, Public Health Service, Health Services Administration, National Center for Chronic Disease Control Nutrition Program; and Food and Agriculture Organization of the United Nations, Food Consumption and Planning Branch, Nutrition Division. Food composition table for use in Africa. Bethesda, MD, and Rome, Italy. 1968.

4. Platt B.S. Tables of representative values of foods commonly used in tropical countries. Privy Council, Medical Research Council Special Report Series No. 302. London: Her Majesty's Stationery Office. 1962.

5. Paul A.A., Southgate D.A.T. McCance and Widdowson's The composition of foods, fourth revised edition. New York: Elsevier/North-Holland Biomedical Press. 1978.

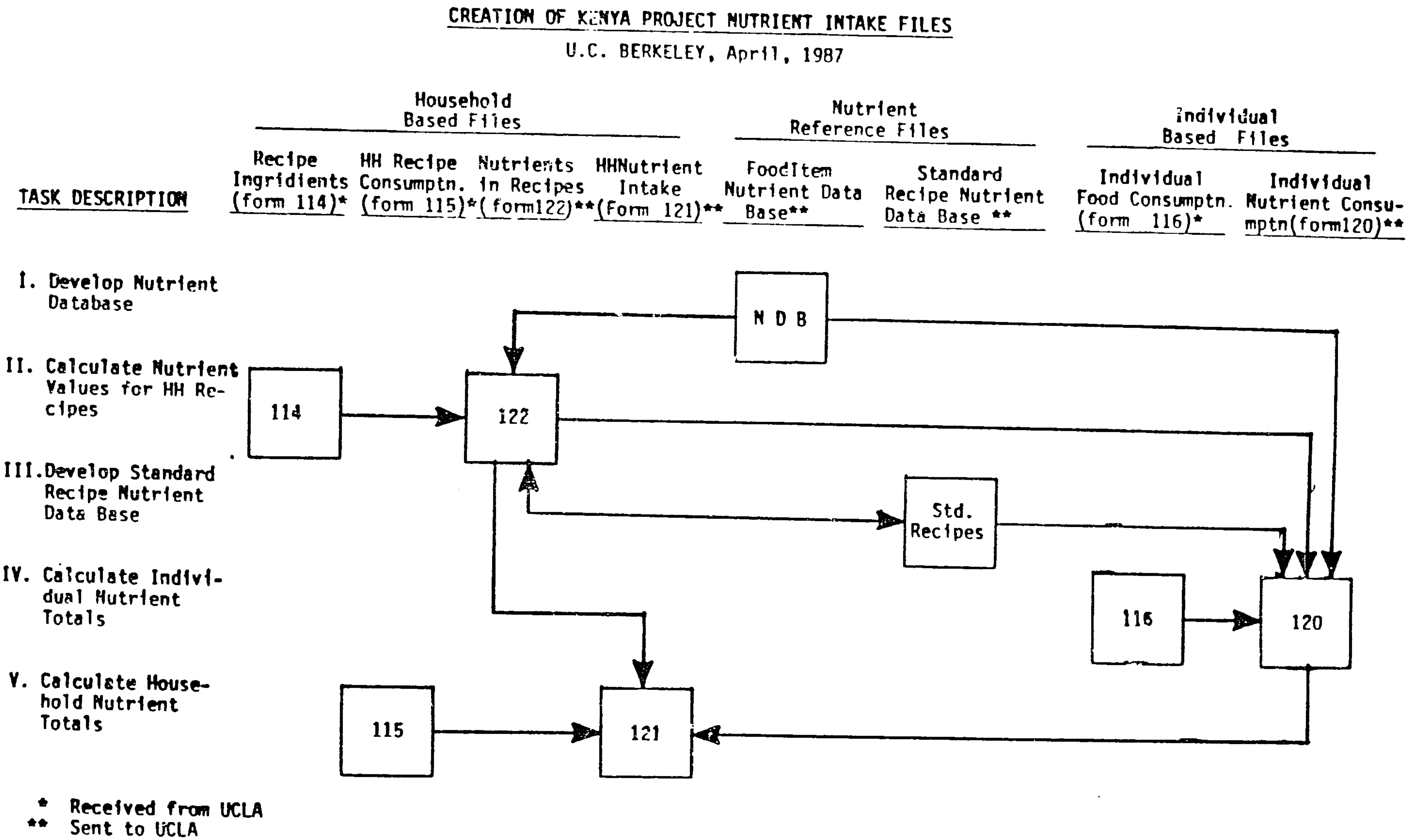


FIG. B.1. Creation of Kenya project nutrient intake files.

Appendix C

CODES FOR MORBIDITY CATEGORIES AND CLASSIFICATION OF ILLNESS EPISODES

1. CODES FOR MORBIDITY CATEGORIES

ICD-9*	CRSP KENYA CODES
	01 SKIN
684	01 Impetigo
682	02 Cellulitis/Abcess, Boil
111.9	03 Fungus (Ringworm)
133.0	04 Parasites-skin (scabies, chiggers)
692	05 Allergic/Contact Dermititis
949	06 Burn
675.2	08 Mastitis
919.9	09 Infected cuts and bites
919.9	10 Insect bites
706.2	11 Cyst
686.9	29 Other
	02 EYE
372.3	01 Conjunctivitis
373.1	02 Stye/Blepharitis
376.01	03 Periorbital Cellulitis
930.9	04 Trauma/Foreign Body
076.1	05 Trachoma
098.4	06 Gonococcal Conjunctivitis or Opthalmitis
379.99	29 Other
	03 EARS
380.1	01 Otitis Externa
382.9	02 Otitis Media
383.0	03 Mastiditis
	04 Foreign Body/Trauma
388.7	05 Swelling of ears, ear pain
388	29 Other

ICD-9	CRSP KENYA CODES
	04 MOUTH/TEETH/GUM
522.5	01 Gum-dental abcess
523.1	02 Gingivostomatitis
112.0	03 Thrush
521.0	04 Dental Caries
525.9	05 Tooth Ache
529.0	07 Bleeding Gums
523.8	29 Other
	05 RESPIRATORY
460	01 Common Cold
465.8	02 Tonsillopharyngitis
464.4	03 Croup/Largotracheitis
490	04 Bronchitis
493.9	05 Asthma/Wheezing
486	06 Pneumonia
465	07 Acute Upper Respiratory Tract Infection
466.1	08 Bronchiolitis
786	09 Trouble Breathing
784.9	10 Nose Bleed
786	11 Chest Problem
519.9	29 Other
	06 CARDIOVASCULAR
428.0	01 Congestive Heart Failure
410.0	02 Heart Attack
785.1	03 Palpitations
429.9	29 Other

* ICD-9 International Classification of Disease (vol. 9)

ICD-9	CRSP KENYA CODES
	07 DIGESTIVE
789	10 Lower Abdominal Pain
783	11 Loss of Appetite
564	12 Constipation
006.3/ 006.4/006.5	13 Amoebic Abcess
537.9	29 Other
	08 GENITOURINARY
599.0	01 Urinary tract infection
090/099	02 Sex. transmitted disease
614.0	03 Pelvic Inflammatory disease
626.4	04 Menstrual Irregularities
616.8	05 Pain, swelling around groin
626	06 Vaginal bleeding
616.1	07 Vaginitis
616.9	29 Other
	09 EXTREMITIES/MUSCULO/SKELETAL
716.9	01 Acute arthritis
715.9	02 Chronic arthritis
829.0	03 Fracture/dislocation/ sprain
724.2	04 Back ache/stiffness
723.1	05 Neck pain/stiffness
786.5	06 Chest pain
719.4	07 Joint pain (including shoulders)
780.9	08 Body pain (multiple pain and aches)
782.3	09 Pain, swelling and edema of feet and legs symptoms
959	10 Multiple body, extremities, musculoskeletal trauma
959.9	29 Other
	10 NERVOUS SYSTEM
780.3	01 Convulsions
320/323	02 Meningitis
850.5	03 Head Trauma/with unconsciousness
290	04 Psychologic/Emotional
784.0	05 Headache/Persistent for more than 7 days
784.4	06 Dizzyness/Fainting
354/355	11 Numbness of extremities
780.7	12 General body weakness
	29 Other

ICD-9	CRSP KENYA CODES
	11 COMMUNICABLE
055	01 Measles
033	02 Pertussis
052	03 Chicken Pox
011.9	04 Tuberculosis: Pulmonary
013	05 Tuberculosis: Extrapulmonary
045	06 Poliomyelitis
072	07 Mumps
780.6	08 Non-specific Xanthem/ with fever
055.8	09 Measles: complicated
033.9	10 Pertussis
052.8	11 Chicken Pox: complicated
	29 Other
	12 NUTRITIONAL
260	01 Kwashiokor/Nutrit. Edema
261	02 Marasmus
280	03 Clinical Anemia
	29 Other
	13 FEVER
780.6	01 Fever - no other signs/
136.9	02 Fever - with other signs/ symptoms
999.9	03 Fever - post immunization
084	04 Clinical Malaria
	29 Other
	14 MISCELLANEOUS
782.2	01 Breast swelling and pain
611.72	02 Masses of the breast
782.1	03 Swelling of the face and body
240	04 Swollen Thyroid gland, goiter, or hyperthyroid
785.6	05 Lymphadenopathy
644.1	06 False labour
	15 MALIGNANCY
239.1	01 Malignancy

2. CLASSIFICATION OF ILLNESS EPISODES

I. LOW GRADE ILLNESS (LGI)

(a) Symptomatic

0405 Toothache
0406 Painful tongue
0509 Trouble breathing*
0511 Chest problem*
0706 Abdominal pain*
0710 Lower Abdominal pain*
0711 Loss of appetite
0712 Constipation
0804 Menstrual irregularities
0901 Chronic joint pain
0902 Acute joint pain*
0904 Backache (stiffness)
0905 Neck pain/stiffness
0906 Chest pain*
0908 Body pain
1011 Numbness of extremities*
1012 Body weakness

* No other signs or symptoms present

(b) Infectious Etiology

0101 Impetigo
0103 Fungus
0104 Parasitic - scabies, chiggers
0109 Infected cuts and bites
0201 Conjunctivitis
0202 Stye/blepharitis
0205 Trachoma
0301 Otitis externa
0403 Thrush
0403 Dental caries
0501 Common cold
0507 Acute upper respiratory infection

(c) Non-infectious Etiology

0104 Skin cyst
0105 Allergic/contact dermitiitis
0107 Soft tissue injury
0110 Insect bites
0204 Eye trauma/foreign body
0304 Ear pain - swelling of pinna
0510 Nose bleed
0903 Dislocation, sprain

II. SIGNIFICANT ILLNESS (SI)

(a) Infectious Etiology

0102 Cellulitis/abcess, boil
0108 Mastitis
0203 Periorbital cellulitis
0302 Otitis media
0401 Gum-dental abcess
0404 Dental caries
0502 Tonsil pharyngitis
0503 Croup/laryngotracheitis
0504 Bronchitis
0701 Acute vomiting
0702 Diarrhea
0704 Intestinal parasites
0801 Urinary tract infection
0802 Sexually transmitted disease
0803 Pelvic inflammatory disease (presumptive diagnosis) (1)*
0807 Vaginitis
1103 Chicken pox
1106 Poliomyelitis - asceptic meningitis (1)*
1107 Mumps
1301 Fever - no other signs (1)
1302 Fever - post immunization
1405 Lymphadenopathy

* Mild form--see Appendix D

(b) Non-infectious Etiology

0106 Burn (1)
0505 Asthma/wheezing
0708 Suspected peptic ulcer
0805 Painful swelling - groin
0806 Vaginal bleeding
0909 Edema - swelling of feet
1001 Convulsions (brief--no loss of consciousness) (1)*
1003 Head trauma
1004 Psychologic/emotional problems
1005 Persistent headache for more than 7 days
1203 Clinical anemia (1)
1401 Breast swelling
1402 Breast masses
1403 Swelling face and body
1404 Thyroid "swelling"

III. SERIOUS ILLNESS (SSI)*

a) Infectious Origin

0203 Periorbital Cellulitis
0206 Gonococcal Opthalmitis
0303 Mastoiditis
0506 Pneumonia
0508 Bronchiolitis
0705 Dehydration - with diarrheal disease (702) or gastroenteritis (709)
0703 Hepatitis
0713 Amoebic abscess
0803 Pelvic inflammatory disease Abscess/peritonitis
1002 Meningitis/encephalitis
1101 Measles
1102 Pertussis
1104 Tuberculosis - pulmonary
1105 Tuberculosis - extrapulmonary
1109 Measles with complications
1110 Pertussis with complications
1111 Chicken Pox with complications
1301 Fever
1302 Fever with other symptoms
1304 Clinical malaria
1305 Cerebral malaria

(b) Non-infectious Origin

0106 Burn , 3^{o} or extensive 2^{o}
0601 Congestive heart failure
0602 Heart attack
0713 Amoebic abscess
0807 Vaginal bleeding
0903 Fracture/dislocation/sprain
0910 Multiple body trauma
1001 Convulsions
1003 Head trauma with unconsciousness
1201 Marasmus
1202 Kwashiorkor
1203 Clinical anemia
1301 Fever (only)
1302 Fever other signs
1304 Clinical malaria
1401 Breast swelling
1415 Malignancy

* All are severe (2)--see Appendix D

Appendix D

PREDETERMINED SEVERITY CRITERIA AND MORBIDITY INDEX

Severity Criteria

Introduction

The criteria for judging severity include several factors:

1. Age
   Some conditions are more severe under one year of age compared to the condition in an older child or adult.

2. Extensiveness
   In skin conditions such as cellulitis or burns, the extensiveness of the condition can make it severe, i.e. 3% vs. 30% of the body surface involved.

3. Degree of febrile response
   Constitutional symptoms.

4. Type of Illness
   Pneumonia is a severe illness as compared to a common cold.
   Measles is a severe illness compared to chicken pox.

5. Presence of complications
   Secondary infection, i.e. infected chickenpox or diarrhea with dehydration

6. Functional State
   Severe limitation of usual activities or totally confined to bed vs. no limitation of activity.

Suggested Criteria for Severity

Illness will be classified as:

	1 = MILD	2 = SEVERE
SKIN	Boils (less/equal to 5) Abcess (less than 2 cm diam) Impetigo - localized Insect bites Ringworm Allergic dermititis Scabies First degree or small 2° burns (3x3)	Multiple boils (more than 5) with Cellulitis Extensive Impetigo (greater than 30% of body) Allergic reaction w/desquamation covering (30% of body and/or 2° infected) Mastitis w/fever and chills Burns (see trauma accidents)
EYE	Conjunctivitis Stye - Blepharitis Foreign body	Perioribital Cellulitis Puncture of globe Corneal abrasion Panophthalmitis Xeropthalmia Trachoma
EARS	Otitis Externa Otitis media no perforation fever less than 38°C	Otitis media w/purulent drainage or bulging red ear drum Mastoiditis Traumatic performation of drum
MOUTH	Thrush Stomatitis without fever and no difficulty eating or drinking	Apthous or herpetic stomatitis with fever and inability to eat or swallow--drooling, gum abcess
RESPIRATORY	Common Cold/Sore Throat ≤38°C fever Asthma/wheezing with no respiratory distress Croup - no retraction	Pneumonia Tonsillopharyngitis with >38°C fever Bronchitis Wheezing with respiratory distress Respiratory Distress Croup - stridor and retractions Cyanosis

Suggested Criteria for Severity

Illness will be classified as

	1 = MILD	2 = SEVERE
CARDIOVASCULAR	-----	Congestive Heart Failure Cyanosis
COMMUNICABLE DISEASES	Pertussis - child over 2 yrs Attentuated or atypical Measles in an immunized person Asymtomatic Tuberculosis positive skin test only Non-paralytic Polio Non-specific Xanthema w/ fever <38°C Mumps with no complications Chicken pox with no complications	Pertussis - child under 2 yrs Measles alone or with complications Tuberculosis - all clinical forms Bulbar Polio Paralytic Polio Xanthema w/ fever >39°C Hepatitis Tetanus Diptheria
EXTREMITIES	Transient stiffness and joint pain	Generalized Arthritis with red swollen joints and fever more than 38°C Monarticular Arthritis fever, redness, swelling of joint
TRAUMA	Minor sprains, bruises Small cuts and abrasions non-debilitating Burn, 1° or small 2°	Compound Fracture Long bone or pelvic fracture Skull fracture Vertebral Column fracture Burn 2° greater than 30% of body and 3° burn

Morbidity Index

Low-Grade Illness Index (LGI)

The low-grade index was defined simply as the number of days during a period in which a target individual was ill from one or more of the illnesses described as "low-grade" plus an added factor for reduced food intake and activity (see Appendix C for classification of diseases into Low Grade Illness).

$$LGI = Days + \frac{[(FI-1 + ACT-1)]}{4} \times Days \text{ (up to 30 days maximum)}$$

Significant Illness Index (SI)

The significant illness index is a function of:

a. The classification of the illness (serious or significant--see Appendix C)
b. The number of days ill.
c. The weeks during a period that illness episode took place.
d. The amount of reduced activity and food intake that took place.*

The Algorithm for Significant Illness Index (SI) and Serious Illness Index (SSI)

$$\text{Index for SI or SSI} = \sum_{i=1}^{1\text{-}3} [W_1 \times (D_i) + (D_i/7)\ K_i/3\ (A)]$$

Comments

Subscripts 1, 2, 3 refer to the actual week of illness

A = Food Intake plus Activity Scores*
W= Weighting e.g., W = 1, W = 2, W = 3, W = 4 (see below)
D = Days ill in a given week e.g., D_i, D_{ii}, D_{iii}
K = Weighting by week for Food Intake and Activity scores (A)*

$K_1 = 3$	$K_2 = 2$	$K_3 = 1$	$K = 1$	after 14 days

One Period = 4 weeks which coincides with illness reporting.

Weighting for Illness Categories by Week of Illness

Illness Category

SI (significant)	$W_1 = 2$	$W_2 = 1$	$W_3 = 1$	W = 1 after 14 days
SSI (serious)	$W_1 = 4$	$W_2 = 2$	$W_3 = 1$	

Examples of Components of the Morbidity Index

1. Pneumonia (SSI) for 9 days, all within one period.
Activity Score: bedridden = 3
Food Intake Score: liquids only = 3

SI = 4(7) + 2(2) + 1(0) + (7/7)3/3(6)	=	38.0
(2nd week FI & Act. Score) + (2/7)2/3(6)	=	1.1
SSI	=	39.1

* Omit food intake scale when analysis involves food intake and morbidity

2. <u>Tonsillitis</u> (SI) for 12 days; first 6 days in period 1, remainder in period 2:
Activity Score: moderate reduction = 2
Food Intake Score: decrease = 2

(period 1) $SI_1 = 2(6) + 1(0) + 1(0) + (6/7)3/3(4)$	=	15.4
(period 2) $SI_2 = 2(1) + 1(5) + 1(0) + (1/7)3/3(4)$	=	7.6
(2nd week FI and Act. Score) $(5/7)3/3(4)$	=	1.9
SI	=	24.9

3. <u>Tuberculosis</u> (SSI) for 60 days:
first 13 days in period 1
next 28 days in period 2
next 19 days in period 3
Activity Score: moderate reduction = 2
Food Intake Score: minimal reduction = 1

period 1: $SSI_1 = 4(7) + 2(6) + 1(0) + (7/7)3/3(3) + 6/7(2/3)3$	=	44.7
period 2: $SSI_2 = 4(0) + 2(1) + 1(27) + (1/7)2/3(3) + 27/7(1/3)3$	=	33.1
period 3: $SSI_3 = 4(0) + 2(0) + 1(19) + (19/7)1/3(3)$	=	21.7
SSI	=	99.5

Appendix E

CARE-GIVING ACTIVITIES

RESEARCH OBJECTIVES

Child development, care, and well-being are important responsibilities of families and may be affected in important ways by the nutritional states of household members. Previous research had suggested that chronic, mild-to-moderate malnutrition of the child or caretaker could influence child-caretaker interaction patterns, which, in turn, could affect cognitive outcome. Other factors are expected to vary with mild-to-moderate malnutrition, including individual characteristics of the child such as growth patterns and activity level. However, the specific home environmental factors that influence and are influenced by chronic, mild malnutrition have not yet been clearly delineated. Activity observations were formulated from both general information about child development and specific conjectures based on preliminary observations carried out on child rearing and child development in rural Kenya. Interpretation of care-giving patterns is dependent on other information collected by the cognitive and social functions of the Kenya CRSP Project and by food intake information.

THE SAMPLE

Care-giving activities were observed for target infants and toddlers from main study households with such members. Infants were observed at 2 months, 4 months, and 6 months of age. Toddlers were observed during the main study period in the months of March, April, June, August, October, December, January, and February. Observations were done a minimum of 6 times per toddler; other data collection responsibilities of field staff precluded a monthly schedule.

DEVELOPMENT OF DATA COLLECTION TECHNIQUES AND STAFF TRAINING

During the development of care-giving procedures, the activity component of the Nutrition CRSP was not definitively incorporated as part of the core data. Pilot testing consisted of field staff observing and recording general activity patterns of a variety of individuals, including children and adults. Examples of pilot studies conducted by senior project staff include a four-week toddler activity observation with periods covering 8:00 a.m. to 4:00 p.m.; and one-hour simultaneous observations by paired enumerators working independently, for each of three days of testing the technique and forms. Development of the sanitation and hygiene part of the social function influenced the selection of activities to be recorded and the individuals to be observed for care-giving. Definition of the CRSP core data requirements also affected its development, since resources, staff, and time were devoted primarily to core data requirements, and care-giving had to be justified for its contribution to those requirements.

The extensive series of pilot studies served to define and refine definitions of activities, timing and recording techniques, design of forms, supervision needs, equipment use, and quality control. Field staff were trained in the classroom on form-filling procedures and observational issues. In the field the staff practiced observations under household conditions and identified further issues for discussion. The piloting period allowed senior staff to select enumerators who were skilled and consistent observers. These were the same enumerators that collected observational data on infant and toddler interaction, and on schooler classroom and playground activities. Immediately prior to the main study, all field staff were involved in the final definitions of activities and procedures through a series of meetings arranged by senior investigators and staff.

TECHNIQUES OF DATA COLLECTION

Household Assignments and Visits

A target child was assigned to an enumerator to observe for 2 hours on a particular morning or afternoon; an alternative assignment was made when possible, in case the target individual was unavailable for observation. Enumerators were not always assigned to observe the same individuals month to month. The time of day when the 2-hour observation took place was shifted when possible. (Other functions also had data collection procedures to perform which affected scheduling and revisits.) Over the 6-8 observations sessions, the periods varied per target individual to cover approximately the hours between 8:30 a.m. and 4:30 p.m

Several procedures were involved in the preparation for data collection. Enumerators explained to the family they would be observing the child during its normal day without interfering with household activities. They also mentioned that the parents should move about as necessary. With careful explanation, families readily accepted the observer without altering their own movements. Enumerators also took time to locate the assigned individual and mother, to select the optional observer position, and to arrange their equipment. There was not a standard, specified period of preparation time for all enumerators to follow upon reaching the household; experience from piloting and household visits suggested it was unnecessary.

Observation Techniques

Under the usual circumstances, the target child was kept in sight, with the enumerator following or moving about as necessary. Target infants were carried to different places and toddlers often moved about on their own; most circumstances required the enumerator to follow the target individual, while continuing observation. The enumerators kept the child in sight to the maximum extent possible. The large clipboards, digital watches, and field-appropriate forms allowed enumerators to accurately record observational data even when walking or standing.

When following the target was impossible, the time period was coded "out of view." If the target individual remained "out of view" for 10 minutes or longer, the observation was terminated and use of the particular form stopped (there was a code to signify the ending of an observation). Two examples of discontinuance were: 1) target child was taken in a vehicle to someplace at some distance from the study area, beyond Kyeni South Location; or 2) target child was in bedroom with its parents. Such circumstances were noted on the comment lines as the last activity recorded before following became impossible.

The target child falling asleep also affected data collection. If part of the observation had been done, the enumerator simply "timed" the child as it slept. However, when sleeping extended for 10 minutes or longer, the observation period was stopped and a new form was begun when the child awoke. Beginning a new form under these circumstances was considered an immediate re-attempt, that is, a new attempt to make the required observation over another 2-hour period. Sleeping was defined as the target individual's eyes were closed for more than 2 minutes and the child was not crying.

Any specific behaviors covered by the categories of activities listed on the form were recorded when observed. When a care-giving activity occurred, an entire line of the recording form was filled in, including time the activity began and ended, and codes for the particular activity began and ended, and codes for the particular activity, types of persons and interactions taking place as the care-giving occurred, and place of the target child and its mother A comment was made on the same line if the activity was unusual, the situation had not been encountered before, or if the activity lasted less than one minute. Comments also were m de when a form had to be terminated before the 2-hour period of observation was completed.

A complete observation was two consecutive hours observed and recorded with no "out of view" or sleeping instances of more than 10 minutes duration per occurrence The care-giving observations were done in real time, with no observe-record cycle. Therefore, lines on the form w re filled one after the other as the relevant activities occurred. The number of lines filled for any given observation period depended, of course, on the number of care-giving activities observed and the length of the observation period. . complete observation period for all target individuals was approximately the same -- two continuous hours.

The completeness of an observation period can be determined by the amount of time between "Time Start" and "Time End" as recorded at the top of the form, and as the first and last entries in the body of the form. There was one exception to the 2-hour requirement for completeness -- when the sleep or "out of view" instance occurred from 1 hr., 50 min. of the period to two hrs. (the last 10 minutes of the two-hour period). Under that circumstance, an observation period of 1 hr., 50 min. was considered complete. The enumerator then commented that for the last 10 minutes the target individual was asleep or out of view. The "Time End" still indicated that two hours had elapsed but the comment indicated that the last ten minutes were "non-observation."

A complete observation was usually two continuous hours of observation, with no interruptions of 10 minutes or more. The reason for having the 10-minute rule for termination of care-giving observations was that long intervals of sleeping or out of view would result in the recording of no or very few care-giving activities, thereby indicating intervals when the target individual was awake and no care-giving was done. Sleeping may have precluded care-giving activities that were different from not performing such activities when the child was awake. Termination resulted in the preparation of a new form and resuming observ tions as soon as the circumstances permitted; this was called a "same-day reattempt" (enumerator remained at the hou ehold to attempt the two-hour observation again). This type of reattempt was considered a revisit.

The Data Collection Form

Form No. 641 was designed for the recording of care-giving activities (see Figure E.1). The data collection form consists of fifty lines for the recording of care-giving activities. The same form was used for both target infants and toddlers. If the number of lines needed for a 2-hour observation period exceeded fifty, a second form was used.

The form header is standard except for two additional boxes, numbers 22 and 23. These boxes were filled with the number of records completed after the observations were ended. The other information at the top of the form included" "Time Start," "Time End;" Page Information, and Supervisor's Approval line. Lines are provided after the activity code boxes for brief comments.

Each "block" on the data collection form consists of 25 lines of observation. Boxes are numbered 24-43 for each line. Comments on the lines provided were brief and made when and if needed. Usual reasons for comments were: an unusual situation or something needing explanation; early termination of observation; a very short (less than a minute) activity; and anytime the observer (the enumerator) became involved in a behavior.

There are three major sections to each "block": activity columns (34-35) for recording the care-giving activities involving the target individual; interaction columns (36-41) to record who is interacting with the individual; and location for which column 42 marked "C" is for child and column 43 marked "M" is for mother of the target child. All codes used for recording data in these columns are given on the form. The three sets of codes were kept as few as possible so that enumerators could learn them readily and thus, use them with ease in the field. Longer, more detailed lists of codes were piloted several times prior to the main study, these presented problems however, and it was difficult for the enumerator to select the proper code quickly and accurately while still maintaining observational attention on the target individual. All codes were discussed with the field staff, and definitions and examples worked out with their help and knowledge.

Certain cases were identified for which special coding instructions were necessary. One case involved how to determine and code the location of the target child's mother, especially when the enumerator could not personally see the mother. Another case involved the use of Activity Codes 60-62 which designated "other care-giving activities". Enumerators wrote brief comments to specify the activity observed. The use of the Missing Data Code required filling in zeros which were not the usual indicators for such data. Given the various numbers for the codes, it was necessary to use a number consistent across the form; there was no need for a "not applicable" code. However, it was also necessary to use zeros to fill-in the "Time Start" and "Time End" lines for the boxes not occupied by the time entry. The use of a time start-time and end line was a change in procedure after several months of main study observations. There were at least four special activity recording situations which had to be consistently handled. These were: 1) activity continuing beyond the observation period; 2) activity remains the same, but the type of interaction changes; 3) activity remains the same, but locations of child, mother or both change; 4) activities occur simultaneously.

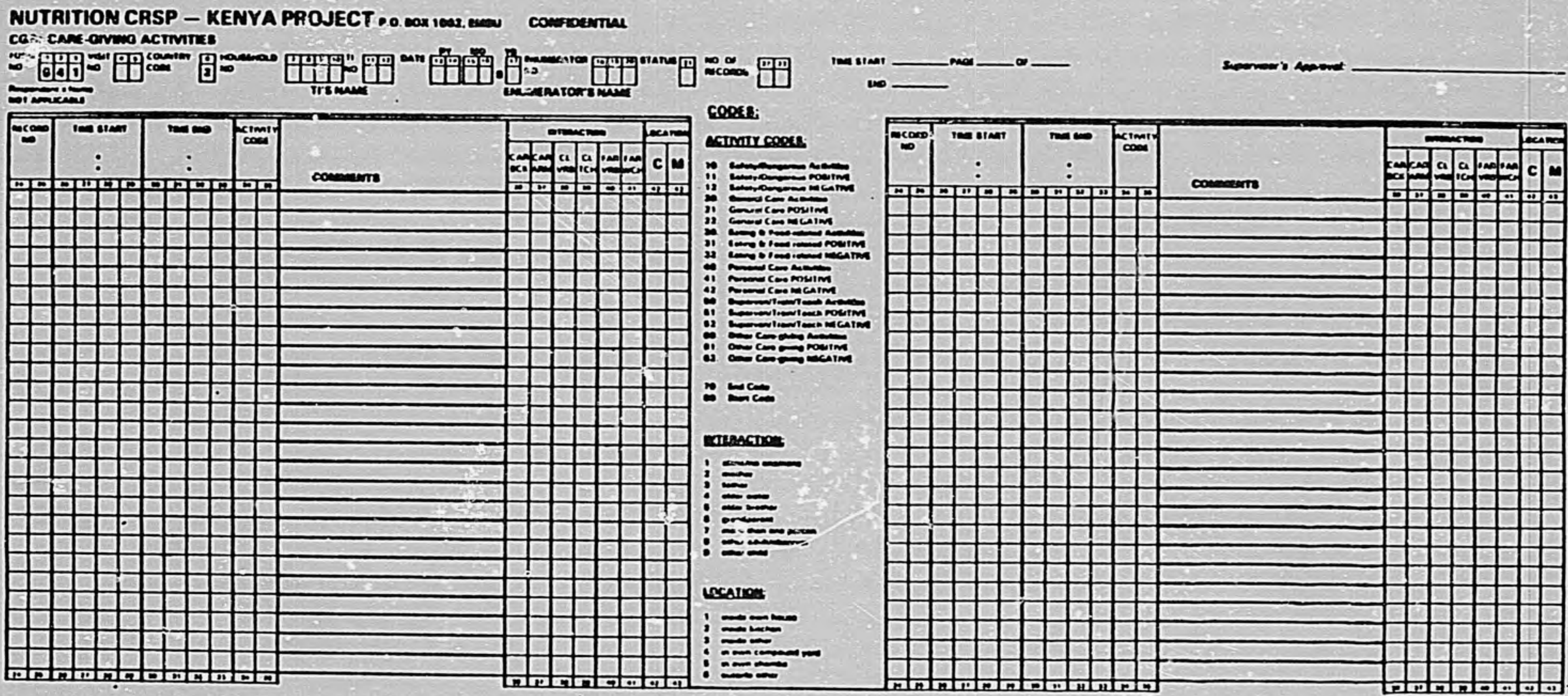
QUALITY CONTROL MEASURES

Field quality control involved both supervisors and enumerators. Supervisors performed the following measures: spot checks of enumerators' observations; observation of enumerators in the field by supervisors to check overall procedures; regular discussion and review of forms with staff; and periodic discussions with study households to assure satisfactory relationships were maintained. In addition, equipment checks were performed to ensure that work was carried out with properly functioning and complete equipment and supplies. Both supervisors and enumerators checked the forms daily to ensure completeness and to make sure the appropriate codes had been used.

Revisits

A revisit was required when the completed observation time was less than 2 hours. (Under some circumstances, the minimum was 1 hr and 50 minutes as explained previously.) On a reattempt, the new observation period was started the same day when circumstances allowed. On a revisit, a new form was used (as was the case with a reattempt) and a 2-hour observation was attempted. Supervisors scheduled revisits after consulting with enumerators. Revisits were scheduled so that observations were not likely to be interfered with by other project work, and so that they had a good chance of success.

Revisits were carried out when complete observations had not been accomplished. If the first try resulted in an incomplete observation and the same-day reattempts did not result in a complete observation, a first revisit was scheduled at the next convenient and possible day. If this first revisit and its same-day reattempts did not result in a complete observation, then a second revisit was scheduled. If this was also unsuccessful (including same-day reattempts), then no further revisit was scheduled for that particular target child for that particular type of observation (care-giving). Note that this series of revisits was based on the condition that the target individual was available and observations were attempted on each visit to the household. If an enumerator found no target individual or for some reason the observations weren't started, then that visit or revisit did not count toward the three days of attempts (original visit, plus maximum of two revisits). The information became "missing" when it was not possible to do the observation after a third visit (and same-day reattempts) and after the month had ended.


NUTRITION CRSP — KENYA PROJECT P.O. BOX 1062, EMBU CONFIDENTIAL

CG: CARE-GIVING ACTIVITIES

TI'S NAME

ENUMERATOR'S NAME

TIME START ____ PAGE ____ OF ____

END ____

Supervisor's Approval: ____

RECORD NO | TIME START | TIME END | ACTIVITY CODE | COMMENTS | INTERACTION | LOCATION C M

CODES:

ACTIVITY CODES:

10 Safety/Dangerous Activities
11 Safety/Dangerous POSITIVE
12 Safety/Dangerous NEGATIVE
20 General Care Activities
21 General Care POSITIVE
22 General Care NEGATIVE
30 Eating & Food related Activities
31 Eating & Food related POSITIVE
32 Eating & Food related NEGATIVE
40 Personal Care Activities
41 Personal Care POSITIVE
42 Personal Care NEGATIVE
50 Supervise/Train/Teach Activities
51 Supervise/Train/Teach POSITIVE
52 Supervise/Train/Teach NEGATIVE
60 Other Care-giving Activities
61 Other Care-giving POSITIVE
62 Other Care-giving NEGATIVE

70 End Code
80 Start Code

INTERACTION:

LOCATION:

FIG. E.1. Care-giving activities form 641.

Validation Studies

A validation study for care-giving was carried out in November 1984. Previous validation exercises for infant and toddler interaction and for schooler classroom and playground observations were performed earlier by the same enumerators. These enumerators had multiple responsibilities for validation studies and thus, could not perform them frequently. Also, such studies took special scheduling. Because a number of the regular observations were dependent on ages of target individuals or the school term, their schedule was not very flexible.

The November validation exercise involved all enumerators and two of the four field supervisors. Infants and toddlers, male and female, were selected; toddlers 20-28 months of age and infants 5 months of age. Enumerator pairs observed infants and toddlers 40 minutes each, individuals were re-assigned to constitute different pairs for the two clusters where supervisors participated. The study extended over three days and included both morning and afternoon observations. In cluster one and three, four paired observations were performed, each with two enumerators; in cluster two and four, 12 paired observations were performed, each with two enumerators and one supervisor.

Field supervisors also performed simultaneous observations with each enumerator; usually these observations lasted about ten minutes. A special code in the Header section of the form was used to identify such field exercises. Senior staff supplied acceptable values for each variable on the form to the Data Manager, and the Embu Office performed the range-checks on the data.

DESCRIPTIVE STATISTICS AND SUMMARY OF FINDINGS

Analysis of this data set has been deferred and thus no descriptive statistics will be presented in this report.

Appendix F

RESULTS OF COMPARATIVE STUDY USING MAX-PLANK RESPIROMETER AND BECKMAN MMC

This appendix presents the results from a comparative testing of the Max Plank Respirometer (No. 59) and the Kenya Project's Beckman MMC. The purpose of the test was to determine the comparability of the two instruments in measuring resting metabolic rate. The results of the test are important when comparing the Max Plank-generated REE data from the Mexico Project with Beckman MMC-generated data from the Egypt and Kenya Projects.

PROTOCOL

Thirteen respondents participated in the comparative test, which was undertaken in early December, 1985. All participants were familiar with both instruments, having participated in both the RMR study (Beckman MMC) and the field measurement of activity energy expenditure (Max Plank). The respondents were asked to refrain from food consumption or intense activity during the morning of the testing. A project vehicle transported the participants to the RMR lab at the Karurumo Health Clinic. After collecting information on sex, age, height and weight, respondents rested lying down for at least 30 minutes before testing.

Each individual was tested following the same identical protocol. The respondents were first tested for 20 minutes on the Beckman MMC, followed immediately by a similar time period on the Max Plank Respirometer. The Project's RMR technician operated the Beckman, following identical procedures used in the larger RMR study. The respondent remained supine during the entire test period.

INSTRUMENT MEASUREMENT CHARACTERISTICS

The Kenya Project used the Nutritional Assessment Program when operating the Beckman MMC. This program produces the following minute values: minute ventilation (L/Min; BTPS), breathing frequency (Breaths/min), tidal volume (mL/breath; BTPS), oxygen uptake (mL/min; STPD), oxygen consumption (mL/min/kg; STPD), carbon dioxide production (mL/min; STPD) and respiratory quotient (VCO_2/VO_2). At the beginning of each test period the ambient FIO_2 and barometric pressure were also recorded. The program allows for calculations of REE to be based on either a steady state period of three minutes or on the last three minutes of each data-collecting period.

As has been documented in numerous reports, the MMC operating protocol employed by the Kenya Project was inappropriate for humid environments. Moisture in the FIO_2 sample has resulted in an underestimation of VO_2, which in turn reduces REE and increases RQ. In response to this problem, the Nutritional Assessment Program's algorithms were rewritten to include a default value of .2093 for FIO_2. The following MMC resting energy expenditure values were produced using the modified algorithms.

The Max Plank respirometer produces minute by minute measurements of ventilation (STPD) and samples expired gases for analysis of percentage oxygen. The percentage of O_2 in the sampled expired air is subtracted from .2093 to determine respondent O_2 consumption. The measurement of O_2 consumption is made using a Teledyne Oxygen Monitor (Model 331-B), which has a range of 0-25% with a sensitivity of 0.125%. Once the expired air volume and oxygen consumption are known, the caloric expenditure for an individual is determined using the Weir formula (1):

$$\text{kcal} = \frac{4.92 \text{ Vol (STPD) X (.2093 - \%}O_2)}{100}$$

It should be noted that the Weir formula uses as assumed RQ of .85. In addition, previous field experience with the Max Plank indicated that the overall standard error of the Weir method, Max Plank Respirometer and Teledyne Oxygen meter is ± 0.3 kcal/min.

ANALYSIS OF DATA

The data are presented in two tables and one figure. Table F.1 presents a comparison of the mean minute RMR values produced by the two instruments. In Table F.2 the minute RMR values are converted into 24 hour estimates (X1440). Finally, in Figure F.1 the 24 hour estimates are plotted to produce a regression line.

TABLE F.1
Mean minute RMR for 13 respondents in MMC/Max Plank comparison test.*

I.D. (HH/TT)	Max Plank (kcal)	Beckman MMC (kcal)
4007/01	.91	.81
4007/02	.99	.96
4009/02	.86	.58
4009/01	.83	.71
4018/01	.94	.80
4018/02	1.07	.94
4020/01	1.29	1.07
4020/02	.97	.84
4030/01	.93	.84
4026/02	1.04	.97
4026/01	1.04	.85
4051/01	.84	.70
4056/01	.99	.74

* n = 13; r = .843; Beckman MMC = -.065 + .918 Max Plank

TABLF [illegible]

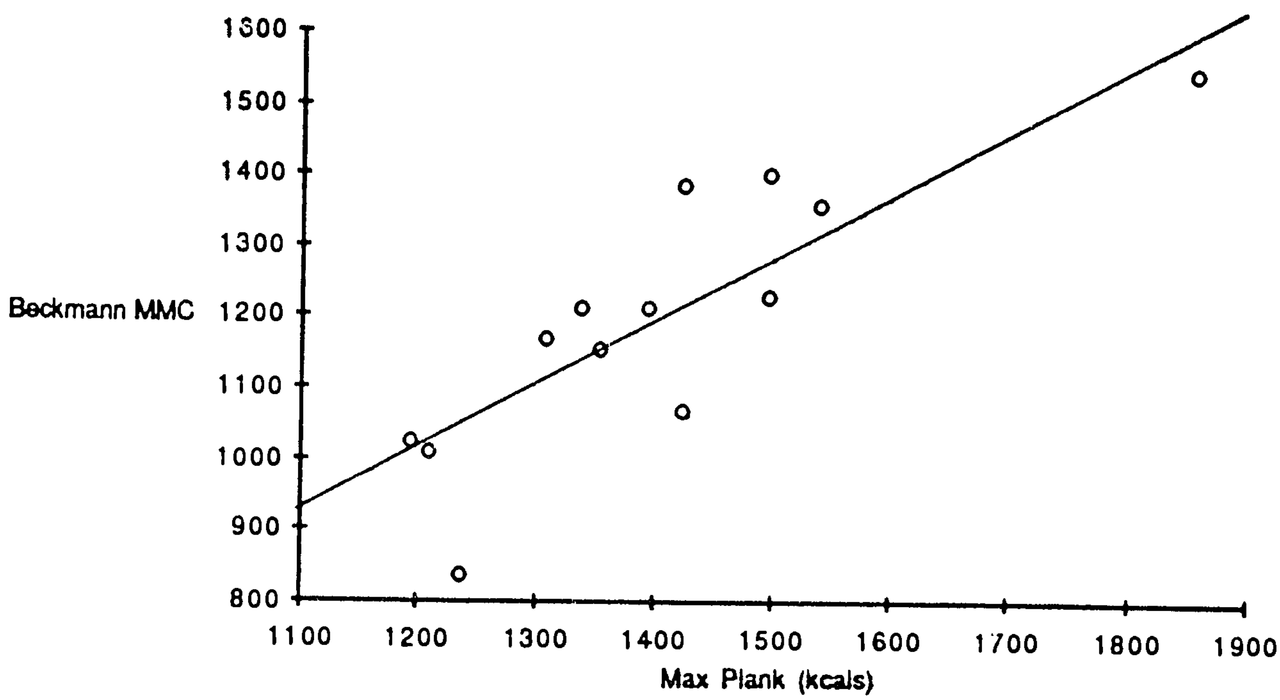
Mean [illegible] .r. RMR for 13 respondents in MMC/Max Plank comparison test.*

I.D. (HH/TI)	Max Plank	Beckman MMC
4007/01	1310 kcal	1166 kcal
4007/02	1426	1382
4009/02	1238	1835
4009/01	1195	1022
4018/01	1354	1152
4018/02	1541	1354
4020/01	1858	1541
4020/02	1397	1210
4030/01	1339	1210
4026/02	1498	1397
4026/01	1498	1224
4051/01	1210	1008
4956/01	1426	1066

* n = 13; r = .843; Beckman MMC = 94.1 + 0.918 Max Plank

REFERENCE

1. Durnin J.V.G., R. Passmore. Energy, Work and Leisure. London: Heinemann.1967.



n = 13
r = .843

a = -94.1
b = .918

FIG. F.1. Distribution and regression line for Beckmann MMC and Max Plank RMR values.

Appendix G

THE ADULT LITERACY TEST

Reading Passages (English Version):

A (Standard One)

This is Juma. Juma is a young boy. He is tall and good. This is Maria. Maria is a young girl. She is small and good.

B (Standard Two)

The work of the father is to dig in the garden, and the work of the mother is in the house. Juma has one brother and three sisters. The parents have three children.

C (Standard Three)

Bibi Asha is a good lady. She has four children. The oldest child is Juma, the youngest child is Hadija. The middle child is Maria. Maria and Hadija are fat. Juma is thin and tall.

D (Standard Four)

Paul and Susan have a lizard. He lives in Paul's classroom at school. His name is Lucky. Lucky runs up and down the walls in the classroom. He catches ants and flies.

E (Standard Five)

He climbed up into the engine and brought out a piece of bamboo bent into a circle with a long handle. It was the same shape as a spoon but much bigger. There was a little leather bag fixed to the bamboo and inside was a kind of big key.

F (Standard Six)

David could hardly wait for the new term to begin. He was longing to see all his friends because he had an exciting story to tell them. His name was going to be in the newspapers. He was going to be famous. People all over the country would read about what he had done.

G (Standard Seven)

That year Ochola had the biggest harvest he had ever known. Some of the maize cobs were so huge that a child could not eat a whole one by himself. The millet was fat and the beans were many. Ochola built three stores for maize and two for the millet and beans. The seeds were stored in drums in the house. Nyapol was pleased. She had been married for less than two years yet she had more food stored than her mother had during her twenty years of marriage.

H (Form One)

Once upon a time there were seven daughters of a chief. They were so proud that they thought nobody was good enough to marry them. So they said they would marry only the person who could find out what their names were. Nobody in the chief's compound ever called the sisters by their names. They called them "princess" or made up special names for them. The sisters never called each other by name when other people were with them, so it would be very difficult to find out their names. Because the sisters were very beautiful, many men tried but none of them succeeded.

I (Form Two)

One of Ibi's hens which had escaped death many times was Jemina. She was eleven years old and she owed her long life to the fact that she was an excellent mother and was chosen by Ibi to hatch out the best eggs. She was a little white hen with a very bad temper and when she was in a rage her face turned bright red. This made her look so much like a white man losing his temper that she was a great joke to the girls. They sometimes teased her on purpose to make her angry, so as to show off her red face to visitors.

J (Form Three)

Not having much development in our village, we all agreed when the Government agent told us that we should do something about it. I remember the occasion very well. It was towards the end of March when the cocoa was all in, packed and sent to the coast and Kwesi Manu started his house again. Every year, he would buy cement, engage a couple of labourers, lay out the blocks and then run out of money. The walls had been built two years ago. Last year he had managed to get the roof on, only to have it flung off again by a great storm which did so much damage. The corrugated iron sheets were flung like a handful of stones across the street knocking down Ama Serwah's stall.

K (Form Four)

When the grownups of the neighbourhood went far away into the fields to work, the children generally assembled in some neighbour's compound to play. Some of us used to get up into a tree to look out for any assailant or kidnapper who might come upon us, for they sometimes took these opportunities of our parent's absence to attack and carry off as many as they could seize. One day as I was watching from the top of a tree, in our compound, I saw one of these men go into the next compound where there were many stout people. Immediately I gave the alarm. He was surrounded by the stoutest of them, who entangled him with cords so that he could not escape until the grownups came.

Comprehension Questions for Reading Passages (English Version):

A.
1) Is Juma a short boy or a tall boy?
2) Is Maria a big girl or a small girl?
3) Are they both bad children?

B.
1) Where does the father work?
2) Where does the mother work?
3) How many sisters does Juma have?

C.
1) How many children has Bibi Asha?
2) Who is the oldest child?
3) Which child is in the middle?

D. 1) What is the lizard's name?
2) Where does he live?
3) What does he eat?

E. 1) From where did the boy get the bamboo?
2) What was fixed to the bamboo?
3) What was in the leather bag?

F. 1) Why was David going to be famous?
2) Why was David longing to see his friends?
3) How would the people come to read about David?

G. 1) Why could a child not finish a whole maize cob?
2) Where were the seeds stored?
3) Why was Nyapol pleased?

H. 1) Why did the daughters think that nobody was fit to marry them?
2) Why did men try to marry them?
3) Why would the sisters never call each other by their name?

I. 1) Why did Ibi value Jemima?
2) How would you know Jemima was angry?
3) Why would the children tease her?

J. 1) Why was Kwesi Manu taking so long to build his house?
2) How do you know the storm was strong?
3) When were the walls of the house completed?

K. 1) Why did some children have to keep a look out?
2) What did these kidnappers want?
3) What happened to the unlucky kidnapper?

<u>Dictation Passages for the Writing Test (English Version)</u>:

<u>a. (Standard One)</u>

This is a long knife. It is a good knife. It is on the table.

<u>b. (Standard Two)</u>

This is the father and the mother. These are the parents of Juma. Juma's father has a book in his hand.

<u>c. (Standard Three)</u>

The children have many things. They have pencils, papers, chairs and desks. These are their things. But a match box is not theirs. Mother has the match box.

d (Standard Four)

In the school holidays, Paul went to Nairobi to stay with his uncle. One day his uncle bought him a beautiful shiny knife with two blades.

e (Standard Five)

Musa was sitting in the classroom but he was not listening to the teacher. It was the last lesson of the day. It was hot. Musa felt sleepy. He was thinking about what he was going to do after school.

f (Standard Six)

Kamau was very angry. He had just had an argument with his neighbour and he was not sure what to do next. He had a very fine tree growing at the edge of his land. It gave a lot of shade. The tree had been there as long as he could remember.

g (Standard Seven)

The party was to be the following Saturday, when most people were at home. It was the biggest party Ochola had ever given, the largest since his marriage day. More than eighty people were invited.

h (Form One)

So the hunter and the girl gathered up the best jewels on the mountain. But the magic of the witch began to make the hunter feel very tired and so he sat down and immediately fell asleep.

i (Form Two)

Sophia was quick. She raced along the beach before she quite knew what she was going to do. But she remembered that the old ship's bell which hung from a crossbar on the beach was there to be rung when there was danger at sea. She ran up to it, caught hold of the thick rope and pulled with all her might.

j (Form Three)

The Ozo men were now to choose a new chief and at first it seemed they were in for an easy task. It would not be like the last election when so many bad words had passed between Ikolo and Sam, and so much bad medicine had been thrown about for the purpose of influencing the minds of opponents.

k (Form Four)

From some things that I have said one may get the idea that some of the slaves did not want freedom. That is not true. I have never seen one who did not want to be free or one who would return to slavery. I pity from the bottom of my heart any nation or people that is so unfortunate as to get entangled in the net of slavery.

Appendix H

EXCERPTS FROM "HOME ENVIRONMENT AND THE DEVELOPMENT OF EMBU TODDLERS"

(Manuscript submitted by Sigman, M. et al for publication)

Description of the Rearing Conditions

In order to understand the children's development, patterns of care and changes over time have to be described. The rearing variables selected for description consist of the following: physical care, holding, touching, talking to, and social interaction (see Table H.1).

The rearing variables were analyzed with 2 (Sex) x 8 (Caregiver) ANOVAs in order to determine whether males and females were treated differently and whether there were significant differences in the percentage of caregiving among individuals. The only significant effect of sex was that males were slightly more involved in sustained social interaction (x = .8%) than the females (x = .6%). There were no significant interaction effects.

TABLE H.1
Definitions of home rearing variables.

Variable	Definition
Physical care	Any care-giving behavior such as feeding, washing, changing clothes, toileting, or putting to sleep.
Hold/carry	Holding in arms or on lap, picking up, or carrying so that the child's feet are off the ground or the child is not supporting her or his own weight.
Touch	Coded when anyone touches any part of the child. An example is two children holding each other's arms.
Social Interaction	Child is actively involved in an ongoing social interchange with someone else or a group. Does not include the child watching others or toddler sitting with a group but not talking or playing.
Talks to toddler	Individual talks directly to the child while looking at the child or holding the child and interacting. Does not include yelling at the toddler from afar.
Response to Vocalization/ Distress	Vocal physical response to toddler vocalization or cries within 5 seconds. Responder must be close enough sotoddler can hear and not involved in conversation with others. Physical response includes patting or rocking the child or handing something to the child.

The main effect of the Caregiver Factor was significant for all five rearing variables. The means in Table H.2 represent the time spent caring for toddlers by the various care-givers expressed as a percentage of the total observation period of toddlers. The means for father, grandparent, and other adult combined since the individual means were so small. As can be seen, the mother and older sister were the predominant care-givers, carrying the toddlers, providing physical care, and talking to them more than any other individuals in the shamba. The only exception to this pattern was in sustained social interaction, which almost always occurred between the toddler and other children. The toddlers were talked to for fully 35 - 40% of the time, with about half of this conversation coming from the mother and older sister.

In order to evaluate changes in rearing patterns over age, regressions were calculated for the durations of the rearing variables over the 15 month period of observation. The only significant changes with age were declines in the percentages of physical care, $r(494) = -.38$, $p < .001$, and carrying, $r(494) = -.43$, $p < .001$. Mothers provided physical care 10% of the time for the youngest age group, 6% of the time for the 18-24 month-olds, and 4% of the time for the 24-30 month-olds. The decline in carrying and holding the toddlers was even sharper. Mothers and older sisters carried the 15-18 month-olds for 23% of the time, the next age group for 12% of the time, and the oldest group for 6% of the time with the mothers carrying the toddlers about twice as much as the older sisters at every age. There were no significant changes with age in the extent to which children were touched, talked to, or involved in social interactions.

Toddler Behavior and Care-giver Responsiveness

Toddlers played with objects for about 35% of the observation time and the total amount of time engaged in play remained relatively constant over the year. Like other individuals in the shamba, the toddlers talked a fair amount -- for about 22% of the time -- and this increased significantly with age, $r(757) = .17$, $p < .001$. They cried only 7% of the time and this decreased with age, $r(797) = -.27$, $p < .001$. They smiled 17% of the time and this increased as they matured, $r(797) = .22$, $p < .001$. There were no sex differences in these behaviors and males and females changed with age in the same way. Responsiveness to the vocalizations and cries of toddlers were analyzed with 2 (Sex) x 3 (Type of Response) ANOVAs and there were significant effects in type of response but no sex differences. The majority of caregiver responses to toddler vocalizations and cries were vocal responses rather than physical or combined vocal-physical responses. Responsiveness to toddler vocalization increased slightly and responsiveness to toddler crying decreased slightly as the toddlers matured.

TABLE H.2
Distribution of time spent caring for toddlers by various care-givers expressed as a percentage of total observation period of toddlers.

Care-givers	Physical Care	Hold or Carry	Touch	Social Interaction	Talk
Mother	5.2	7.3	3.0	<1	10.8
Other Adults	1.1	1.1	1.2	<1	5.7
Older Sister	1.8	3.4	3.5	1.6	9.7
Older Brother	<1	<1	2.0	1.3	5.5
Other Child	<1	<1	<1	1.9	2.7
More than one Individual	<1	<1	1.0	<1	2.6

Cognitive Performance

Two Factor (Age x Sex) Repeated Measures ANOVAs were calculated on the Bayley Verbal Score and Bayley Performance Score. As would be expected, there were significant age effects on both measures. There were no significant sex differences nor significant interactions of age x sex. The mean scores for the 21 verbal items from the Bayley administered at 18, 24, and 30 months of age were 5.2, 11.4, and 17.2 respectively. For the 22 performance items administered at 24 and 30 months of age, the mean scores were 10.8 and 15.1. As there were no significant sex differences in performance on any of the cognitive measures, all subsequent analyses were carried out with the data from male and female subjects combined.

Consistency in Rearing Conditions

Since individual children were exposed to different rearing conditions, the question has arisen whether there was consistency in their experiences from one time period to another. In order to address this issue, the observational data for each child was grouped into five different age periods and correlations were then computed between the variables from one period to the next. There was significant consistency in the extent to which the children were talked to and held and in the frequency of responses to their vocalizations (see Table H.3). The durations of social interactions was stable over the first six months of observations but varied subsequently. Responsiveness to crying remained stable only up through the third observation period; there were no significant correlations from one period to the next after 25.5 months. The extent to which the children were cared for physically and were touched showed great variability from one period to the next and there were no significant correlations in these measures between periods, so these variables have been omitted from Table H.3. To summarize, the individual differences that children experienced in the extent to which they were held and talked to remained relatively constant over the 15 month observation period, while physical care and touching were variable.

TABLE H.3
Correlations between age periods.*

	Age Period 1-2	Age Period 2-3	Age Period 3-4	Age Period 4-5	Age Period 1-5
Home Variables					
Holds/Carries	.49	.22	---	.18	.31
Social Interaction	.31	.38	---	---	---
Talks to	---	.18	.33	.32	---
Responsiveness to Vocalization	.25	.26	.26	---	.27
Responsiveness to Distress	---	.21	.22	---	---
Child Behaviors					
Child Talks	---	.28	.42	.39	.38
Child Smiles	---	.26	---	.24	---

* All correlations shown, $p < .05$; Two home rearing variables (physical care and touches) and two child behaviors (plays and cries) were omitted from the table because there were no significant correlations from one period to the next.

Consistency in Toddler Development

Test Performance

Correlations were calculated between scores on the measures administered at 18, 24, and 30 months. The Bayley Mental Scale showed consistency in individual differences. The correlations between total scores at succeeding periods were both r = .55 with a sample of 96 toddlers. The correlation between the total score on the verbal items administered at 18 months and the total score on all items administered at 30 months was r (100) = .42.

Toddler Behavior in the Home

Correlations were computed between the total duration of toddler behaviors from one of the five age periods to the next and from the first to the last. There was no consistency in the total amount of play with objects but there was strong consistency in the frequency of toddler vocalizations. Individual differences were stable across the entire age range (see Table H.3). In the affective domain, there was some limited stability in the amount that toddlers smiled but no consistency in the frequency of distress.

Relations between Rearing Factors and Development

Bayley Scores - 24 months

Correlations were calculated between the mean percentages over all home observations carried out when children were between 15 and 24 months of the 7 rearing scores (physical care, holds or carries, touches, talks to, social interaction, responsiveness to vocalizations, and responsiveness to crying) with total score on the Bayley items at 24 months. Because there was some variation in the ages of the children at the time of the home observations, the mean age was partialed out of these correlations. There were significant positive associations beween Bayley Total Score and two rearing variables, Talks (see Table H.4) and a nearly significant association with another rear ing variable, Responsiveness to Toddler Vocalizations, r (99) = .19 $p < .05$.

Bayley Scores - 30 months

Correlations were calculated between the mean percentages over all home observations of the 7 rearing scores with the total score on the Bayley items at 30 months. The mean age of observation was partialed out of the correlations. There were significant positive associations between Bayley Total Score and three rearing variables: Talks, Social Interaction, and Responsiveness to Toddler Vocalizations (see Table H.4). There was one negative association; toddlers who were held more had lower scores on the Bayley items at 30 months.

Bayley Motor Scale

There were fewer associations between the rearing variables and performance on the Bayley Motor Scale items at 30 months of age (see Table H.4). The only home variable to be associated with the overall score on the motor items was the duration that the child was held and this association was negative as was the correlation for the Bayley Mental score.

Toddler Affect

In order to assess the child's predominant emotional state, the total percentage of time in the last two observations that the child cried or smiled was calculated. Correlations were computed between the percentage of time that the child smiled or cried and the rearing variables considered over the 15 month period (see Table H.4). Children who smiled a great deal at 30 months were responded to more and involved in far more social interaction than children who smiled less. Children who cried at this age had been had been involved in fewer sustained social involvements.

TABLE H.4
Correlations between home variables and child characteristics.*

Home Variable	24 Month Bayley Mental Score	30 Month Bayley Mental Score	30 Month Bayley Motor Score	Freq. of Cries	Freq. of Smiles
Physical Care					
Hold/Carries		-.24	-.24		
Touches					
Talks to	.26	.19			
Social Interaction		.29		-.19	.34
Responsiveness to Vocalization	.19	.23			.24
Responsiveness to Distress					

* All correlations shown, $p < .05$.

The Effects of Rearing Conditions Independent of Toddler Characteristics

The evidence reviewed so far indicates that the social rearing conditions experienced by these Kenyan toddlers influenced their cognitive and emotional development. However, it can be argued that the child elicits physical and social care from the parent so that associations between rearing conditions and child development really reflect continuities in the child. In order to address this issue, two regression analyses were carried out in which a measure of the child's earlier verbal ability was entered before the rearing variables as predictors of the total score on the Bayley scale at 30 months (see Table H.5).

The first verbal measure was total score on the 18-month Bayley verbal scale and the second verbal measure was the percentage of time that the child talked during the first six months of home observations. In both cases, the rearing variables contributed significantly to the earlier verbal measure in accounting for total Bayley score at 30 months, $F(7,93) = 2.01$, $p < .06$; $F(7, 90) = 4.18$, $p < .01$.

TABLE H.5
Regressions between home variables and Bayley Mental Score at 30 months with earlier verbal score entered first.

Variables Entered N=99	r	R^2	Coefficient	F to Enter
Bayley Verbal Score	.43	.18	.17	21.9
Social Interaction	.49	.24	.33	8.4
Hold	.51	.26	-.10	1.8
Responsiveness to Vocalization	.53	.28	.09	2.4
Total	.54	.29		
Variables Entered N=102				
Toddler Verbalizes	.21	.04	.10	4.39
Social Interaction	.38	.15	.39	11.63
Hold	.44	.19	-.18	5.32
Touch	.48	.23	-.35	4.98
Responsiveness to Vocalization	.52	.27	.13	4.41
Total	.53	.28		

Parental Literacy and Child Abilities

As reading and writing literacy were highly intercorrelated (r's = .82 and .84), only the scores for maternal and paternal reading skills will be used in this paper. The reading abilities of the two parents were correlated, r (110) = .35, p <.001. The correlations of the parents' reading scores and total items passed on the Bayley Mental and Motor Scales by the 30 month toddlers were calculated. Fathers' reading scores were significantly associated with the toddler scores at 30 months, r's (105) = .24 p = .007. The only home rearing variables associated with paternal reading scores were those measuring physical contact so that toddlers of less literate fathers were held and touched somewhat more.

A regression was calculated between total score on the Bayley mental at 30 months with the 7 home rearing variables with paternal reading score entered first and the results are shown in Table H.6.

The home rearing conditions account for some of the variance in the child's competence at 30 months beyond the contribution made by paternal literacy, F (7, 96) = 2.55, p < .02. This regression suggests that both proximal and distal variables affect the child's development.

Discussion

There has been increasing recognition of the need for observations of child rearing conditions to make sense of the differences in the ways that children from varying cultural groups develop. In this light, Whiting (1) has enjoined the researcher that "it would be very valuable if there were more field studies with accurate time samples of the amount and type of contact between infants and caretakers. . . . Those who plan to study infants in other cultures, please take note." Cross-cultural studies are important not only for identifying variations in child development as a function of different rearing patterns but also for identifying similarities in relations between rearing factors and child development across cultural settings.

TABLE H.6
Regressions between home variables and Bayley Mental Score at 30 months with paternal literacy.

Variables Entered (N=105)	r	R^2	Coefficient	F to Enter
Paternal Literacy Score	.24	.06	.19	6.37
Social Interaction	.34	.11	.29	6.44
Hold	.37	.14	-.12	2.97
Responsiveness to Vocalization	.43	.18	.09	5.03
Total	.45	.21		

The home environment was associated with the child's development in much the same way in this part of rural Kenya as has been described in the United States. For this age group of children, the most consistently important variables reflected the verbal and social milieu in which the child was raised. The amount that the child was talked to and responsiveness to the child's vocalizations were correlates of subsequent abilities. These associations might have been less evident in a cultural group that was less verbal and interactive. Both the adults and the toddlers talked to each other frequently in the home setting. The meaning of verbal interactions and the aims of child rearing in this cultural group have yet to be explored.

Physical care and contact and responsiveness to distress were less critical for these 15- to 30-month-olds. The amount that the child was held or carried was negatively correlated with development. This finding replicates an obser-vation made with ten 7-16-month-old Logoli children by Munroe & Munroe (2), and with 12-month-old Zambian children by Goldberg (3) who suggested two hypotheses to explain the negative association. First, carrying a child after the first year of life may restrict exploration of the environment so that the child's development is deleteriously affected by this practice. Alternatively, children may be carried in the second year of life who are already developing more slowly. Data on physical maturity, illness, and food intake that will become available on this sample should allow us to determine whether children who were carried more were seriously ill or malnourished.

Interaction with peers and siblings appeared helpful for the child's cognitive achievements. Most of the sustained social interactions were with other children and the frequency of these interactions was correlated with many of the cognitive measures, particularly at 30 months of age. Leiderman and Leiderman have pointed out the importance of polymatric rearing for the development of infants in another tribe in East Africa (4). There appears to be less shared rearing with other adults in this population that is composed mostly of nuclear families although older sisters are frequently involved. However, the toddlers' contacts with older brothers, sisters, and neighbors were positively related to their subsequent development.

The home rearing variables accounted for only a small part of the variance in toddler development, as is true in Western studies, and these were independent of the child's earlier characteristics. Thus, appropriate verbal stimulation may be helpful in the second to third year of life even for slowly developing toddlers. On the other hand, the significance of high scores on the Bayley scale for future development in this culture is unknown. The Bayley Mental Scale at 30 months does tend to predict later abilities in other parts of the world. A follow-up study of this group at five years of age is currently being conducted which should allow the assessment of the predictive validity of the measures employed in this study.

The independence of the rearing variables from other home conditions is difficult to determine. Scarr & Weinberg have argued persuasively that environmental causation cannot be established in children reared by their natural parents as genetic factors are confounded (5). Genetic causation can also not be proved because none of our measures of ability tap genetic factors alone (6). Furthermore, rearing conditions may not be important in their own right but may really reflect the availability of other environmental determinants of development. We have tried to address this issue by examining the independence of the rearing effects from parental literacy. The ability of fathers to read is tied to the economic conditions of the household as well as to the intelligence and education of the parents. The fact that both paternal literacy and rearing conditions impact the children's development suggests that development may be advanced among toddlers in this culture, who are talked to, responded to, and involved in social interactions, whatever the economic and educational level of their families.

REFERENCES

1. Whiting J.M.W. Environmental constraints on infant care practices. In R.H. Munroe, R.W. Munroe, & B.B. Whiting, eds. Handbook of cross-cultural human development. New York: Garland Press. 1980:155-179.

2. Munroe R.H., Munroe R.L. Infant experiences and childhood cognition: A longitudinal study among the Logoli of Kenya. Ethos. 1984;12:291-306.

3. Goldberg S. Infant development and mother-infant interaction in urban Zambia. In P. Leiderman, S. Tulkin, & A. Rosenfield, eds, Culture and Infancy. New York: Academic Press. 1977:211-244.

4. Leiderman P., Leiderman G. Affective and cognitive consequences of polymatric infant care in the east African highlands. In A. Pick, ed., Minnesota Symposium in Child Psychology, Minneapolis: University of Minnesota Press, 1974; 8:81-110.

5. Scarr S., Weinberg R.A. The Minnesota adoption studies: Genetic differences and malleability. Child Development. 1983; 54:260-267.

6. Gould S.J. The mismeasure of man. New York: W.W. Norton. 1981.

SUMMARY: NUTRITION CRSP KENYA PROJECT

Although the most prevalent human form of malnutrition globally is mild to moderate or marginal malnutrition, little is known about the consequences of this situation. The Nutrition Collaborative Research Support Program (CRSP) sought to study the functional consequences of chronically decreased energy intake in three geographically, ecologically, and culturally diverse areas to see whether or not a relationship exists between energy intake and human function. The Nutrition CRSP attempted to address three important hypotheses: the effect of maternal food intake during pregnancy and lactation on mother and infant, the effect of toddler food intake on cognitive performance, and the effect of toddler food intake on growth and morbidity.

The Kenya project took place in Kyeni South location in Embu District (Eastern province) which is located in central Kenya on the southeastern slopes of Mt. Kenya. The 60 sq. km. study area ranges from a densely populated, coffee growing area at 4000 to 5000 ft. to a more sparsely populated, drier, less fertile area at 3000 to 4000 ft. where cotton is grown. The Kenya project sample is slightly biased as to age distribution, household size, and educational level when compared to the general area. A higher percentage of women are in the 20 to 40 year old group a lower percentage of lead males and females had no schooling, and mean household size was larger than in the general area.

The independent variable studied by the Nutrition CRSP Kenya Project was food (energy) intake. Five functional areas were studied and comprised the core hypotheses of the study. The functional areas are physical growth, disease (including morbidity, immune function, parasitology, and hematologic status); reproductive outcome and lactation; cognition and psychology; and resting metabolic rate. Socioeconomic status, sanitation, weather, agriculture, and child care were investigated as "core" topics for their potential importance as explanatory variables.

In addition, the Kenya project investigated several other highly relevant research topics important to the understanding of the core hypotheses. These topics included household income and expenditure; SES ranking of households by local chiefs; time allocation; energy expenditure of common activities; agricultural production; adult literacy; anxiety and depression; alcohol consumption among adults; and the impact of the severe drought of 1984.

Food Intake:

The objective of Food Intake data collection was to measure the consumption of energy by study households and target individuals. The Kenya project developed a quantitative method to collect data on food prepared and consumed. The major technique utilized was the direct weighing and volume measurement of ingredients and foods, with recall of consumed foods and dishes used when direct weighing and measurement were not possible (from 6 pm to 7 am). "Child following" was utilized for the toddlers whenever possible to observe and record self-fed snacks.

A nutrient data base for Kenyan food items (Embu District) was developed in order to calculate the energy value and content of protein, fat, carbohydrates, iron and other selected nutrients of foods.

The diet is based mainly on maize, beans, a variety of green leafy vegetables, and a variety of vegetables (tomatoes, potatoes, pumpkin) and fruits (papaya, banana, mango, avocado). Most food is obtained from the family farm, but sugar, vegetable, or animal cooking fat is purchased. Very little animal protein or fat is consumed in the diet; milk (cow) is the main source of animal protein (taken in tea). In fact, animal protein and fat intake are markers of SES correlating positively with SES.

The Embu diet appears to meet about 75% to 78% of the estimated FAO/WHO/UNU recommended requirement for energy for the target individuals. Iron availability in the diet is low and iron deficiency is a widespread problem in the study population. Marginal iodine deficiency is expressed by a goiter prevalence of 15 to 20% and protein requirements are generally satisfied.

Anthropometry:

The Kenya project conducted anthropometric measurements to assess the effects of food intake on body size, composition, and growth, and as an intermediate variable between food intake and function. Anthropometry provides an understanding of the impact of pregnancy, lactation, disease, socioeconomic status, and other variables upon nutritional status and growth. The anthropometry data provide a description of the study population's nutritional status over time.

Among the findings are that Embu study children are within the normal range for length and weight at birth. They grow at the 40-50th percentile levels for the first three or four months but then begin to decline to consistently low levels. At the toddler stage, stunting emerges as a widespread phenomenon. By the time Embu children reach school age, they are even more stunted and underweight for age. Adults, particularly men, are generally short, underweight, and thin by comparison to urban upper class and other Kenyans. Women are also short, but fewer are underweight and relatively as low in body fat.

Disease:

The objectives of disease assessment were to measure household and target individual (TI) disease burden and to determine how morbidity and mortality are affected by energy intake. The disease variables investigated by the project serve as functional outcome in themselves, or as confounding or explanatory variables in the analysis of other functions. Almost all other functional outcome variables are affected by disease to some degree.

Respiratory illness (mainly acute upper respiratory infections and the common cold), digestive tract illness (largely diarrheal disease in children and abdominal pain and vomiting in adults), fever (including cases of clinical malaria), and eye and skin infections comprise most of the "infectious" illnesses. For adults, a high proportion of illness episodes were attributed to "Extremities and the Musculo-skeletal System" and headaches. Seasonally, respiratory illness is most prevalent in the colder months (June-August) and diarrheal disease in warmer and rainier seasons (Sept.-Nov.). Malaria is endemic. Only a few cases of measles and no diphtheria, tetanus, or pertussis were seen. Immunization rates for DPT, measles, and BCG among children under three years old is over 90%. The most commonly reported chronic diseases were chronic discharging ears, epilepsy, and visual problems. There were three adult deaths--two due to hepatomas and one due to esophageal cancer. Three peri-natal deaths were associated with low birth weight and prematurity and a schooler died a few months after the end of the fieldwork with hepatic cirrhosis.

Relatively greater percentages of reduction in food intake were seen in the significant and severe disease categories compared to mild disease categories. There was a surprising degree of decrease in food intake with mild disease.

Iron deficiency anemia and low serum ferritin was most widespread in toddlers and lead females, less so in schoolers, and least of all in lead males. Hookworm and ascaris were the most prevalent intestinal parasites found. Immunologic studies findings showed generally elevated immunoglobulins compared to USA standards, presumably due to higher infection prevalence. Depressed cell mediated immunity (% T-cells) was seen in toddlers, with positive correlations between % T cell, anthropometric measures, and energy intake. Negative correlations were seen with occurrences of significant illness. No other immunologic data have thus far been analyzed.

Reproduction and Lactation:

Reproduction and lactation outcome data were examined in relation to energy intake. The majority of women were assisted at delivery by trained mid-wives. Relatively few women were delivered by traditional birth attendants and more relied on relatives or self-deliveries at home. The rate of Caesarian section was 6.1% mainly because of cephalo-pelvic disproportion. Infant gestational age, as determined by Dubowitz examination, was consistently two weeks greater than gestational age calculations from the reported date of LMP.

Nearly all mothers initiated breast-feeding during an infant's first days of life. The dominant practice was to breast-feed only one infant at a time and for about 18 months. About 25% of mothers breast-fed their infants until 20 to 24 months. Embu mothers introduced supplemental milks (cow or goat), and weaning foods (e.g. maize gruels) surprisingly early, starting in the first month of life. Little commercial formula was used. The illness incidence was no higher in supplemented infants vs. non-supplemented infants. When combined with other variables in a multivariate model, supplemented feeding had a slight negative effect on growth.

The Kenya sample of women enter pregnancy with generally low body weight, short stature and less body fat than found in Egyptian, urban Kenyan and U.S. women. Energy intake decreases during pregnancy compared to intake among non-pregnant women. Pregnancy weight gain is 6 kg and some women actually lose weight. Despite all of the above, the mean birth weight of the newborns is 3.1 kg., about 300 to 400 grams less than European and American infants. The fact that women can produce infants of normal or near normal birth weight in the face of low energy intake and low pregnancy weight gain has been confirmed in several studies. Another area of concern evidenced by the data is that by four to five months, infants are beginning to appreciably decrease their rate of linear growth and their rate of weight gain. A possibility is that this is due to displacement of breast milk by supplemental feeding.

A consistent finding is that the nutritional status of women (long term as reflected by height and head circumference; short term as reflected by weight, fat and protein stores) is a major determinant of pregnancy outcome. The data indicate that serious consideration should be given to designing interventions that would monitor the growth of females throughout their lifespan. The slightly stronger relationship between food intake and pregnancy weight gain and birth weight in the presence of goiter suggest the possibility that women who develop goiter might be better compensated (thyroid status wise) than those who do not. This will be further examined with measurement of thyroid hormone levels on a subsample.

As with pregnancy weight gain, maternal food intake plays a definite, but modest role in infant growth. The factors that stand out more than maternal food intake are maternal nutritional status, birth weight and gestational age. All maternal anthropometric measures in pregnancy and lactation show positive correlations with all attained infant weights and lengths at 6 months. Those infants with a high incidence of significant illness show negative relationships between maternal intake and their growth. With maternal illness during lactation, one also sees negative relationships with maternal intake and infant rate of weight gain.

One set of findings with implications for intervention policies and programs involves mothers who lose the most fat and weight during lactation, particularly after three months. Negative associations are seen with rate of infant linear growth, weight gain and attained length and weight at six months. Monitoring of lactating mothers' weight and arm circumference along with their infants' weight monitoring would help both.

Cognition and Psychology:

Structured and unstructured assessments were used to examine the cognitive and behavioral functioning of target individuals at several age levels. The primary objectives of the structured assessments were to investigate 1) the relationship between energy intake and cognitive, motor, and behavioral development and performance among infants, toddlers, and schoolers, and 2) the relationship between adult cognitive functioning as it relates to their childrens' cognitive capabilities. The unstructured assessments were designed to assess child behavior in ways that could not be accomplished by structured assessments, i.e., toddler play or intra-family interaction. Some test items were modified for use on Embu children.

To date, only toddler data has been analyzed to any extent in relation to energy intake. Significant association between food intake of toddlers 18 to 24 months old and their non-verbal skills at 24 months, and between food intake during 24 to 30 months and the Bayley Mental Score at 30 months were found. Fat intake and total Kcal intake are of particular importance. Both low grade illness and significant illness between 18 to 24 months of age had adverse effects on 24-month verbal scores and on the Bayley Mental Scores at 30 months. Significant associations between size (wt, length) were found between cognitive and motor development at all ages. The taller and heavier toddlers, at any age, scored higher for both verbal and performance scores at 24 and 30 months. Socioeconomic status and paternal literacy were positively associated with the toddler's performance. Home rearing conditions, particularly those reflecting verbal and social interactions, were positively associated with 30 month developmental scores. Thus food intake, illness, social interaction, and home rearing all contribute to the developmental competence of the toddler.

Food Intake and Toddler Health:

The toddler group, aged 18 to 30 months, is known for its vulnerability to infection and malnutrition. Total Kcal intake, iron, fat and animal protein (but not total protein) were found to be low, and the toddlers showed varying degrees of stunting in about 25% of the group. Their low weight-for-age can be attributed largely to this stunting rather than to wasting. Infection rates are high and respiratory disease is the most common type of illness. No deaths were seen in this group.

In general, food intake was found to have a limited influence on morbidity in the toddler. The most important factors in toddler morbidity were found to be season, sex, and the toddler's morbidity experience at 18 months; this may imply a continuation of adverse factors that result in high levels of morbidity or the harmful effects of morbidity on the nutritional status of the child. Maternal illness (particularly low grade) was found to be a strong factor in toddler illness and maternal intake seems to be protective against toddler illness. Future analyses of the maternal caregiving data and its relationship to toddler illness should be of great interest.

In general, children who entered the drought and cold months of July-September encountered illnesses (particularly respiratory diseases) more than did other children.

Resting Metabolic Rate (RMR)

The purpose of determining RMR every three to four months. was to estimate the energy available for activity (food intake minus resting metabolic rate) and to determine whether a lowering of the resting metabolic rate (RMR) was adaptive in helping to restore energy equilibrium. A lowering of RMR for target individuals was hypothesized as a physiological adaptation to lower levels of food intake and, in the case of women, increased energy demands due to pregnancy and lactation.

The occurrence of drought and food scarcity in late 1984 presented an opportunity to examine the relationship between an acute decline in energy intake and RMR. Low but positive correlations were found between RMR and energy food intake.

Concurrently measured body weight and RMR, quarter by quarter, show statistically significant correlations, as did RMR and arm muscle area and circumference (protein stores). In pregnant, lactating, and postpartum women, (positive) correlations between RMR and arm muscle and arm circumference are low but still statistically significant.

Socioeconomic Status (SES):

The Kenya Project investigated a wide range of socioeconomic variables in the effort to determine whether households' social position and economic well-being are related to their nutrition and health. Preliminary analyses suggest that household SES correlates positively with food intake, sanitation and hygiene, and negatively with morbidity. The SES ranking of households by chiefs based upon locally-used criteria showed a high congruence with the SES scores derived from the project's questionnaire.

Sanitation and Hygiene

The Kenya Project conducted a sanitation and hygiene study to determine the extent to which household sanitary practices and conditions are associated with health, nutrition, socioeconomic status, and other factors. Household sanitation and hygiene practices show positive correlations with SES, literacy of the lead male, food intake, and available energy. Significant negative correlations are found with morbidity.

Non Core Studies

The Kenya Project conducted studies of six "non-core" topics, in order to better interpret and analyze the data from the "core" studies. The "non-core" topics were time allocation, agricultural production, activity/energy expenditure, adult literacy, anxiety and depression, and alcohol consumption.

Time Allocation:

The Kenya Project conducted a time allocation study among project households for a period of one year to learn how household members spent their time. The Kenya time allocation data demonstrate that a number of important differences exist between how lead males and lead females spend their time. More insightful patterns will undoubtedly emerge from analyses that distinguish, for example, households of high vs. low food intake, or households of high vs. low household SES. Men spend a greater percent of time in recreation and inactive time. Pregnant women are far more inactive that nonpregnant women.

Activity Energy Expenditure:

A major objective for studying energy expenditure of selective common activities was to test the hypothesis that changes in food intake bring about social and biological responses of energy expenditure relevance. More specifically, a decrease in energy intake results in both a decrease in metabolism and a decrease in the performance of high energy demanding activities. Analysis of the energy expenditure data has just begun and considerable additional work is necessary.

Agricultural Production:

Although the Nutrition CRSP is principally concerned with the "functional effects of food intake," food intake itself is intricately related to and dependent upon food availability. As expected, households consistently reported maize and beans to be two of the three most important crops. Measurements taken of gardens and crop yields will give an excellent idea of household food production.

Adult Literacy:

Literacy was assessed through the measurement of reading comprehension and writing ability of the lead males and females of the Kenya project households. It was anticipated that this information would be useful for determining whether the quality of a household's nutrition, as well as its health, sanitation and hygiene, socioeconomic status, and cognitive development, are associated with the literacy level of one or both lead adults. The most obvious pattern to emerge from the distributions of scores is that at least twice as many men are literate compared to women. Literacy, particularly of the father, correlated positively with SES, energy and fat intake, cognitive function of the children, and negatively with significant illness.

Anxiety and Depression

The Kenya Project conducted a study of anxiety and depression among lead males and females after recognizing that some individuals appeared to be experiencing obvious mental health problems which were not reported as morbidity. These conditions can influence the quality of an individual's nutrition and physical health, as well as a household's sanitation and hygiene, socioeconomic status, and other functions. Preliminary analyses indicate that significantly more women (about 13%) are anxious and depressed than men (about 4%).

Alcohol Consumption:

The Kenya Project carried out a highly confidential questionnaire on alcohol consumption. This survey was conducted because project personnel recognized that alcohol consumption, a socioculturally sensitive issue, was probably being underreported. Accurate measurement of alcohol consumption is important for both the overall energy intake study as well as its relation to other functional outcomes. Women drink virtually no beer. Men, on the other hand, were found to consume significant amounts of beer, especially the local traditional variety. Certain individuals in particular consumed large amounts and corrections for energy intake for these lead males will be considered.

Documentation of a Severe Drought in the Study Area

Major lessons were learned from the experience of a severe drought in 1984. Farmers such as those in Embu were found to be highly vulnerable to environmental fluctuations. The existing infrastructure needs to be strengthened in order to insulate communities from the ravages of severe drought or near famine. The experience of the Kenya Project highlighted the need to develop preventive interventions that would provide positive avenues for dealing with the sudden climatic changes that induce critical food shortages. Problems caused by the severe drought were a drastic reduction in intake, a disruption in the normal pattern of activities, and loss of body weight and fat. The acute food shortage offered the opportunity to explore cases of more severe nutritional deprivation than the original study design envisioned. Lack of household food stores, seed, drought resistant crops, emergency famine crops and opportunities for obtaining cash to purchase food were observed.

Policy Implications of the Findings:

Mild to moderate malnutrition has been credited with having greater impact on development efforts than more extreme forms of malnutrition, touching on nearly all developing countries. This fact gives great potential weight to the findings that will emerge from the Nutrition CRSP Projects and their impact on policy. The contribution to policy development can be found in the extensive longitudinal data set on food intake and its "functional outcomes" as well as a wealth of explanatory or intervening variables on both households and individuals. The data will help define the adverse affects of decreased energy intake on the day to day lives of people.

Future analyses of the Nutrition CRSP Kenya Project data will provide an analytical basis for determining intervention strategies that would be appropriate for improving the nutrition of families.