THE COLLABORATIVE RESEARCH AND SUPPORT PROGRAM ON FOOD INTAKE AND HUMAN FUNCTION

MEXICO PROJECT

FINAL REPORT

April, 1982 - September, 1987

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

15 November 1987

The University of Connecticut
Department of Nutritional Sciences
Box U-17, 3624 Horsebarn Road Extension
Storrs, Connecticut 06268

Dr. Lindsay H. Allen
Dr. Gretel H. Pelto
Principal Investigators

Instituto Nacional de la Nutricion
Salvador Zubiran
Division de Nutricion de Comunidad
Vasco de Quiroga #15
Delegacion Tlalpan
14000 Mexico, D.F.

Dr. Adolfo Chavez
Principal Investigator

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14000 Mexico, D.F.

Dr. Adolfo Chavez
Principal Investigator

MEXICO CRSP PHASE I STAFF

UNIVERSITY OF CONNECTICUT

Dr. Lindsay Allen	Principal Investigator
Dr. Gretel Pelto	Principal Investigator
Dr. Pertti J. Pelto	Co-Investigator, Social Data
Bruce Bernstein	Program Administrator
Dr. Roy Tembi	Data Manager
Peter Guarnaccia	Research Assistant, Productivity

INSTITUTO NACIONAL DE LA NUTRICION

Dr. Adolfo Chavez	Principal Investigator
Dr. Alfonso Mata	Physician, Field Director
Dr. Homero Martinez	Field Physician, Reproductive Study
Pesaj Goldfeder	Data Manager
Pilar Alvis	Medical Resident, Reproduction Study
Catalina Garcia	Nutritionist, Diet Study
Mirna Cuellar	Nutritionist, Diet Study
Josefina Farrera	Secretary
Ramon Lira	Programmer, Data Management
Dr. Beatriz Castillo	Physiologist, Activity Study
Barbara Loyo	Interviewer, Cognitive Development
Luzma Meneses	Interviewer, Socio-economic Study
Tere Carus	Nutritionist, Diet Study

SUBCONTRACTS

Dr. Gordon Finley (Florida International University): Adult Cognitive Development

Dr. Tiffany Field (University of Miami Medical School): Infant and Child Cognitive Development

Dr. Ranjit Chandra (Memorial University of Newfoundland): Immunology

MEXICO CRSP PHASE II STAFF

UNIVERSITY OF CONNECTICUT

Dr. Lindsay Allen	Principal Investigator
Dr. Gretel Pelto	Principal Investigator
Dr. Pertti J. Pelto	Co-Investigator, Social Data
Bruce Bernstein	Project Administrator, Final Report Editor
Charlene Pepin	Secretary
Jeffrey Backstrand	Data Manager
Robert Braden	Data Management Assistant
Kelley Scanlon	Research Assistant, Activity Studies
Richard Ely	Programmer, Data Analysis
Denise Beaudoin	Secretary
Connie Capacchione	Data Management Assistant
Nancy Swanson	Administrative Assistant
Mary Lung'aho	Graduate Assistant, RMR
Ann Black	Graduate Student, Laboratory Analyses

SUBCONTRACTS

University of Massachusetts School of Public Health

Dr. Edward Stanek	Consulting Statistician
Martha Zorn	Research Assistant
Susan Shetterly	Statistical Assistant
Borko Jovanovic	Research Assistant
Greg Klein	Research Assistant

University of Miami School of Medicine

Dr. Tiffany Field	Infant and Child Psychology
Nitza Vega-Lahr	Research Assistant

Florida International University

Dr. Gordon Finley	Adult Psychology

INSTITUTO NACIONAL DE LA NUTRICION

Dr. Adolfo Chavez	Principal Investigator
Dr. Alfonso Mata	Physician, Field Director

Area Chiefs

Dr. Julia Beatriz C.	RMR, Activity, Anthropometry
Gloria Contreras	Anthropometry
Ramon Lira	Data Management
Dr. Gerardo Lezama	Clinic Head
Dr. Homero Martinez	Morbidity, Data Analysis Unit
Eulalia Martinez	Psychology
Margarita de Mata	Laboratory
Luzma Meneses	Census, Social Data, Social Work Chief
Elsa Molina Rivera	Food Intake, Coordinator of Area Chiefs
Dr. Jose Santos	Clinic Head
Lorraine Schlaepfer	Data Analysis Unit
Leticia Serrano	Food Intake
Alba Sosa	Food Intake
Mirna Vara	Chief of Physicians, Morbidity
Jorge Sosa	Data Management in the Field
Eudwiges Tellez	Activity

NUTRITIONISTS

A. Del Mazo M.
M. Dominguez Z.
M.E. Flores M.
E. Hernandez L.
S. Medina
B. Rodriguez C.
G. Gutierrez
A. Martinez
C. Baizabal
F. Bautista F.
C. Loyola
C. Torres
G. Ramirez
R. Pacheco
G. Sanchez
H. Ortega G.
R. Borges V.
C. Sanchez
L. Luna M.
M. Cuellar T.

ADMINISTRATION

J. Freijoo
R.M. Espino H.
R. Rios R.

PHYSICIANS

J. Barba C.
E. Quintero H.
C. Garcia T.
L. Gonzalez G.
M. S. Hernandez C.
S.G. Legama P.
N.R. Mendez M.
M. Betancourt
E. Lopes G.
O. Maricela Nava
S. Gonzalez
B. Vasquez Z
H. Vias
S. Rocha
D. Meneses D.

SOCIAL WORKERS

C.P. Castillo M.
J. Contreras
E. Gonzalez
G. Moreno M.
H. Ortega E.
C. Pedro C.
S. Urbina P.

PSYCHOLOGISTS

D.M. Cortes S.
S. Maldonado H.
M. Montes O.H.
T. Saturnino
N. Guarneros S.
A. Garcia L.
H. Camancho A.

LAB TECHNICIANS

M. Gonzales Z.
J. Gonzales G.
C. Ramirez N.
G. Martinez
M. Gutierrez
E. Gonzalez G.
A. Roldan A.
M.E. Garcia
G. Alcantara P.
M.R. Cervantes N.
A.H. Cervantes N.
H. Hernandez R.
A. Hernandez R.
A. Palacios T.

STATISTICIANS

A. Bustos
C. Cevallos

AUXILIARIES

S. Garcia O.
G. Moreno M.
J.L. Garcia
C. Armenta
M. Alvarez
J. Roldan P.
A. Bautista CH.
E. Saldivar
A. Martinez
R. O. Diego
Y. Bolanos
G. Ruiz
R. Flores R.
V. Garcia A.
H. Martinez
M. Fuertes
R. Rodriguez
M. Saldivar
J. Bautista
A. Vega
F. Garcia
A. Lalinde
J. Tapia
G. Bautista
J. Garcia
J. Rodriguez

A. Alcantara
A. Plata A.
A.M. Saldivar
R.M. Velasquez
B. Roldan P.
A. Rojas R.
A. Martinez
C. Alcantara S.
J.L. Plata M.
A. Zuniga N.
S. Bautista
R. Barrios E.
R. Hernandez F.
V. Perez M.
F. Martinez
M. Diaz
F. Rodriguez
Q. Hernandez
F. Isidro
F. Rivera
J. de la Cruz
S. Palomares
P. Garcia
L. Roldan
J. Hernandez
J. Plata

P. Moreno M.
S. Chavez M.
L.R. Plata
P. Trejo L.
G. Perez M.
M. Rojas R.
P. Rubio
M. Aguilar
H. Esquivel R.
C. Ruiz R.
S. Alvarez
S. Baena G.
L. Dominguez G.
R. Duran M.
T. Martinez
B. Garduno
G. Rodriguez
D. Garcia
A. Gomez
R. Roldan
J. Martinez
J. Alba
F. Romero
R. Pillado
T. Plata
S. Salazar

C. Mendoza R.
D. Mendoza M.
G. Armenta
V. Lopez
S. Pina N.
R. Sosa R.
C. Flores
S. Sanchez
A. Meza B.
Z. Bolanos
C. Aguilar
C. Nava S.
L. Reynoso P.
I. Rojas R.
C. Saldivar
F. Escobar
P. Rodriguez
E. Alcantara
C. Dominguez
G. Zaldivar
C. Olvera
F. Plata
M. Garcia
B. Moreno
F. Martinez

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EXECUTIVE SUMMARY

The Mexico Collaborative Research and Support Program on Nutrition and Function (Mexico CRSP) was a joint effort of researchers from the Instituto National de la Nutricion Salvador Zubiran (INN), Division de Nutricion de Comunidad in Mexico City and the University of Connecticut (UConn), Department of Nutritional Sciences. The project, which was funded from April, 1982 - September, 1987, was undertaken to investigate the relationships between marginal nutrition (measured primarily by intake of kilocalories, protein, and anthropometric status) and biological and social "outcomes" (especially growth, morbidity, reproductive competence, and psychological development and functioning). Pilot and "Phase II" (Main Study) data were collected over approximately a three year period in six communities of the Solis Valley, located in the rural central highlands of the state of Mexico. Data analysis was conducted at INN, UConn, and the Department of Biostatistics at University of Massachusetts School of Public Health.

The Mexico CRSP was one of three parallel projects, together with the Kenya CRSP (Nairobi University/University of California, Los Angeles) and the Egypt CRSP (Nutrition Institute of Cairo/Purdue, Kansas and Arizona Universities). These were funded for cross-national exploration of the above relationships by the United States Agency for International Development (USAID). Co-ordination of the three country projects and data archiving was provided by an administrative unit--the Management Entity (ME)--at the University of California, Berkeley.

RESEARCH OPERATIONS

The project was conducted in three stages: a preliminary period of project organization and pilot surveys ("Phase I"), the period of collection of the "main" data of the study ("Phase II"), and a period of data checking, correction, archiving and analysis, which overlapped the later stages of Phase II.

Phase I

Phase I of the Mexico CRSP began, in effect, in the first few months in 1982, when Drs. Lindsay Allen and Gretel Pelto (UConn Principal Investigators) met with Dr. Adolfo Chavez (INN, host country Principal Investigator) in Mexico to select a research site, identify appropriate field staff, and undertake other administrative tasks necessary for initiation of the project.

The Solis Valley was selected for the project primarily because of 1) its accessibility to Mexico City (approximately 75 miles to the northwest), 2) its rural nature and apparently minimal migration, 3) the existence of marginal malnutrition in the Valley suggested by anthropometric and other data available from previous studies, 4) the existence of a number of similar communities in the Valley suitable for the study, 5) the availability of a clinic, suitable residence for the field staff, and other local institutions in the vicinity which could support a major research project, and 6) the past experience of INN and UConn researchers in the area.

In the spring of 1982 four Solis Valley communities (San Nicolas, San Miguel, San Antonio and Cerritos) were selected as a major focus of preliminary research, which was to be the principal objective of Phase I. This research was designed 1) to verify that Solis was an appropriate site for the project with regard to the prevalence of marginal malnutrition and

the feasibility of conducting research in the area, and 2) to develop protocols and train personnel for Phase II. In addition, collection of comparable data from the three CRSP projects was a major objective of the CRSP. Thus data from preliminary studies would inform the construction of Phase II protocols, which would support this objective.

The field staff recruited for Phase I included some 30 personnel, mostly Mexican--three physicians, three nutritionists, a physiologist, two programmers, a secretary and approximately 20 assistants and other auxiliary personnel. UConn P.I.s and a co-investigator (anthropologist) were also in field residence for much of the period and field visits were made by consulting psychologists from the U.S.

The Phase I "Preliminary Survey," which commenced in May, included 1) a full census of the four communities (3895 individuals from 622 households), with basic demographic data on all households, 2) an anthropometric and dietary survey of a random sample within each community, and 3) a study of social characteristics in a subsample of 109 households, selected randomly from the households in the diet-anthropometry study. Ethnographic work was also carried out throughout the summer. An additional two month pilot study exploring food intake, anthropometry, health status, psychological functioning, activity and illness patterns, and reproductive histories was undertaken in the Fall with 39 families in San Francisco Solis, a community which would not be included in the Phase II study.

The preliminary research of Phase I indicated substantial variation in nutrient intake levels and nutritional status in the Solis population. Anthropometric and ethnographic data showed a considerable prevalence of malnutrition, primarily marginal malnutrition with a small incidence of severe malnutrition among children of various ages. Dietary intake data suggested a significant incidence of substandard calorie and protein intakes relative to U.S. Recommended Dietary Allowances. The people of Solis appeared to be representative of impoverished rural Mexicans--pursuing a mixed economic strategy of subsistence agriculture and wage labor, and consuming a marginal diet relying on corn and beans, with little consumption of foods from animal sources. The community response to the research was cautiously positive, but it was apparent that the more extensive, invasive research anticipated for Phase II would require sensitivity to local culture in design of protocols and tangible contribution to the community from the project. In addition, it was clear that collection of meaningful data would be a slow process, particularly in the initial stages of the project, when a substantial investment of time would be required to gain the confidence of respondents.

Phase II

Following the completion of Phase I data collection in October, 1982, project energies turned toward preparation for Phase II, a process which would require more than a year to accomplish. The major tasks completed during this period included: augmenting and training of field staff in Mexico; developing the administrative machinery in Mexico and Connecticut to support full-scale operation of the project; identification, purchase, and, in some cases, U.S.-to-Mexico transfer of equipment and supplies necessary for measurements and assays; optimizing relationships with the research communities; and finalizing the Phase II protocols, including articulating research objectives, developing, testing and refining interview instruments, and identifying and recruiting the target sample.

Special efforts in the area of community relations included support for the local clinic. The project provided funding for a physician and for supplies and construction of the laboratory facilities. Fiestas underwritten by the project were held in each of the research communities. Project social workers also assumed residence in each of the communities to serve residents as social resources and liaisons to the project.

Protocols were developed through an iterative process involving review of preliminary study experience and data by Mexican and U.S. researchers, meetings of the three country project P.I.'s and the M.E., at which tentative plans for common data to be collected were formulated, review of cross-project recommendations in Mexico with field staff, revision, and feedback to the M.E.

Ultimately protocols (including approximately 50 interview instruments and forms for data collection) were designed to collect the following data from various "target" individuals and households: habitual food intake, anthropometry, morbidity, mortality, health histories, physical examinations, pregnancy outcomes, laboratory analysis of blood, urine,

feces, and breast milk samples, resting metabolic rate, psychological development and functioning, activity patterns, socioeconomic status, sociocultural attitudes and behaviors, household sanitation and agricultural productivity. At the community level, data on climate and local food prices would also be collected.

Five types of individuals were designated as targets for the study: infants (0-6 months), toddlers (18 to 30 months), school children (7 to 9 years), adult females (pregnant and mothers of target children) and adult males (heads of target households). The study protocol called for collection of data on 100 individuals in each target group for a one-year period. In addition, the inclusion of households as a unit of analysis in the study necessitated collection of some data, especially on morbidity and anthropometry, from "non-target" individuals in target households.

Although census activities were carried out the previous summer, Phase II began in essence in January, 1984 in the four communities of the preliminary survey. In July, a fifth Solis Valley community (Calderas) was added to the study. A sixth (San Jose) was added in April, 1985 to increase the number of pregnancies and infants in the sample. The data collection required 2.5 years to complete. During the height of Phase II the project employed a staff of approximately 100 field workers and a group of data management and administrative personnel in Mexico City.

The resulting Phase II data set includes information of varying amounts on 1,058 target individuals from 290 households, as follows:

Phase II Sample: Targets

Infants	134
Toddlers	158
Schoolers	198
Adult Females	290
Adult Males	288
Target Households	290

Data Management and Analysis

The data management task of the Mexico CRSP involved:

1. recording of data on more than 600,000 pages of interview forms and other documents,
2. entry in Mexico of these data into computer files,
3. error checking and correction of entered data,
4. storage of data in Mexico and transfer of computer files to Connecticut,
5. storage, reorganizing, and error checking of data, and return of questionable data to Mexico for review,
6. transfer of corrected data from Connecticut to ME at University of California for archiving,
7. transfer of "analysis files" from UConn to consulting statisticians at the University of Massachusetts and to the data analysis unit at INN (Mexico).

Basically two data entry strategies were employed in Mexico at various stages of the project, as a function of variation in available resources and demands for data utilization. During Phase I and the early part of Phase II, data were entered on microcomputers, primarily in Solis, and either transferred to magnetic tape through IBM-Mexico facilities for trans-

fer to UConn or sent on floppy diskettes. Later in Phase II most data were entered onto tape via mainframe at the large data processing center of Salud Publica (Public Health Department) in Mexico City. The tapes were read at IBM's Centro Scientifico in Mexico City and printouts of raw data were sent to Solis for checking against original interview forms. Tapes were hand carried or air-express mailed to UConn for processing. Copies were air-expressed from UConn to ME for archiving. "Analysis files" were provided to UMass statisticians primarily on floppy diskettes and on several occasions via electronic mail (the "Bitnet" system).

Data management tasks occupied the majority of the period following the completion of Phase II data collection in June, 1986 to the end of the project. Although preliminary analyses were conducted at earlier stages, a system of analysis files for most areas of the study utilizing corrected data developed at UConn was not ready for use until early summer, 1987. Descriptive statistics for the majority of Phase II data are included in this report. Initial analyses concerning toddler food intake and growth, psychological development, and pregnancy outcome (the agreed upon cross-project analyses for the final report), have been carried out at UMass, UConn and INN.

RESULTS AND DISCUSSION

Phase II data indicated that the study communities were indeed marginally malnourished. Growth stunting of children starts around three months of age, becomes severe during the first six months of life, and persists so that by 18 months weight- and length-for-age deficits are greater than during infancy. On average, the rate of growth of the Solis preschoolers between 18 and 30 months of age parallels that of the standards for well-nourished children, but no signs of catch-up growth are evident for the group as a whole. Schoolers are the most growth-stunted group of all; they averaged between the 10th and 20th percentile for weight and the 12th percentile for height. Average weight-for-height was relatively normal in all groups. Cross-sectional anthropometric data that were collected once from all individuals in the target households revealed that growth percentiles remained very low throughout adolescence.

Some of the more in-depth statistical analyses in this report used the data from the preschoolers. A number of conclusions can be made about the relationships between food intake, nutritional status and function in this group. It is apparent that most of the growth-stunting occurs before the age of 18 months and that the majority of the children do not shift their weight or length percentiles substantially between 18 and 30 months of age. Nevertheless, there is considerable variability among the children in their weight and length growth rates during this period.

Several analytical strategies were used to determine the role of nutrient intake in the growth of these children. Total energy intake is not related to growth rate, but the degree of consumption of animal foods is a significant predictor of the average increase in weight and length between 18 and 30 months of age. Diarrhea, measured either as the percent of days observed that diarrhea was recorded or as the presence or absence of diarrhea between the ages of 18 and 30 months, has a negative effect on weight and length increase during this period. An autoregression method was used so that we could test whether food intake or morbidity in the preceding period predicted weight or length in the subsequent period. The method demonstrates that the amount or percentage of animal foods consumed in the previous three months predicts length in the subsequent three months, and that morbidity in the preceding month predicts a smaller weight in the subsequent month. The weight and length adequacy of children at 30 months was related to the intake of animal foods during the preceding 12 months, but not to the amount of diarrhea recorded during this period. The most likely explanation is that size at 30 months reflects the cumulative experience of the child from birth and that illness events after 18 months do not have a detectable effect on the size attained at 30 months.

Analyses to date suggest that animal foods are more limiting to the growth of Solis preschoolers than is total energy intake. The reasons for this are unknown but some possible explanations are apparent, including inadequate quality of protein from non-animal sources in the diet, inadequate intakes of iron and/or zinc, and the possibility that intake of animal foods may be easier to measure accurately than that of total energy.

The length (and probably weight) of the child at 30 months of age, and the amount and percent of kcal and protein consumed in animal sources, are significantly associated with another functional outcome--the child's score on the Bayley mental performance test. Although socioeconomic status and the mother's child care score also correlated with the Bayley mental performance score at 30 months, the variance explained by dietary animal products remains significant when these social measures are statistically controlled. Analysis of the extent to which the cognitive and behavioral performance of children is influenced by their iron status will receive a high priority.

In a subsample of 41 mother-preschooler pairs, frequent observations were made of the activities of both individuals and of the interaction between the mother and her child. The preliminary analyses presented in this report again indicate that the average amount or percent of kcal or protein from animal sources are important, in this case significant positive correlates of the percent of time that the child plays and interacts verbally, and negative correlates of the time the child spends "doing nothing" or being changed or cleaned. The average weight and length Z-scores of the child during the 18 to 30 month period--anthropometric variables that we know are associated with the consumption of animal foods--show similar associations with the child's activity patterns to those seen with animal food consumption. For example, taller, heavier children spend more time in play and verbal interaction, and less time doing nothing. These preliminary analyses suggest that the marginally malnourished preschooler who is shorter, lighter and consumes less animal products, is an apathetic, less active child eliciting less interaction with his/her caretaker. It remains to be determined whether iron status of the children explains some of these behavioral differences.

It is also apparent that the mothers who consumed fewer foods from animal sources spend more time "doing nothing" and less time in child care. Further analyses are needed to clarify whether these maternal behavioral differences are explained by the mother's nutritional status (especially anthropometry and iron status) and/or the child's nutritional status.

Fewer analyses have been performed on schooler and adult data, but there are some important results. The prevalence of iron deficiency anemia is high in schoolers and adult women, approximately 33 and 20 percent respectively as assessed by ferritin levels. In contrast, adult males rarely exhibit iron deficiency anemia as judged from ferritin, hemoglobin and hematocrit values. Rather there is a high prevalence of low red blood cell counts (41 %) and high mean cell volumes (27 %) in the adult male group, a picture suggestive of folic acid and/or vitamin B_{12} deficiency anemia. There were significant correlations between the amount of pulque (the local alcoholic beverage) usually consumed by both men and women and mean cell volume, so that it is probable that the consumption of this drink induces a folate-deficiency anemia.

The data concerning pregnancy, pregnancy outcome and infant growth during the first six months of life were analyzed in some depth. The energy and protein intake of the pregnant woman bear little relationship to her size or the birth weight of her infant. There is a weak positive association between maternal energy intake and weight gain in late pregnancy, and the latter is in turn associated with more infant growth. Women do not increase their energy intake significantly during pregnancy, an observation that agrees with data from many other population groups including those that are well-nourished. Of interest is the fact that resting metabolic rate (RMR) rises much less in the Mexican women than it does in well-nourished women studied in other countries. In a subset of 35 women followed from before pregnancy through lactation, the only significant increase was in RMR per cm height in the third trimester. In contrast to pregnancy, energy intake during lactation increases quite dramatically. An association was seen between maternal energy intake between six and eight months of lactation and the size of her infant at six months. RMR is not significantly different at any point in lactation from non-pregnant, non-lactating values.

One of the most striking relationships is between the size (especially weight and fatness) of the mother in late pregnancy and the weight and length of her infant at six months. Fatter mothers have babies who grow faster for the first six months--an important observation in a group where growth stunting starts to occur at three months of age. Maternal size is at least in part attributable to her nutritional history, and it is evident that in Solis this is a stronger predictor of infant size and growth than current maternal nutritional status. Maternal morbidity during pregnancy was negatively related to pregnancy weight gain, but neither maternal nor infant morbidity during lactation was related to infant growth.

Chronology of Major Events in the Mexico CRSP

January, 1982	Drs. Chavez, Allen, and Pelto convene in Mexico to identify research site and begin organization of project. Dr. Allen begins year of residence in Mexico.
March, 1982	Solis Valley selected as research site. Instruments developed for Phase I. Community survey begins.
May, 1982	Phase I data collection begins in four communities.
September, 1982	Additional pilot study commenced in San Francisco, Solis. First round of Phase I data capture completed. First computerized data transferred from INN to UConn.
November, 1982	All CRSP PIs and ME staff review pilot data and establish "common" data to be collected in Phase II.
January, 1983	External Advisory Panel reviews Phase II research design with PIs. Suggests revisions.
July, 1983	Pretesting of Phase II instruments completed in non-study Solis Valley community of Garabato.
November, 1983	Selection of initial target families, socioeconomic status interviews, and re-census in Phase II communities.
January, 1984	Phase II data collection begins in four communities (San Miguel, Cerritos, San Nicolas and San Antonio).
May, 1984	Computer entry of Phase II data begins in field.
July, 1984	A fifth community (Calderas) is added to the study.
September, 1984	First Phase II data transferred to UConn on diskettes.
April, 1985	A sixth community (San Jose) is added to the study.
May, 1985	Salud Publica (Mexico City) agrees to provide data entry services. IBM Centro Scientifico (Mexico City) agrees to provide computing facilities and consultation.
September, 1985	Major earthquake strikes Mexico City.
June, 1986	Phase II data collection completed.
April, 1987	Phase II data entry and error correction complete in Mexico and copy of all data transferred to UConn.
July, 1987	First draft of Final Report prepared.
September, 1987	Final version of Final Report prepared.

PART I

BACKGROUND

Chapter 1

INTRODUCTION TO THE MEXICO CRSP

Just as in war, malnutrition casualties should be counted not only by deaths, but also by the "wounded" people (1.1).

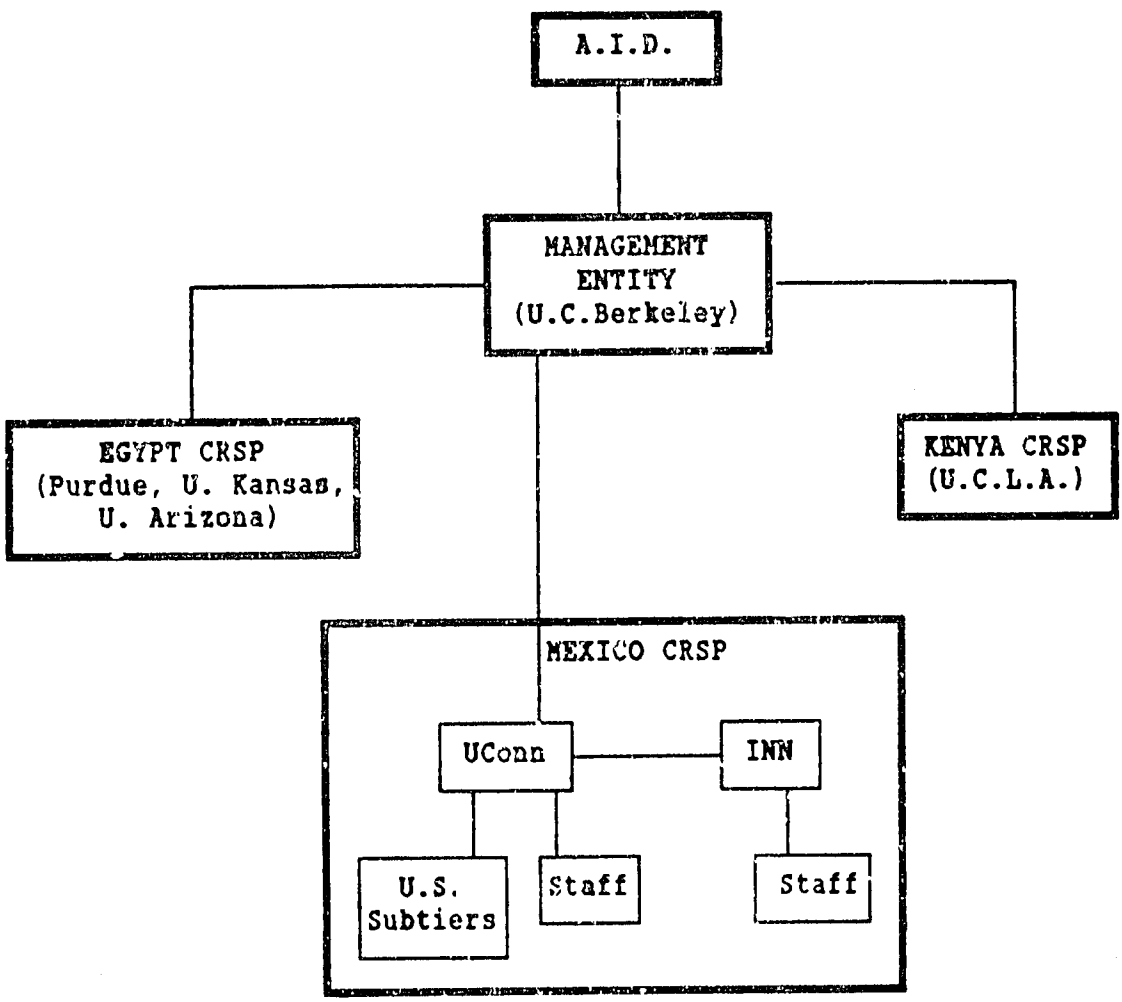
By the latter half of the 1970s, the consensus in the international scientific community was that mild-to-moderate malnutrition might well be the world's most serious nutrition problem. Marginal nutritional status, presumed to be primarily the result of inadequate food intake, was believed to be substantially more prevalent than the more visible states of severe malnutrition. There was no doubt that moderate malnutrition carried with it the impairment of individual health and physiological and social functioning. Nutritionists had begun to question the reliability of standard anthropometric indices as sufficient measures of adequate nutrition. Few definitive data were available, however, on the biological and social consequences of habitual marginal food intake (1.2). Without these data it is virtually impossible to differentiate insufficient from inconsequential low food intake.

In recognition of these circumstances, the United States Agency for International Development (A.I.D.) identified the functional definition of nutritional status as a primary research direction. With the input of senior investigators from the U.S. and developing countries, functional areas (including morbidity, reproductive competence, work output, cognitive functioning, and social and behavioral functioning) were identified as major areas for investigation. Food intake was identified as the major independent variable of interest. Additional objectives articulated for this research program, included: 1) assessment of food intakes whose range included mild to moderate restricted levels, 2) collection of data which would not be country specific, but could be generalized to developing countries, thus development of protocols which would support replication across countries, 3) development of research with potential policy implications, and 4) institution building in participating developing countries (1.3).

The Mexico Collaborative Research and Support Program (CRSP) was one of three projects funded by A.I.D. as part of an integrated cross-national investigation of the functional consequences of marginal nutrition. Similar projects were also conducted in Kenya (Nairobi University/UCLA) and Egypt (Nutrition Institute of Cairo/Purdue, Kansas and Arizona Universities). The Mexico project was a collaborative effort of the Division de Nutricion de Comunidad, Instituto Nacional de la Nutricion of Mexico and the Department of Nutritional Sciences, University of Connecticut. Consultation was obtained via subcontract with the University of Massachusetts School of Public Health (statistics), the University of Miami Medical School (infant and child psychology), the Florida International University (schooler and adult cognitive performance), and the Memorial University of Newfoundland (immunology). The general organizational structure of the Mexico CRSP is depicted Figure 1.1.

The general objective of each CRSP project was to gather extensive, longitudinal food intake, anthropometric, physiological, social, and psychological data on individuals and families, sufficient in scope for exploration of the relationship between levels of food intake and various functional outcomes. Substantial effort, coordinated by a central administrative unit (the "Management Entity"), and a committee formed by the Principal Investigators of the three country projects, and representatives of the Management Entity (the "Scientific Coordination Board") was invested in the development of protocols in each project that would allow parallel (i.e. cross-national) analyses.

FIGURE 1.1: NUTRITION CRSP GENERAL PROGRAM STRUCTURE



The Mexico project research site was six communities in the Solis Valley, located in the rural central highlands in the northwest corner of the state of Mexico, approximately 75 miles from Mexico City. The project was conducted from approximately January, 1982 through September, 1987, in three stages:

1. **"Phase I"** (January - November, 1982) - a preliminary period of project organization, pilot surveys, review of preliminary activities and cross-project (three CRSPs) discussion in preparation for the projects' primary data collection ("Phase II").

2. **"Phase II"** -- (November, 1982 - June, 1986) - a year of protocol development, pretesting, revision, and sample recruitment followed by 2.5 years of collection of the project's "main data". This involved collection of cross-sectional and longitudinal data from 1,068 individuals from 290 households, requiring a field staff of approximately 100 workers during the most active period of data collection.

3. A period of data checking, correction, archiving, and preliminary analysis following the completion of Phase II data collection (June, 1986) through September, 1987.

This report focuses primarily on the background, methods, and results of the Phase II research. The report is divided into four parts.

The remainder of **Part I: Background** describes the demographic and socio-cultural characteristics the Solis Valley (Chapter 2) and Phase I operations and findings important for Phase II of the project (Chapter 3).

The research protocols of Phase II are summarized in **Part II: Mexico CRSP Phase II Methodology**, which includes an overview (Chapter 4), chapters describing the protocols of the 12 major data areas of the project--Census (Chapter 5), Food Intake (Chapter 6), Anthropometry (Chapter 7), Morbidity (Chapter 8), Mortality (Chapter 9), Clinical (Chapter 10), Laboratory (Chapter 11), Resting Metabolic Rate (Chapter 12), Social (Chapter 13), Household Sanitation (Chapter 14), Psychological Development and Functioning (Chapter 15), and Activity Studies (Chapter 16)--and a discussion of data management in the project (Chapter 17).

Part III: Results contains 10 chapters of descriptive data (Chapters 19-28), and three analyses agreed upon by the SCB to be undertaken with comparable approaches by each country project for the final report. These include an exploration of the associations between toddler food intake, growth, and morbidity (Chapter 29); the relationships of food intake to cognitive development in toddlers (Chapter 30); and the associations of reproductive outcomes with maternal food intake (Chapter 31). These are preceded by an Introduction (Chapter 18), which outlines the derivation of cross-sectional and longitudinal samples, and other major features of the descriptive and analytic strategies.

A summary and discussion of the major findings and implications of the Mexico CRSP is provided as **Part IV** (Chapter 32). It is emphasized that the analyses of the Mexico CRSP data are in preliminary stages as of this report.

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1.2 Calloway, D.H. Functional consequences of malnutrition. Reviews of Infectious Diseases. 4 (4). 1982.

1.3 Collaborative Research Support Program (CRSP). Revised Research Design - Phase II. University of California. Berkeley, 1983.

Chapter 2

THE RESEARCH SITE

I. THE SOLIS VALLEY

The Mexico CRSP research was carried out in the Solis Valley of the Lerma River in the municipio of Temascalcingo. The municipio, with a population of approximately 44,000 people, is situated in the northwest corner of the state of Mexico in the Central Highlands. From Mexico City one can travel by bus or automobile on paved roads to Temascalcingo in approximately three hours, on a route west to Toluca (capital of the state of Mexico), then northward through the market center of Atlacomulco, turning onto a paved secondary road that passes a number of Mazahua Indian communities before descending into the town of Temascalcingo (see Figure 2.1).

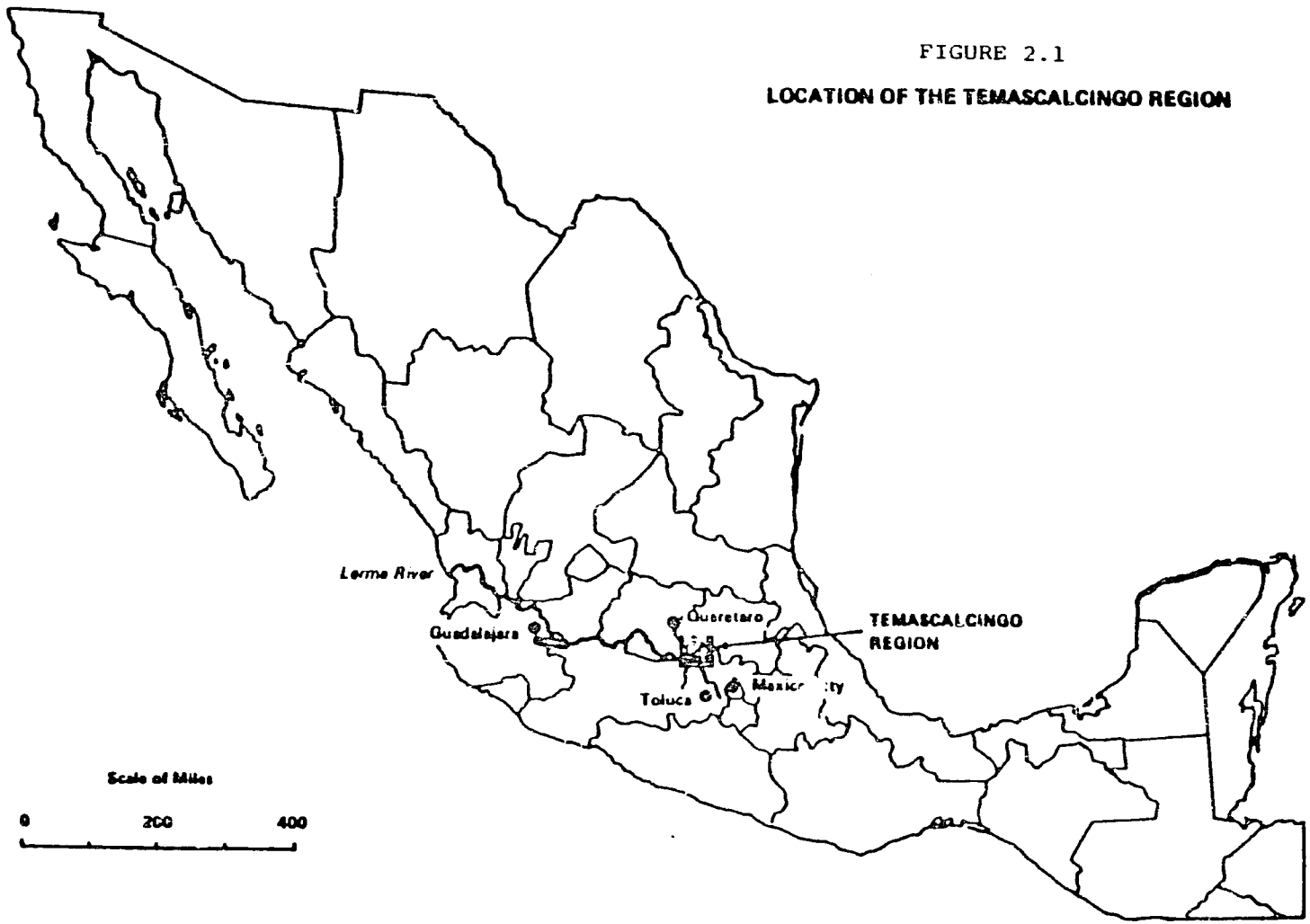
The communities that comprise the municipio of Temascalcingo are primarily Mestizo (Mexican-oriented, Spanish-speaking) on the valley bottom, whereas the Indian communities in the hills surrounding the valley are Mazahua (on the south and west) and Otomi on the northeast side. Prior to 1929, when the redistribution of land ownership resulting from the Revolution (1910-1917) reached the area, the valley was dominated by the rich Hacienda Solis, with its thousands of hectares of wheatlands and numerous villages of Indian and Mestizo peoples, who were held in peonage as laborers for the hacienda owners. The Hacienda Solis -- now properly referred to as Ex-hacienda Solis -- still dominates the center of the valley scene, but the central hacienda building has been converted into an agricultural education center, and the new and modern Health Center Solis now stands in the shadows of the building that in earlier decades symbolized the pre-Revolutionary hegemony of the privileged elites.

The municipio of Temascalcingo, like many areas of Mexico, is full of contrasts: between the Mestizos and Indians; between town dwellers and the villagers; between the small number of local elite with middle class occupations and economic resources and the majority of low-income families. The town of Temascalcingo, located in the south end of the valley, is the political center and also the market town for the local population. Temascalcingo has a bank, a small hotel, an extremely busy bus station, and a considerable variety of commercial enterprises. The weekly market takes place on Sunday (with some carry-over to Monday) and attracts a large number of vendors from other locations, who sell fresh produce, factory-made clothing, jewelry, a variety of "dime store" items, and locally manufactured pottery.

Until 1970, there were no paved roads through the valley other than the main road that connects the town of Temascalcingo to the wider world. However, in recent years the nine kilometer road from Temascalcingo to the village of Solis and its extension northwards to the small city of Amealco have been paved, as has the road eastward from Temascalcingo to the municipio of Acambay. The number of vehicles on the roads in the valley has greatly increased, including many more buses in the network of transportation that links the local people to market centers and employment locations in Atlacomulco, Toluca, and Mexico City.

FIGURE 2.1

LOCATION OF THE TEMASCALCINGO REGION



In pre-Revolutionary days, at least throughout the 19th century and perhaps earlier, the valley area was irrigated by means of an extensive system of canals and waterworks that controlled the Lerma River and permitted distribution of river water to almost all parts of the valley floor. This irrigation system fell into disrepair after the Revolution, but has now been restored and augmented through large-scale construction efforts in the 1960s. The extensive (and expensive) construction activities, including the creation of a new river bed through most of the valley, brought a period of high employment and moderate prosperity to the valley area during the 1960s. By 1970 most of the irrigation construction was completed, and opportunities for wage labor in the local area diminished substantially.

II. PHYSICAL ENVIRONMENT

The valley floor, on which the communities in the study are located, has an elevation of approximately 2500 meters above sea level, with some of the surrounding hills reaching to elevations over 3000 meters. The climate is moderate during the summer months, while winters can be quite chilly -- in common with other regions of the Central Highlands. As in other parts of Mexico, the rainy season is expected in late May or early June, and lasts throughout the summer months. From autumn (Sept.- Oct.) until late spring there is very little rainfall, so that any crop-growing during that period requires irrigation.

The climate essentially followed this typical pattern over the course of the CRSP research. Temperature and rainfall measures were made daily during the project. These data are summarized in Figures 2.2 - 2.5.

III. THE ECONOMIC SYSTEM OF THE SOLIS VALLEY

A. Agricultural Activities and Characteristics

In the heyday of the Hacienda the Solis valley was an important wheat-producing region. In the 1930s, after the Revolution (1910-1917), land was redistributed through the ejido system, a program that established community regulated lands, and allocated them to individuals. Inheritance rights were held by children of the original ejidatarios, but provisions to protect the community rights by prohibition of individual sale, and some restrictions designed to prevent reconcentration of land in the hands of a few wealthy owners. After the redistribution of the lands to the individual ejido communities, most of the local people preferred to sow their lands in maize, thus ensuring home production of the primary food staple, while surplus could be sold for cash as needed. Despite the efforts of governmental agriculture specialists -- who have sought to develop other income-producing crops -- the devotion to maize production has remained predominant. Eighty-six percent of acreage in the irrigated lands and well over 90% of the cultivated, non-irrigated acreage is devoted to maize (2.1)

In the municipio, non-irrigated land is nearly three times more extensive than the irrigated area, and the pattern of cultivation in the dry land areas is even more completely devoted to maize. As recently as the mid-1970s, the valley region had a much higher percentage of irrigated lands devoted to fodder -- perhaps nearly a thousand hectares. Fodder production was strongly encouraged by government agricultural specialists, who intended to convert the entire valley area into a dairy economy. Several dairy cooperatives were established in the valley, but these organizations disintegrated during the period from 1976 to 1980, in part because of economic difficulties and in part because of internal management problems. Consequently, the local market for fodder declined dramatically.

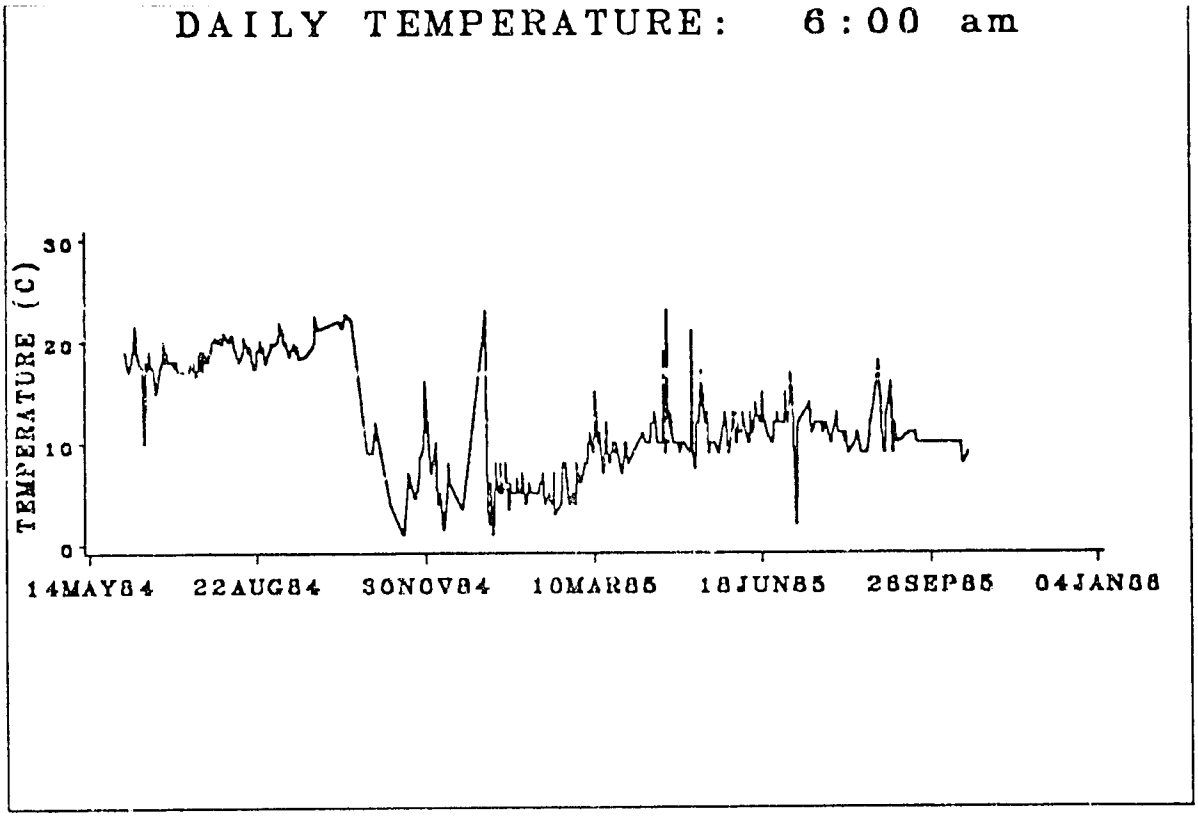


Figure 2.2 Daily temperature at 6:00 am, Solis, Mexico.

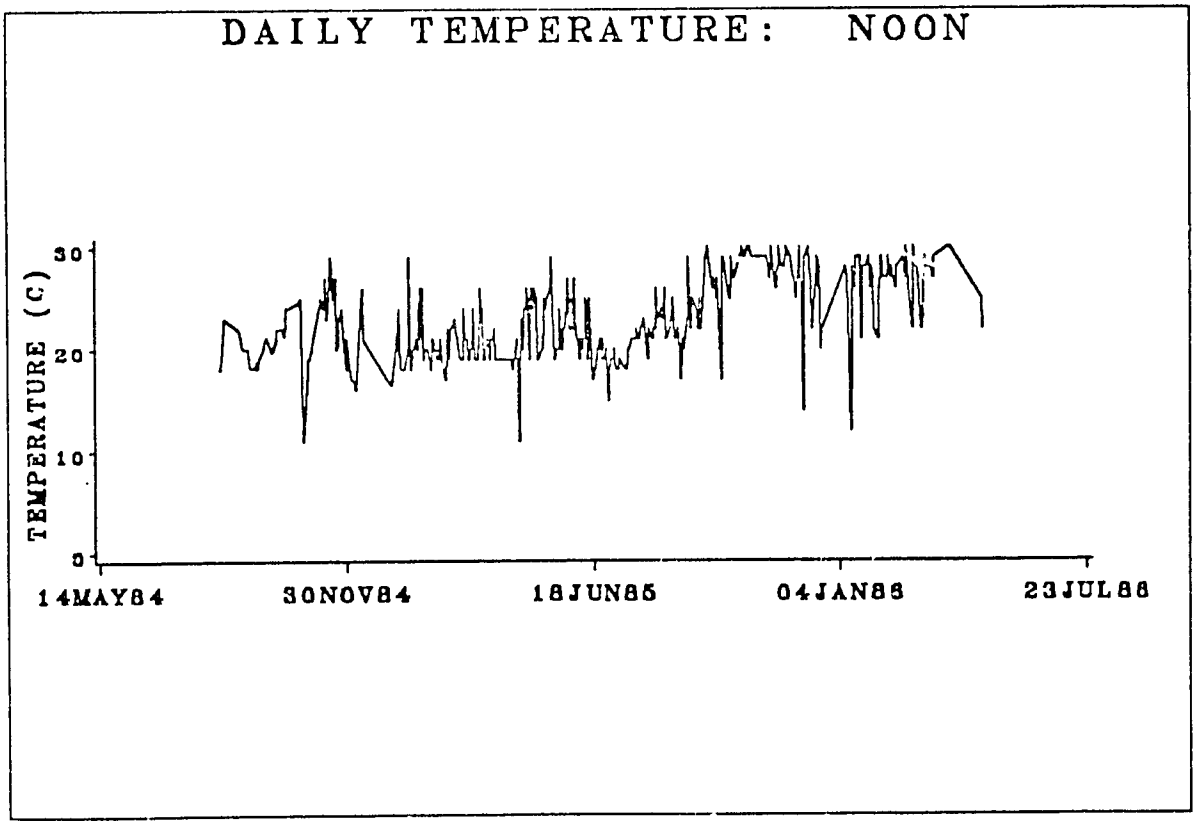


Figure 2.3 Daily temperature at noon, Solis, Mexico.

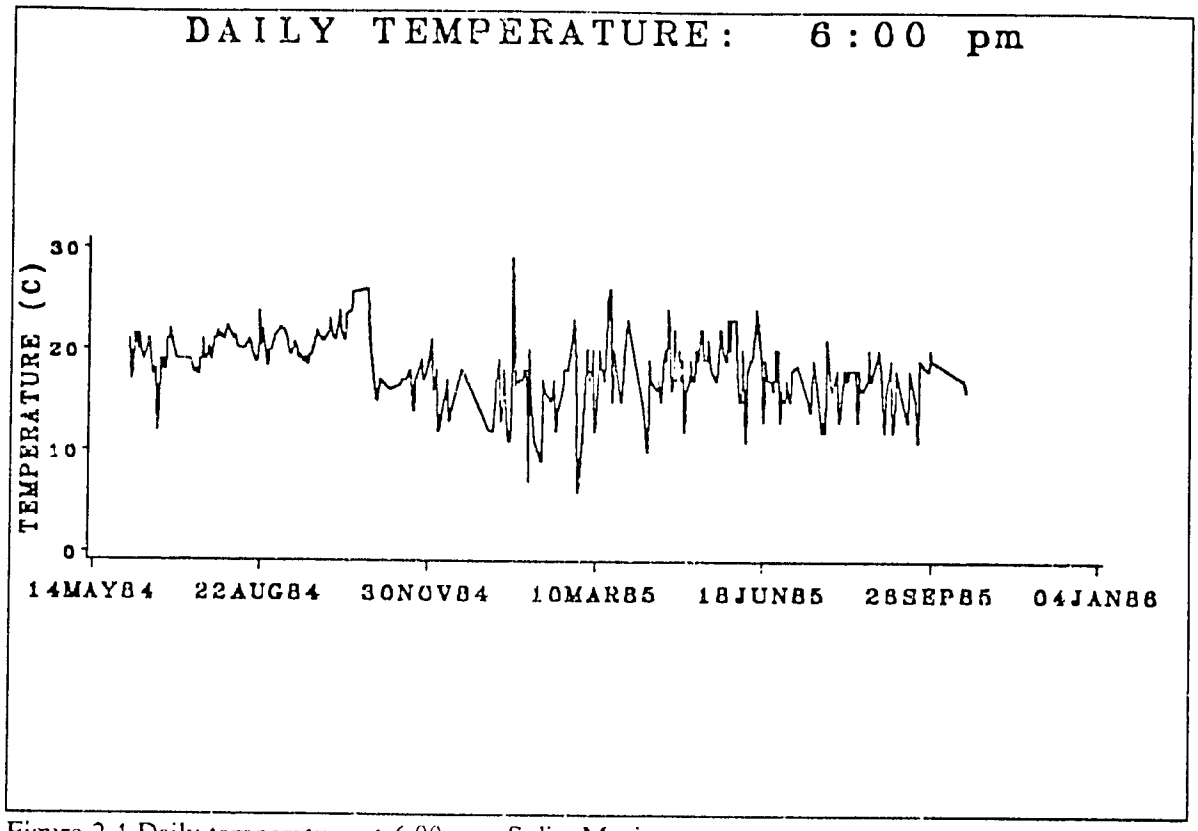


Figure 2.4 Daily temperature at 6:00 pm, Solis, Mexico.

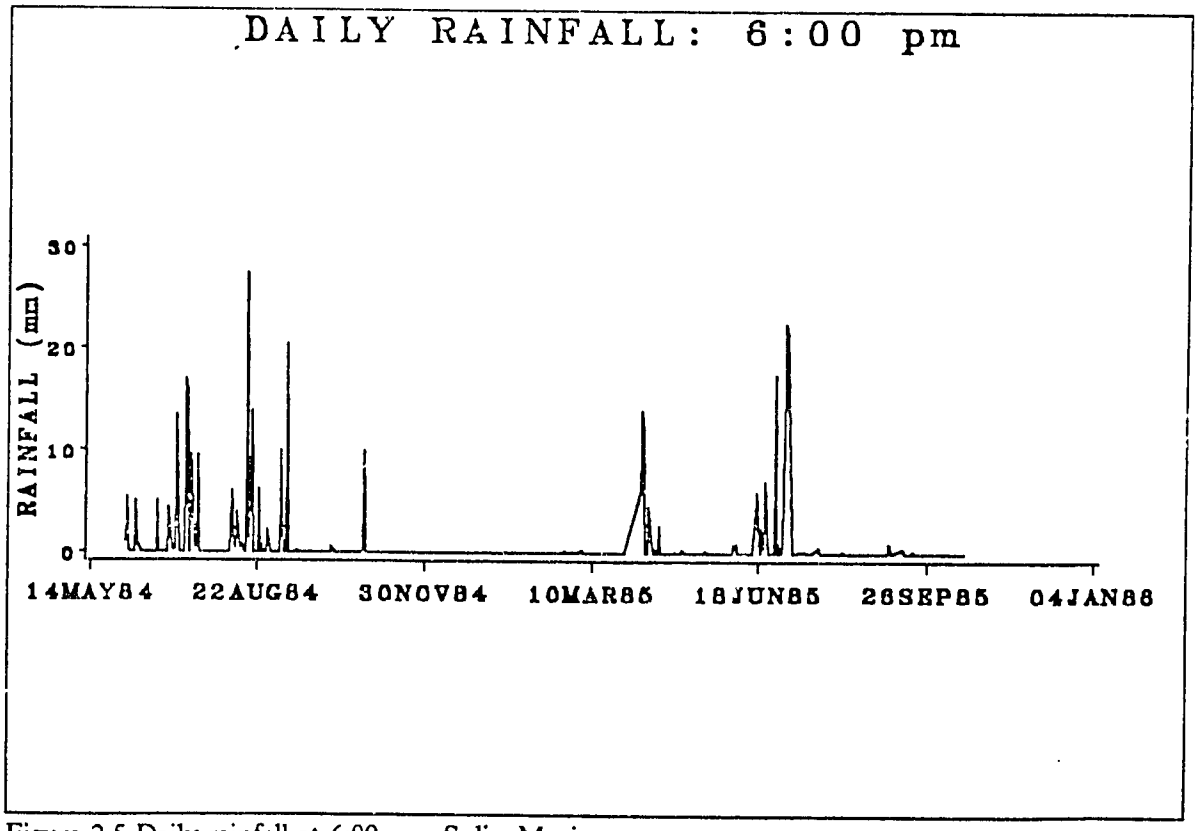


Figure 2.5 Daily rainfall at 6:00 pm, Solis, Mexico.

The subdivision of ejido plots to the offspring of the original holders has led to a situation in which most households have only very small plots. In March-April, 1985, 204 households in the study were interviewed concerning their agricultural practices. In response to the question, "How many hectares of land do you have?", 33% of respondents (the modal category) said they had between 1.0 and 1.9 hectares. Only 18% had 2 or more hectares, while another 26% reported owning less than 1. Most surprising in view of the past land reform actions is that nearly one-fourth of the households (23%) reported that they "had no land" and their agricultural activities were carried out on rented or borrowed plots.

B. Employment Outside of Agriculture: Wage Labor and Migration

In addition to farming, one of the main artisan industries of the Temascalcingo region is pottery. The Mazahua Indian communities are all pottery communities, in which nearly every household is involved directly in the manufacture of inexpensive household pottery. Most of the pottery produced in these communities has not gone into the tourist market, though pottery truckers carry Temascalcingo wares throughout Mexico, and some of it is sold over the border in Texas. The pottery industry is particularly important for the Mazahua communities because they have very little irrigated land, so their crops are far from adequate for maintaining household subsistence economies.

Other minor cottage industries exist in the area. Basketmaking and manufacturing of straw hats are carried out by a few families in the Indian communities; whereas in the town of Temascalcingo one finds a few modern manufacturing enterprises including a small-scale metal-working establishment, a thriving "gelatin" manufacturer (the "gelatins" are sold like candies in public gathering places), and a small clothing factory. Brick manufacturing and stone quarrying is also carried out by a few individuals, mainly for local utilization. Occasionally households produce pulque, milk, or eggs in excess of their own consumption needs and sell the surplus to neighbors. However, this is not a consistent source of income for the family.

Like most areas of highland Mexico, the Solis Valley is experiencing a dramatic economic transformation, which is exacerbated by the national economic crisis that began in the early 1980s. One indication of the severity of the crisis has been the precipitous drop in the value of the peso on the international market. (See Figure 2.6.) Today it is impossible for most families to acquire enough cash from the sale of farm products to meet even very modest monetary needs. In nearly all households, economic activities involve a mixture of wage labor and farming.

While some opportunities for wage labor are available within the Solis Valley and in Temascalcingo, many men find that they must seek work outside of their home area. Mexico City, which is the primary source of jobs, is too great a distance from Solis for daily commuting. Hence a common pattern is for men to travel to Mexico City, living there during the week and returning home on Friday night to spend Saturday and Sunday in the community. Some men do this on a more or less permanent basis, while others only engage in periodic wage labor in the city.

During the basic household economic interview (described below), we collected data on work patterns, seeking to identify when, and to what extent, adults were living and working outside of the community. This interview was carried out twice for each household during the period of time the family was in the study and provides the basis for the generalizations that follow.

Throughout the 1980s, 50% of the adult men in our sample traveled outside of the valley for work in any given year. There was virtually no out-migration of married women, although some teenaged daughters left the community seeking work in urban centers. For many men, work in Mexico City became their permanent economic strategy. Forty-eight men (35% of those who migrated at all during the year) worked twelve months outside of the community. In fact, this type of permanent "commuting" was the common mode. On the other hand, only 12% of the 140 men who migrated to work in 1984-85 did so for only one or two months. Almost without exception, they worked as unskilled laborers and received minimal pay.

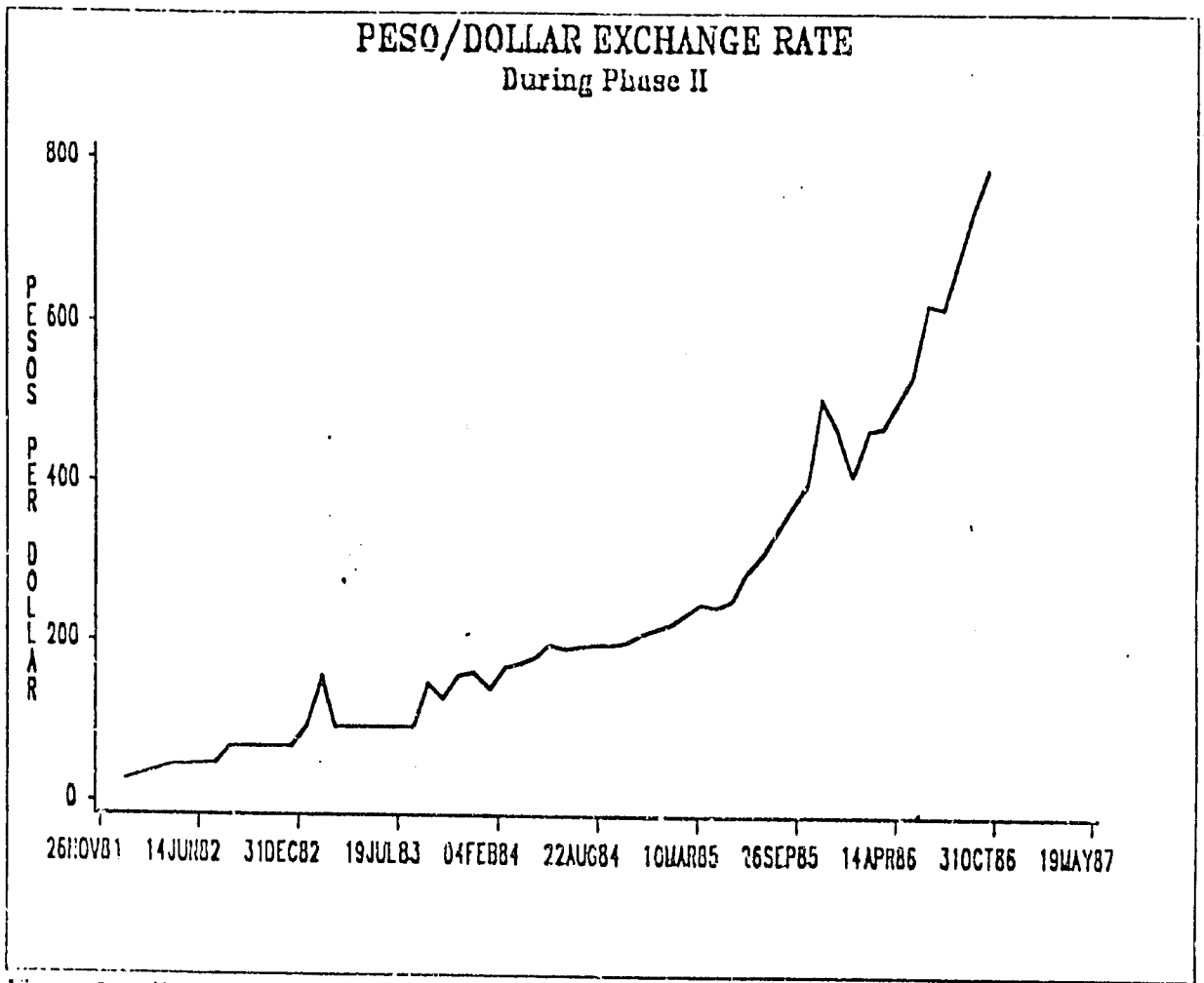


Figure 2.6 Pesos per dollar 1981-1987.

The new economic strategy, based on male out-migration to wage labor, is changing the nature of life in the valley. Community and household organization is being affected by the pattern of the sporadic presence of adult men. In some households women are taking on an increasing amount of agricultural work, although in others, the absent husband's labor is being substituted with hired help from other villagers. Some households have been able to substantially improve their material lifestyle, particularly a small subgroup in which the husband has migrated to the United States or Canada. In others, however, wage labor is necessary in order to buy food, clothing and other essentials, and has not led to a significant improvement in living conditions. Moreover, rampant inflation, which has included food, seeds and agricultural production costs, means that cash from wage labor is being used increasingly to meet basic needs.

IV. THE FOOD SYSTEM IN THE VALLEY

Located in the heartland of central Mexico, where the corn-beans-squash-chili complex evolved as the staple that supported the growth of Mesoamerican civilization, the people of the Solis Valley are heavily committed today to the food of their ancestors. Corn, consumed primarily in the form of tortillas (and less frequently in other ways) is the major staple. The other cereal grains in the diet are rice and wheat. The primary legume is beans (phaseolus vulgaris), with minor use of fava and lentils. Animal foods, which account for only a very small proportion of caloric intake, include eggs, chicken, turkey, beef, pork and dairy products. The main beverage is a traditional product that predates the Conquest--pulque, a moderately alcoholic drink made from the fermented sap of the maguey (agave). Coffee and lime-and-sugar-flavored water are also regularly consumed. Chapters 6 and 20 below provide detailed information on food intake and consumption patterns.

The food utilized by valley households comes from three sources: home-produced; purchased from markets, stores or vendors; and collected or gathered. In agricultural households much of the corn is home-produced, although many households are not self-sufficient in maize. A common pattern is to sell some corn after the fall harvest in order to obtain cash and then purchase additional corn the following spring or summer when home-produced stores are exhausted. Squash, beans, chili, and other vegetables are also produced for home consumption, but in the Solis valley few, if any, households raise all the beans they need, and chilies, tomatoes, onions, and other main foods are also frequently purchased.

Every Sunday, vendors of food (and other goods) converge on Temascalcingo, the market town, bringing food products from other parts of Mexico. In addition to a large variety of fruits, vegetables, beans, chilies and dried corn, processed foods (cheese, bread, dried fish, ices, gelatins, and sweets) are also available. More than 100 vendors set up their stands each week in the central plaza. In addition, vendors of in-season local products, such as squash blossoms, avocados, apples, and peaches, sell their small inventories on street corners near the market.

In addition to the large market on the "dia de la plaza", numerous stores in Temascalcingo, including general grocery stores and specialty shops (eg. butcher shops and bakeries), provide access to a wide range of foodstuffs.

In some rural communities, small stores with a highly restricted inventory can be found. Most people in the villages make major purchases at the weekly market in Temascalcingo and supplement these with purchases from the local stores, as well as from vendors selling produce from their trucks.

There is also some utilization of wild foods, including the fruit of the nopal cactus and various wild greens.

V. HEALTH, ILLNESS AND HEALTH CARE IN THE SOLIS VALLEY

As in most parts of Mexico, the health care system in the Temascalcingo-Solis region offers a mixture of services that includes private doctors, pharmacists, and other "private sector" facilities, the public health service (with several dis-

tinct governmental agencies), and traditional healers, whose training and expertise derive for the most part from popular beliefs and practices originating in both the Indian and European cultures.

A. Public Health Facilities

The area is served by four different kinds of public health facilities. Each system is sponsored by a particular governmental agency, and operates relatively independently. There is a system of health centers organized by the Secretaria de Salubridad y Asistencia (SSA) and administered through local municipal governments. Each municipio has its own Health Centers, with a system of referrals to hospitals for secondary and tertiary medical services.

The SSA Health Center in the town of Temascalcingo is staffed by a medical doctor who is serving his/her one year of mandatory service immediately following graduation from medical school. In addition to the full-time services of the doctor (pasante), the Health Center generally has one nurse on duty during regular hours, from 8 AM until 3 PM. In addition to the SSA Health Center in Temascalcingo, there is a center in the town of Santiago Mexquititlan in the lower end of the valley area. Santiago is in the state of Queretaro, but people can readily cross boundaries to seek the services of the Health Centers.

There is a second health center system operated by ISSEMYM (Instituto de Seguridad Social of the State of Mexico and the Municipios). Like the SSA Health Centers, this system is a part of the State governmental structure, with provisions for secondary and tertiary services at hospitals in Atlacomulco and Toluca. Unlike the SSA Health Centers, the services at ISSEMYM are available only to local and state governmental employees who pay a health insurance premium, in return for which consultations at the Health Center are free. The ISSEMYM Health Center in Temascalcingo was established in the mid-1970s and has a medical doctor available 24 hours per day.

A third component of the general health care system are the centers operated by the Instituto Mexicano de Seguro Social. Unlike the SSA and ISSEMYM Centers, the IMSS health services are managed directly by the federal government. In the Temascalcingo-Solis region, four such centers have been established in the past two years. At each one, the staff consists of a medical doctor (available 24 hours a day, Monday through Friday) and two nurses.

The IMSS COPLAMAR Health Centers are unique in that they provide free consultations, medicines, and other services. They are truly "free clinics". When asked why all the people in the area don't make use of the IMSS COPLAMAR services, the social worker at the Solis Hospital replied that there is widespread belief that low cost or free medical services are of lower quality. Hence people prefer to go to the private physicians whenever the illnesses are sufficiently serious that "the best available treatment" is desired.

The Unidad Medico Social in Solis

The Unidad Medico Social in the town of Solis, which was also the Mexico CRSP project headquarters, is a hybrid organization with a complex history of sponsorship by several different state and federal agencies. At the time of the study the hospital received its chief budgetary support from the National Nutrition Institute (INN). The hospital also had budgetary and administrative links to the state SSA system as well as to CODAGEM (Coordinating Commission for Agricultural and Animal Husbandry Development of the State of Mexico). CODAGEM was involved in the maintenance of the Solis Hospital because the hospital buildings are on the grounds of the ex-hacienda Solis, which CODAGEM maintained as an agricultural extension and training facility. The hospital includes a delivery room plus four beds for adult patients, beds for children, and cubicles for eight newborn infants, including an incubator for intensive care of premature infants. The unit also has X-ray and laboratory facilities, two consultation physicians, the medical director's office, and a small library.

B. The Private Medical Sector

The municipal center of Temascalcingo has had private doctors for many years. In 1970 there were three doctors, one of whom operated a pharmacy in connection with his practice. By the time the CRSP research began there were 12

private doctors in Temascalcingo, and one part-time doctor in San Nicolas, one of the study communities. (The part-time doctor teaches English in the secondary school in Temascalcingo and practices medicine in the afternoon). In general, the fees of the private doctors are considerably higher than the modest fees at the public health clinics.

There are five pharmacies in the town of Temascalcingo. The pharmacies sell (with or without prescription) a number of antibiotics and other medications. Many people rely on the pharmacies for "informal consultations," on the basis of which they buy antibiotics and other medications without incurring the costs of going first to consult with an M.D. Hawkers of medications (mercolicos) also appear in the area from time to time, selling patent medicines and other preparations outside the control of health authorities.

C. Traditional Healers and Medications

Although the present research did not explore the nature and extent of traditional healing facilities and practices, relatively superficial surveys (door-to-door interviews) in the late 1960s and 1970s demonstrated that practices involving traditional healing were widespread among the Indian populations of the region, and that only a small minority of the Mestizo people made extensive use of folk practitioners. A major exception to this generalization is the large number of women who continue to utilize traditional birth attendants (See Chapter 23). People also continue to use hueseros ("bone setters") for muscular and orthopedic complaints.

In 1967 the Instituto Mexicano de Estudios Sociales (IMES) conducted a social and demographic survey in the Solis Valley (2.1). Table 2.1 highlights some key features of traditional health practices noted in the research, showing contrasts between an Indian community (Santiago) and the Mestizo population in Temascalcingo.

Survey interviewing is generally a poor method for learning about traditional health practices. Many people avoid divulging much about traditional health practices, which they feel are seen by outsiders as "backward" or "not- sophisticated." On the other hand, the general impression that the majority of people in the valley, especially the Mestizo populations, have largely put their faith in modern medicine is supported by a variety of kinds of data. In the mid-1970s K. DeWalt reported on health practices and beliefs in one of the communities adjacent to Temascalcingo, using the title "The Illnesses No Longer Understand" (2.2). Her research indicated that people regarded modern medical resources as more effective, adding by way of explanation that perhaps the illnesses themselves had changed in character.

TABLE 2.1
FIRST TREATMENT FOR ILLNESS:TEMASCALCINGO (MESTIZO) AND SANTIAGO (INDIAN)

	TEMASCALCINGO		SANTIAGO	
	No.	%	No.	%
Use herbs	11	21.2	60	49.6
Pharmacy	12	23.1	12	9.9
Doctor	29	56.0	44	30.4
Curandero	0	0	4	3.3
No answer	0	0	1	0.8

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Chapter 3

PHASE I STUDIES

I. INTRODUCTION

In the spring of 1982, following the decision to locate the project in the Solis Valley, a series of activities were initiated that involved several components:

a) Ethnographic studies, focusing particularly on economic, dietary, and ethnomedical characteristics and household activity patterns.

b) A mapping and full census of the households in the communities of San Nicolas, San Miguel, San Antonio and Cerritos -- the four communities initially selected as the research sites.

c) Dietary studies on approximately one-fourth of the households in the study communities to obtain data on "habitual diet."

d) Anthropometric measurements on approximately 60 percent of the individuals in the study communities.

e) A pilot study in the community of San Francisco, Solis, in which several research procedures were carried out on the same households.

In addition to these activities, Phase I was a period devoted to development and refinement of the research tools and instruments, staff recruitment and training, and community preparation. Experiences during this period in specific areas of data collection are detailed in the methodology chapters in the following section.

A. Ethnographic Studies

Ethnographic work during Phase I was carried out during the months of June - August, 1982 and January - August, 1983.

The description of the research site in the previous chapter is based on Phase I ethnographic work. The ethnographic data also provided the base for constructing a number of the interview schedules, including all of the social data collection instruments (socioeconomic, sociocultural, and productivity) and the activity recalls.

B. Community Census

The mapping and census of the four initial communities was a Phase I activity. This census, periodically up-dated between 1982 and 1986, and augmented by two additional communities (Calderas and San Jose), is the basic census, reported in detail in Chapters 5 (Census Methods) and 19 (Household Characteristics).

C. Dietary Studies in the Four Communities

Dietary studies in the four communities were made on a total of 437 individuals, from 24% of the households in the census. In each household, information was collected on the "habitual diet" of the female household head, the male household head, and one child. The purpose of the study was to develop a picture of the types of foods consumed and the variation among households, and to assess whether there were differences between communities.

The procedure for collecting the dietary data involved the following steps:

1. The female household head was asked to report, in the context of the previous month, what the family usually ate for each meal of the day and for snacks.

2. The ingredients used in each recipe were recorded, as were the amounts or volumes and method of preparation.

3. The quantity of each recipe consumed by each of the key individuals was elicited and sample portions (or water as a substitute for liquids and soup) were weighed.

4. The quantity of other foods not prepared in recipes (e.g. tortillas) was described and weighed when available.

5. The proportion of the family recipe consumed was calculated by hand for each individual, and the nutrient content of the diet was calculated by computer, after the quantity of each ingredient was calculated and coded. The nutrient data base utilized for this exercise was the Nutrient Values of Mexican Foods (1980) developed by INN.

In addition to the nutrient analysis, a subset of records for 28 households in San Nicolas was randomly selected for additional analysis, including the calculation of a food frequency table and studies of variation of food preparation.

The Phase I "habitual diet" study provided a number of important generalizations:

1. Women were both willing and able to describe food preparation techniques and serving sizes quantitatively. (It should be stressed that this was not a rigourous assessment of the accuracy of their reporting but of their general willingness and capacity to respond to quantitatively phrased inquiry.)

2. Maize, consumed primarily in the form of tortillas, remains the most important dietary staple, and there is relatively little incursion of factory-produced foods into household diets.

3. There was considerable variation from one household to another in both the quantity of foods reported to be habitually consumed and in the consumption of specific foods. For example, in San Nicolas 15% of households consumed chicken two to three times a week, the great majority consumed it once a week, and 10% consumed it only rarely. The findings suggested that the communities we had selected would provide an adequate range of variation in dietary quantity and quality to permit hypothesis testing.

4. There was a considerable range of variation among women in food preparation practices and recipe content for specific, named "dishes". This finding suggested that we could not use standarized recipes in the Phase II study, but we would have to ask at each interview about the specific quantities of each ingredient in a recipe and the method of preparation.

D. The Anthropometric Survey

A team of anthropometry fieldworkers from INN was trained in June 1982, after which anthropometric data were collected from a random sample of households in the four communities. A total of 2,374 individuals were measured.

The measurements taken on subjects included body weight, height (length under 24 months), arm circumference, and triceps skinfold thickness.

Body weight was measured on a Detecto balance, without shoes and without excess clothing. Recording was to 0.05 kg. Infants were weighed, while being held by their mothers, with the weight recorded by difference. Height was measured against a fixed steel tape measure and checked for verticality with a plumb line. A square was positioned on the head, and the subject stood without shoes, with heels against the wall and knees straight. Recording was to 0.1 cm. Infants (under 2) were measured with a wooden infantometer. Arm circumference was measured with a flexible tape on the left arm, half way between the elbow and shoulder, with the arm bent and hand on the thorax. Recordings were made to 0.01 cm. Triceps skinfold thickness was measured with a Lange caliper on the back of the left arm at the midpoint. The arm was relaxed and the skinfold held 1.5 cm. above the midpoint. Recordings were made to 0.5 mm in duplicate.

A number of important generalizations were derived from this exercise:

1. The results of the survey indicated significant growth stunting in the four communities, suggesting the presence of chronic marginal malnutrition:

a) Twenty-eight percent of the children between 0 and 12 years of age were below the 90th percentile (WHO standards) in height-for-age.

b) In children aged 1 to 5 years, 6% were below the 90th percentile in weight-for-age, while among children 8 to 12 years old, 72% were below the 90th percentile.

c) During the first year of life, 20% of the infants fell below the 90th percentile of weight-for-height. By 2 - 5 years, this was true for 10% of the children.

2. Several logistical problems were encountered, which suggested that further work would have to be done to make the measurements acceptable to the families. Among the specific problems:

a) People were reluctant to remove heavy clothing or shoes during cold weather (perhaps because of fear of becoming "cold" and developing a "cold disease", in the context of the "hot/cold" system of disease causation.)

b) Many adults expressed doubts about the usefulness of the measures.

c) The staff complained that carrying the anthropometric equipment from house-to-house, often uphill for long distances, is extremely tiring.

These problems lead to the conclusion that, to the fullest extent possible, anthropometric measurements should be made in the clinic, in the context of other data collection procedures.

II. THE PILOT STUDY IN SAN FRANCISCO SOLIS

As a further test of specific instruments and a trial of the logistics of administering multiple data collection procedures, the decision was made to conduct a pilot study in a community that would not be used in Phase II.

The small community of San Francisco Solis, located about 10 kilometers southwest of project headquarters, was selected as the site for the pilot study. The community was sufficiently similar to the study communities to suggest that it was a reasonable site for pretesting protocols and techniques of administration. Three components of the pilot study are described below: the dietary intake study, the anthropometric study, and a study of activity patterns in adult women.

A. Dietary Intake

In San Francisco Solis quantitative data on food intake for a seven-day period were collected for the female household head, the male household head, and one child (between 8 and 12 years of age) from 30 households.

Two professional nutritionists were trained to supervise the dietary interviews, which were carried out by seven high school students from the municipal center of Temascalcingo. These seven were selected from an initial 17 young people, all of whom participated in a one-week training course. The training course included general information on methodology and training in administering the interview schedule, use of balances, and calculating the amounts of ingredients consumed from recipes.

The method of short-term recall involved visiting the family twice per day; the first visit was made after breakfast between 9 and 12 AM, while the second was between 3 and 6 PM, following the main meal of the day. The first day of data collection was on different days of the week for different families. From seven to 35 days were needed to obtain data on all six weekdays. Data on Sunday intakes were obtained from six families by recall on Monday.

Each woman was asked to recall what she had eaten at the previous meal, as well as what had been consumed by her husband and the selected school-age child. Portions of food equivalent to the recalled amounts were weighed, as were the amounts stated to have been used in the recipe from which the foods were prepared. At the second interview, the procedure was repeated, augmented by questions about what had been eaten away from home. After the second interview, the mother was given a sheet of paper on which to note the foods consumed after the interviewer left the house. This was done after determining that someone in the household could write.

The following morning the interviewer returned and reviewed the list, asking about specific quantities. The amount described by the mother was then weighed. Foods that were not available for measurement were estimated by a description of size (e.g. medium potato) or the equivalent volume of water was weighed (e.g. boiled beans).

Tables 3.1 and 3.2 show the mean caloric intakes for adults in children by day of the week and interview sequence. A series of exploratory analyses of variance were conducted to determine whether there were any significant variations between types of subjects, day of week or interview sequence, with results as follows:

1. When all subjects (N= 50) are included in a repeated measures ANOVA model with sex and age, significant sex and age group effects ($p<.05$) were obtained for day of the week and interview sequence, as well as sex and age group. The latter two were expected.

2. There was a significant difference ($p<.05$) between adult men and women for "day of the week," but no direct "day of the week" effect. The source of this effect is the higher caloric intake of males on Thursday, Friday and Saturday.

3. There was a significant difference between adult males and females by interview sequence, attributable to intakes on interviews 1, 2 and 4.

4. There were no differences for children.

These results indicated that in the longitudinal study it would be important to adhere strictly to a sampling strategy that alternated the days on which food intake data were collected, so that each day would be equally represented in the total corpus of an individual's measurements. The presence of an interview effect, at least with respect to the first six interviews, suggested we would find some variation over time that was a consequence of respondent/interviewer interaction.

TABLE 3.1.
KCAL INTAKE BY DAY OF WEEK AND INTERVIEW SEQUENCES
FOR ADULTS IN SAN FRANCISCO SOLIS

	MALES (N=12)		FEMALES (N=20)	
	Mean	(SD)	Mean	(SD)
Monday	2581	(857)	2149	(705)
Tuesday	2475	(540)	2081	(870)
Wednesday	2242	(1089)	1798	(661)
Thursday	2740	(651)	2080	(603)
Friday	2541	(629)	2144	(898)
Saturday	2677	(555)	2144	(634)
Interview				
One	2792	(417)	2206	(761)
Two	2659	(561)	2196	(561)
Three	2436	(887)	1979	(934)
Four	2701	(626)	1920	(602)
Five	2285	(1035)	1858	(759)
Six	2384	(737)	1880	(762)
Total	2543	(564)	2006	(487)

TABLE 3.2
KCAL INTAKE BY DAY OF THE WEEK AND INTERVIEW SEQUENCES FOR SCHOOL AGE CHILDREN IN SAN FRANCISCO SOLIS

	MALES (N=9)		FEMALES (N=9)	
Day	Mean	(SD)	Mean	(SD)
Monday	1260	(534)	1563	(361)
Tuesday	1594	(373)	1445	(525)
Wednesday	1705	(389)	1216	(526)
Thursday	1626	(376)	1413	(452)
Friday	1558	(469)	1310	(559)
Saturday	1659	(308)	1462	(484)
Interview				
One	1739	(312)	1357	(536)
Two	1519	(391)	1388	(483)
Three	1769	(400)	1267	(495)
Four	1506	(373)	1555	(456)
Five	1480	(371)	1419	(514)
Six	1390	(596)	1425	(479)
Total	1567	(259)	1401	(326)

B. Anthropometry

Anthropometric data were taken from 25% of the households in San Francisco (N=26). The research team included two community assistants and a physician who was trained in anthropometry by a consultant from INN. Prior to data collection, the team participated in a training workshop. The procedures were identical to those described above for the survey in the four communities.

The tables below show the results for children 0 - 5 and 8 - 12 years of age. Criteria for defining levels of nutritional status were based on comparison with WHO standards, in which 90% of height-for-age and weight-for-age is regarded as normal.

TABLE 3.3
CLASSIFICATION OF WEIGHT-FOR-AGE IN CHILDREN: SAN FRANCISCO SOLIS

Age	N	% Adequacy of Weight 70-79		80-89		90-99		100+	
		n	(%)	n	(%)	n	(%)	n	(%)
0-.9	17	1	(6)	4	(24)	9	(53)	3	(18)
1-1.9	9	2	(22)	3	(33)	4	(44)	0	
2-2.9	19	5	(26)	5	(26)	9	(48)	0	
3-3.9	24	2	(8)	10	(42)	12	(50)	0	
4-4.9	14	1	(7)	6	(43)	7	(50)	0	
8-8.9	12	2	(17)	5	(42)	5	(42)	0	
9-9.9	19	3	(16)	10	(53)	6	(32)	0	
10-10.9	14	2	(14)	10	(71)	2	(14)	0	
11-11.9	21	2	(10)	9	(43)	10	(48)	0	

TABLE 3.4
CLASSIFICATION OF HEIGHT-FOR-AGE IN CHILDREN: SAN FRANCISCO SOLIS

Age	N	% Adequacy of Height 70-79		80-89		90-99		100+	
		n	(%)	n	(%)	n	(%)	n	(%)
0-.9	16	2	(13)	5	(31)	8	(50)	1	(6)
1-1.9	11	5	(45)	3	(27)	3	(27)	0	
2-2.9	19	9	(47)	6	(32)	4	(21)	0	
3-3.9	24	10	(42)	9	(38)	5	(20)	0	
4-4.9	13	3	(23)	7	(54)	3	(23)	0	
8-8.9	12	3	(25)	6	(50)	3	(25)	0	
9-9.9	19	4	(21)	10	(53)	5	(26)	0	
10-10.9	14	6	(43)	7	(50)	1	(7)	0	
11-11.9	20	3	(15)	10	(50)	7	(35)	0	

TABLE 3.5
CLASSIFICATION OF WEIGHT-FOR-HEIGHT IN CHILDREN: SAN FRANCISCO SOLIS

Age	N	% Adequacy of Weight-for-Height 70-79		80-89		90-99		100+	
		n	(%)	n	(%)	n	(%)	n	(%)
0-.9	17	0		1	(6)	12	(71)	4	(23)
1-1.9	11	2	(18)	1	(9)	6	(55)	2	(18)
2-2.9	20	0		5	(25)	15	(75)	0	
3-3.9	24	0		0		22	(92)	2	(8)
4-4.9	13	0		3	(23)	9	(69)	1	(8)
8-8.9	12	0		0		10	(83)	2	(17)
9-9.9	19	0		2	(11)	16	(84)	1	(5)
10-10.9	13	0		0		12	(92)	1	(8)
11-11.9	17	0		2	(12)	14	(83)	1	(6)

The children in San Francisco Solis have a very high proportion of low height-for-age. Approximately three-fourths of the children are short for their age. While the situation is somewhat better for weight, 47% of the preschoolers and 66% of the school age children have low weights. As would be predicted in a population with chronic but not acute low intake, the majority of children are within normal limits on weight-for-height.

C. Physical Activity of Women

The survey of physical activity patterns was intended as a test of whether women would be willing and able to provide information on their daily activities. Twenty four families with a child between 8 and 12 years of age, representing a range of socioeconomic status, were selected for this substudy.

The activity interview schedule consisted of two parts:

1. A timetable of activities, divided into two time periods:
   - "morning" (before comida) and
   - "afternoon" (after comida)

2. A series of questions concerning the nature, duration, and seasonality of activities.

Specifically, the interview elicited information on the following features of activities: amount of time devoted to an activity; number of days per week it was typically carried out; the rhythm (with or without interruptions); body position(s); conditions of terrain in which activity took place; amount of weight carried; effort; level of fatigue; description of the elements of the activity; periods of rest; and seasonal variations.

The interview required approximately 35 minutes to complete and was carried out in respondents' homes.

The major activities described by the women in the study were as follows:

1. Tending a store (eg. taking articles from a shelf, putting them on the counter), which involves primarily walking, sitting and kneeling.

2. Breast-feeding, which involves sitting during the day or lying down at night.

3. Sewing (mending by hand or with a machine, or weaving wool or cotton), which is carried out in a seated position.

4. Milking cows, which is an activity done while seated.

5. Ironing clothes (mainly standing).

6. Washing dishes (washing utensils used in serving or preparing food, cleaning, rinsing and drying), which is mainly done while standing.

7. Stripping kernels of maize from the cob, an activity done while seated.

8. Cooking (including lighting the stove, cooking or heating food, sometimes with a wood fire), which is primarily a standing activity.

9. Making tortillas (placing the dough in a press, cooking the tortilla, and placing it in a container), which is primarily a seated activity.

10. Caring for children (bathing, dressing, combing hair, changing diapers, and feeding), which are mainly standing activities.

11. Cutting weeds and grasses for animal feed, which requires bending and walking.

12. Caring for animals, which includes giving water and food, taking them to pasture, and cleaning their quarters.

13. Carrying milk in buckets.

14. Washing clothes, which includes soaking the clothes the day before washing them, scrubbing, rinsing, and hanging them to dry.

15. Cleaning house, including sweeping, bed-making, and cleaning furniture.

16. Going to the mill to have maize ground, which requires carrying heavy buckets of pre-soaked corn to the mill and back.

17. Gathering firewood (walking to the hills, gathering or cutting wood by hand, making a bundle, putting it on an animal or carrying it on the back).

A chart was constructed showing, for each informant, the number of days each activity was performed per week and the amount of time devoted to each activity per day and per week. Number of hours worked per day, as well as sleep and rest, were also recorded.

D. Results

The results of the activity survey showed that housework occupies a substantial amount of most women's time. Cooking required more time than any other activity, on average more than 9% of the total working hours in a week. All respondents reported cooking seven days a week. All but three women wash dishes daily, devoting four percent of their time to this activity and another six percent to cleaning house. Washing clothes required an average of 7.7 hours per week. The number of days per week spent on this activity varied from two to six days. Those who spent fewer days washing, spent more hours on the activity on wash days.

Generally women reported stripping maize off the cob and making tortillas three to four times per week. The amount of time devoted to stripping the cobs varied from 15 minutes to one hour, whereas making tortillas required one to five hours per day.

Seven of the women in the survey were breast-feeding, an activity that required an average of nearly 10% of their time.

All but one respondent reported spending some time during the week caring for animals. Twenty said they cared for animals seven days per week, but the amount of time spent in this activity varied considerably from 15 minutes to seven hours per day.

The activities least often performed were milking, carrying milk, cutting animal feed, and gathering wood. Two women tended a store, working either 10 or 13 hours per day. However, since other activities were performed simultaneously with tending a store, it is difficult to interpret the energy demands represented by this activity.

III. DISCUSSION

The pilot study was not designed to test hypotheses about the relationship of food intake to functional outcomes. Rather, its purposes were to train field staff in the appliciation of research tools and instruments, to assess the community response to our research procedures, and to provide feedback on the effectiveness and feasibility of the proposed measures. A variety of methods were used for training, quality control, and interviewer reliability testing. Most of the interviews were tape-recorded so that problems could be detected and retraining or modification of the protocols could be implemented.

In the analysis of the data sets from San Francisco Solis there were a number of strong correlations, including the following:

For female household heads:

kcal/day and wt/ht squared:	r = .68 (n=20)
kcal/day and kcal cost of activity/day:	r = .61 (n=15)

For adult males:

kcal/day and wt/ht squared:	r = .58 (n=17)

For school children:

kcal/day and wt/ht squared:	r = .77 (n=20)
kcal/day with mother's kcal/day:	r = .64 (n=22)

The data from Phase I, both from the four primary research communities and from the pilot study, provided the clear evidence that there was a range of variation in nutritional status in the valley's population. Ethnographic data, food intake data, and anthropometric data confirmed a substantial incidence of low intake and small body size. The socioeconomic context of the nutritional picture emerged clearly; the people of the Solis Valley are a rural population pursuing a mixed strategy of subsistence agriculture and wage labor. In this respect the valley population is representative of many contemporary, marginally nourished Third World peoples. The Phase I activities also demonstrated that, while we could expect some difficulties, the basic protocols were feasible and generally acceptable to the people of the communities. Finally, the data and the experiences gained in gathering them were used in meetings of the Scientific Coordinating Board to guide the final study design.

PART II

MEXICO CRSP PHASE II METHODOLOGY

Chapter 4

PHASE II METHODS: OVERVIEW

I. INTRODUCTION

The Phase II research involved collection of a variety of types of data ("data areas") from January, 1984 through June, 1987. These included data on individuals (census, food intake, anthropometry, morbidity, clinical and laboratory data, resting metabolic rate, psychological development and performance, and activity studies); household-level variables (mortality, household sanitation, SES and migration measures, agricultural productivity, and family activity); and community-level variables (ethnography, food prices, and climate). Most data were collected repeatedly (longitudinally) according to differing schedules, with the objective of obtaining data over a one year period in the specified data areas.

Chapters 5-16 provide details of the protocols for data collection in each of the data areas. An outline of the data collection schedules by type of individual is provided in Table 4.2 at the conclusion of this chapter.

II. FIELD STAFF

The research was conducted by teams devoted to specific areas. These were headed by "jefes de area" ("Area Chiefs"), who were professionals trained in their respective or related fields. Teams were staffed by professionally trained workers and auxiliaries. A number of staff on some teams (e.g. anthropometry, food intake) were recruited from the Solis region. The project also employed general support personnel (drivers, cooks, etc.), most recruited locally in the Solis Valley. A varying number of project staff (data management, laboratory, and administrative personnel) were based in Mexico City at INN. The structure of the field staff, as constituted for most of Phase II, is provided in Figure 4.1.

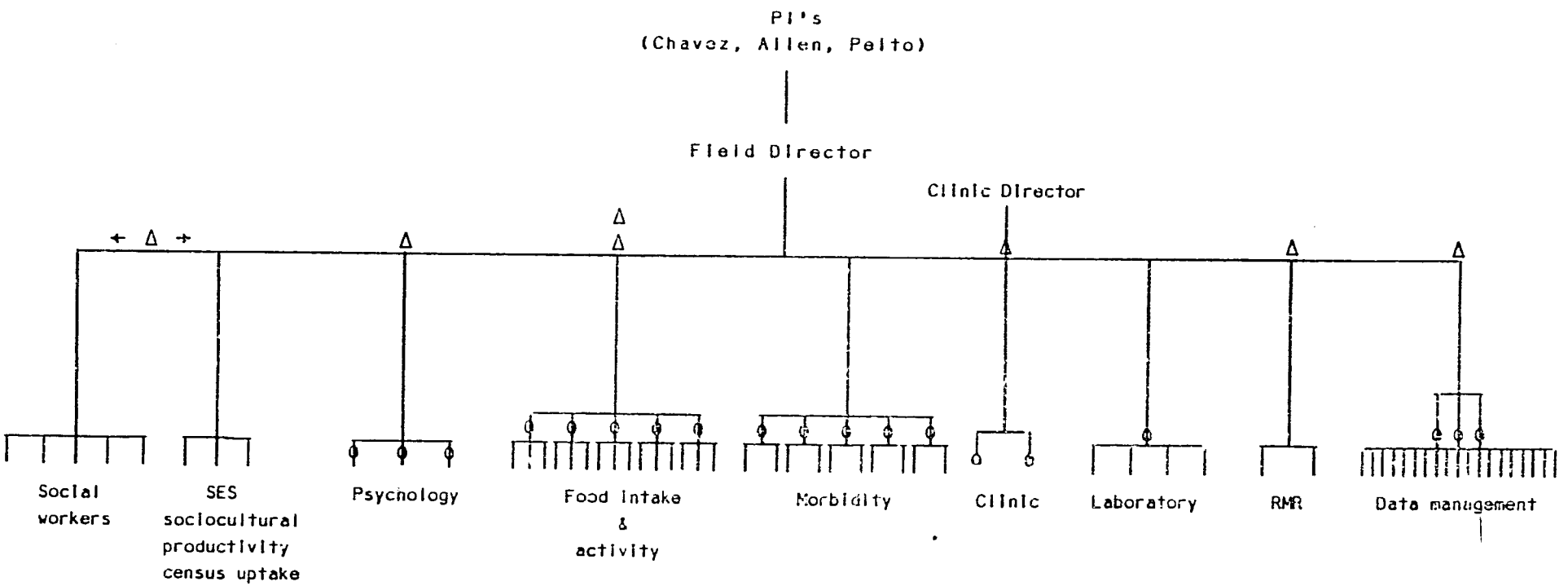
The field staff was housed in facilities of the exhacienda in the community of Solis. Teams traveled in project vans to research communities each morning (Monday through Saturday). Some data (e.g. RMR, laboratory samples, clinical examinations) were collected at the clinic in Solis.

III. TARGET GROUPS

Several types of individuals were identified as the "target groups" of the study. Data collected on all targets included census information, food intake, anthropometry, morbidity, clinical history and examinations, laboratory data, psychological tests and/or observations, and social and sanitation data from their households.

FIGURE 4.1

GENERAL PROGRAM STRUCTURE



KEY

Δ Chief of Area

O Professionally-trained worker

| Local personnel

The target groups were defined as follows:

Infants: Individuals from birth to six months of age. When possible, these infants were followed to eight months of age.

Toddlers: Children from age 18 - 30 months. Some data were collected on children as young as 15 months, but toddler "analyses files" were restricted to data from children aged 18-30 months with a several week overlap at the younger and older ages.

Schoolers: Children from aged 7 - 9 years, with a several week overlap on both limits.

Adult Females: Mothers of target children and/or women who became pregnant and whose infants were anticipated to become part of the study, also referred to as **Lead Females** of "target households." Frequently, adult females changed physiological status during the study. Thus, subgroups of adult females which had to be separated for most analyses included non-pregnant, non-lactating (NPNL), pregnant (only), lactating (only), and pregnant and lactating females.

Adult Males: Also **Lead Males**. Fathers of target children and/or husbands of target adult females.

IV. RECRUITMENT AND MAINTENANCE OF THE SAMPLE

Using age and household composition data from the census, households were recruited from four communities (San Miguel, Cerritos, San Nicolas, and San Antonio) in the Fall of 1983. Two additional communities were added later in the study (Calderas, July, 1984 and San Jose, April, 1985) in order to reach the CRSP goal of 100 individuals of each target type. The majority of households in the last two communities were chosen for the presence of pregnant women and toddlers. The need for these additional communities had not been anticipated from the demographic data collected in the Valley in 1982. However, the birth rate fell substantially during the next two years.

The criteria for initial selection of the households included: 1) presence of male and female head of household and, 2) at least one target child. All households meeting these criteria were approached by the chief social worker and/or physicians in the study, and asked if they would participate. They were given (and where necessary, read) a letter describing the purpose of the study, the kind of participation that was needed, and a statement that their withdrawal from the study at any time would not prejudice their medical care or access to the Solis clinic. Those households who agreed to participate at this point were then entered into the interview process. They were also given special "medical cards" showing that they were eligible for free or discounted medical care at the Solis clinic.

The timing of the actual entry of target subjects into the interview schedules was dependent on a number of factors. Table 4.1 shows the pattern of recruitment by individual type for all subjects. The initial group selected was predominantly households containing schoolers. Starting in May, 1984, households with toddlers and pregnant women were added, if the toddler was 18 months or the woman was less than five months pregnant. During the rest of the study, pregnancy testing was done every three months to recruit more pregnant women, and additional toddlers were added as they reached 18 months of age. When it became clear that less than 100 pregnancies, infants, and toddlers would be recruited from four communities in the time permitted, the two additional communities were recruited. Some households were studied for more than one year, usually because the mother of a target toddler or schooler became pregnant, or a non-target child reached 18 months of age in a household initially recruited for target schoolers or pregnancies.

Recruited households that later declined to participate usually did so after the first few interviews. The project staff held monthly review and scheduling meetings during which each household was assessed in terms of adequacy of data and accessibility of household members. At this time, the decision was sometimes made to drop households from the study

because of frequent absence of target females, or unwillingness of the families to participate. Reasons for such decisions were recorded.

Considerable effort was expended on maintaining good relationships with the communities and study households. In addition to the initial discussions with community leaders and households about the purpose and importance of the project, community fiestas, etc., a crucial strategy was to assign project staff to be "responsible" for each study household. During 1984, these responsible individuals were the project social workers who were assigned to each community. From January, 1985 onwards, the responsible person was the nutritionist assigned to the specific household. These staff members were responsible for checking the monthly interview schedule for each family, informing the household of when visits were to be made, rescheduling interviews when necessary, arrangement of transportation of household members to the Solis clinic for RMR tests and medical exams, and collection of urine and fecal samples. The use of one staff person for all of these responsibilities greatly reduced confusion and scheduling problems, and minimized intrusion into the households. In turn, the households turned to this staff person for help in medical and other family emergencies, transportation problems, etc. The Field Director usually became involved at this point to ensure that the project was as helpful as possible within the obvious constraints involved. One of the most valued and usual ways that assistance was given was transportation of a seriously-ill household member to Mexico City and provision of medical treatment at the INN hospital.

V. DATA MANAGEMENT: OVERVIEW

A detailed description of the overall Phase II data management system is provided in Chapter 17. Data management procedures utilized in specific data areas are described in the respective methodology chapters (5 - 16). A summary of certain key elements of data management in the project will be useful here.

Data collected by interviewers were recorded on forms either in the course of the interview or soon after. Data from laboratory assays, RMR measurements, etc. were recorded on data forms as assays, etc. were completed.

Coding was necessary in some data areas. Generally, coded values were entered onto separate forms for computer entry. In most data areas, little or no coding was necessary and data were entered directly from the interview forms utilized in the field. Interview schedules, data forms, and code sheets were stored in the field headquarters at the exhacienda Solis.

Most of the data were keypunched at the Mexican Public Health Department's data center (Salud Publica) in Mexico City. Some small datasets were keypunched using microcomputers in the field (Apple IIs) or at INN facilities in Mexico City. Error checking and correction of computerized data were done at INN and the IBM Scientific Center (Centro Cientifico), also located in Mexico City.

Data were transfered for further checking, processing and analysis to the University of Connecticut. Most data were sent on magnetic tapes, but floppy diskettes were also employed. Data were subsequently transferred to the Management Entity at UC. Berkeley for archiving and to statisticians at the University of Massachusetts for specific analyses.

TABLE 4.1
ENTRY* OF TARGETS BY MONTH

	Infants	Toddlers	Schoolers	Adult Males	Adult Females
1984					
January	--	3	67	77	95
February	--	--	17	24	22
March	1	--	12	12	9
April	--	34	16	10	8
May	--	9	2	1	1
June	--	2	6	2	1
July	--	13	41	38	45
August	--	8	22	21	25
September	--	6	6	14	10
October	3	14	5	14	13
November	31	18	1	14	17
December	16	4	3	3	3
1985					
January	6	2	--	6	--
February	13	16	--	8	5
March	8	14	--	11	12
April	6	14	--	4	12
May	6	1	--	18	10
June	13	--	--	--	--
July	8	--	--	--	--
August	7	--	--	--	--
September	2	--	--	--	--
October	5	--	--	--	--
November	8	--	--	--	--
December	1	--	--	--	--
TOTAL	134	158	198	288	290

* Date of first diet or anthropometry data, "cross- sectional" sample (see chapter 18)

TABLE 4.2:
DATA COLLECTION SCHEDULES

	Infants	Toddlers	Schoolers	Adult Males	Adult Females (NPNL*)	Adult Females (Pregnant)	Adult Females (Lactating)
CENSUS	1/yr	1/yr	1/yr	1/y	1/yr	1/yr	1/yr
FOOD INTAKE	2/mn	2/mn	2/mn	2/mn	2/mn	2/mn	2/mn
ANTHROPOMETRY	1/mn	1/mn	1/3mn	1/3mn	1/3mn	1/mn	1/mn
MORBIDITY	1/wk	1/wk	1/wk	1/wk	1/wk	1/wk	1/wk
CLINICAL DATA							
Clin. Hist.	1	1	1	1	1	1	1
Physical Exam	1/3mn	1/3mn	1/3mn	1/3mn	1/3mn	1/mn	1/mn
LABORATORY DATA							
Fecal Analysis		1	1/3mn	1/3mn	2	1/3mn	23
Urinalysis	-	-	-	2	1/3mn	2	3
Hematology	-	1	1	1	1	2	3
RMR†	-	-	1	1/3mn	1/3mn	2	4
PSYCHOLOGY							
Brazelton	1	-	-	-	-	-	-
Bayley	1	3	-	-	-	-	-
IBR‡	1	3	-	-	-	-	-
Interaction Obs.§	2	3	-	-	-	-	-
Schoolyard Obs	-	-	2	-	-	-	-
Classroom Obs.	-	-	2	-	-	-	-
Cognitive Tests	-	-	2	1	1	1	1
SOCIOCULTURAL	-	-	-	1	1	1	1
ACTIVITY STUDIES							
Adults	-	-	-	2/mn	2/mn	2/mn	2/mn
Mother-Toddler	-	1/mn	-	1/mn	1/mn	-	
HOUSEHOLD DATA							
SES and Migration	1/year						
Agri. Prod.**	2/year						
Sanitation	2/mn minimum, observed by interviewers						
Family Activity	1/study						

* NPNL = Non-pregnant, non-lactating.

† RMR = resting metabolic rate

‡ IBR = Infant Behavior record

§ obs. = observations

** Agri. Prod. = Agricultural Productivity

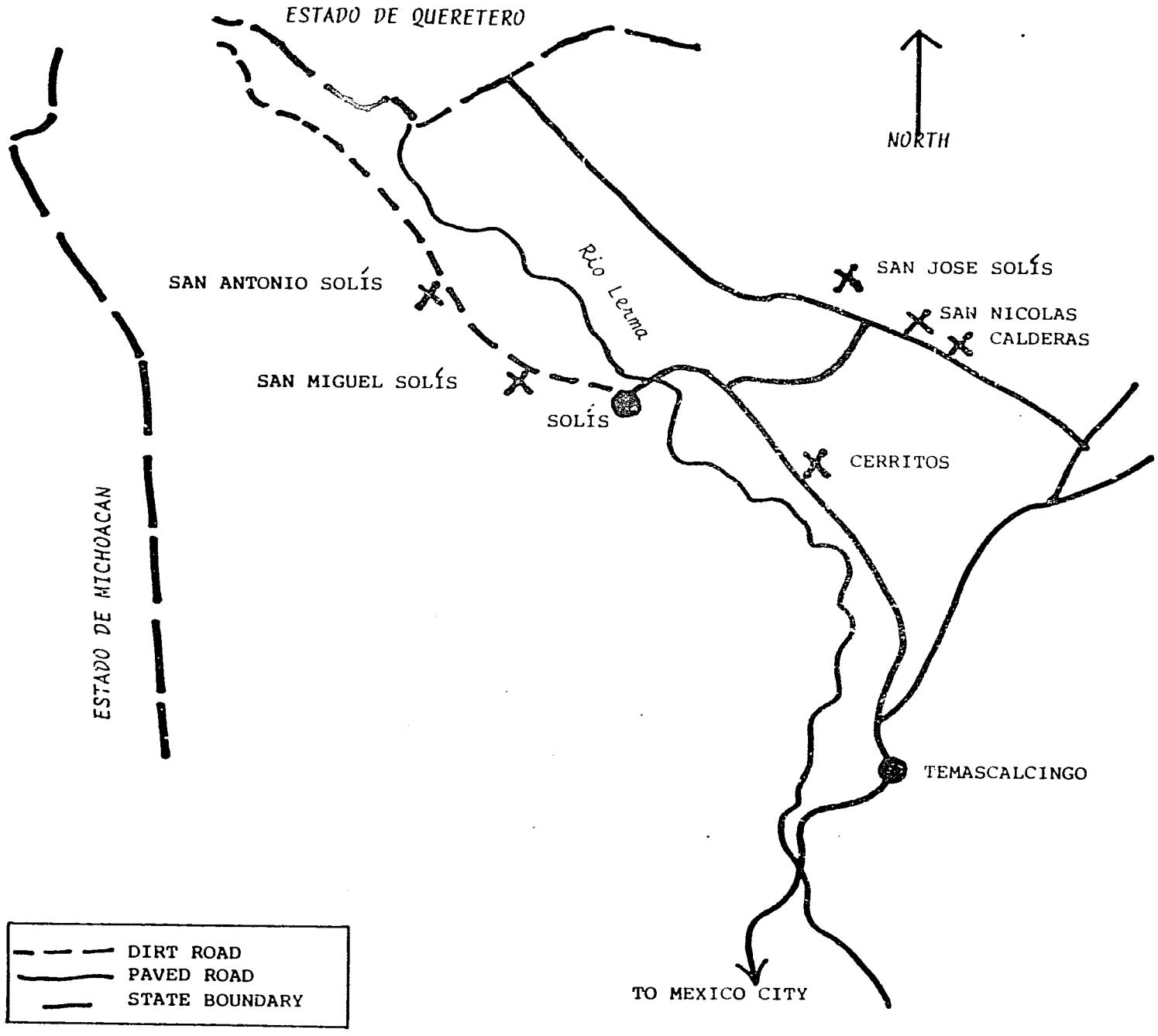


FIGURE 4.2: LOCATION OF THE RESEARCH COMMUNITIES

Chapter 5

CENSUS METHODS

I. PURPOSE

The community census provided a basis for recruiting families into the study, provided demographic information on individuals and households, and supplied data on the population of study communities.

II. DATA COLLECTED

Data collected included description of the household location in relation to a community map (including community, sector, and house number); information on individuals comprising the household (including full name, i.e., first name and last names of father and mother); sex; position in the family relative to household head; birth date and type of documentation of birth date; birthplace; principal occupation; and ability to read and write.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

Households to be interviewed for census data were identified by the Area Chief for Census and SES. In 1982, she drew up a complete map of the initial four communities. Each dwelling was then assigned an identification number. Communities were divided into sections. Community maps were then drawn up to indicate sections and locations of all dwellings, as well as the locations of roads, paths, and community landmarks.

Data were collected during interviews in homes of respondents and recorded on the standard census form utilized for all studies in the Division of Community Nutrition at INN. The interview was conducted by a team of two interviewers. One questioned the respondent, while the other recorded responses. On the following workday, interviewers returned to previously interviewed households to fill in missing data. When birthdate documentation was missing, the Area Chief visited the family to explain the need for accurate birthdates. This usually resulted in her viewing the available birth records. If none were available, this was noted on the census file.

The first census of the four communities initially selected for the study was carried out in September and October, 1983. A recensus was made of these households in 1984, at which time the initial census of a fifth community was also conducted. These data were utilized to update the 1983 census file in the computer. At the end of data collection in 1986, households in the first five communities were re-interviewed and those in the sixth community were initially censused. A final census was constructed by correcting the initial census where necessary and adding data on individuals born since 1983.

The methodology of the first recensus followed the procedure described except that the request for birthdate verification was not made. Birthdate documentation was requested at that time only for children born since 1983.

B. Personnel Training and Supervision

Following the pretesting of the census protocol (carried out in 1983 in one village), the Area Chief recruited high school students from a nearby town, training them in the procedures for conducting census interviews. The Area Chief accompanied the interviewers to each community, waiting at a local temporary headquarters for interviewer teams to return from the households to check completed forms with them. The final recensus was carried out by Community Health Aides who had worked in the community health outposts since the beginning of the project. They were trained by the Area Chief.

IV. DATA QUALITY CONTROL

A. Primary Coding of Data

Census data were entered directly onto census forms by one of the interviewers on the census team.

B. Error Checking and Correction of Data

After the interview teams had completed several interviews, the Area Chief reviewed each form with them, discussing ambiguous or doubtful entries. When necessary, revised data were collected the next workday by the interview team. Data were entered into the computer directly from the interview forms, initially in Solis (using Apple computers). A printout of this computer file was visually checked against the raw data. Errors noted were corrected. Later, the corrected data were transferred to tape via mainframe file at IBM Centro Cientifico, where updates were entered as needed.

Chapter 6

FOOD INTAKE

INDIVIDUAL AND FAMILY INTAKE

I. PURPOSE

Food intake data were collected in order to measure the nutrient intake of target individuals within households. In addition, family food intake can be estimated from the amount of food in household recipes plus non-recipe foods consumed each day, divided by the number of persons consuming in the household (weighted by age, sex, and size). In this way, households can be ranked in terms of nutritional adequacy, and their food patterns and behaviors described.

II. DATA COLLECTED

There were four main parts to the interview, which elicited data from two consecutive 24-hour periods each month. These were: a record of the household members and which meals they consumed; a list of foods and recipes prepared and the proportion of each consumed by the household; a record of the amounts of ingredients used in each recipe; and the weight of each food or recipe consumed by the target individuals.

From these data the intakes of the following nutrients were calculated: calories, protein (g), fat (g), carbohydrates (g), calcium (mg), iron (mg), thiamin (mg), riboflavin (mg), niacin (mg), ascorbic acid (mg), and vitamin A (ug eq). The nutrient data base is complete for all foods, except for some local herbs and teas.

III. DATA COLLECTION PROCEDURES

The method used for collection of dietary data during Phase II was chosen for several reasons. While it is generally accepted that there is no perfect method for the measurement of food intake, observation and direct weighing of intake are assumed to be the most precise (although the interviewer could affect the usual behavior of the subjects). The considerable experience of the INN personnel, and of project personnel during the Pilot Study and Phase I, clearly demonstrated that the majority of households would refuse to accept the continuous presence of interviewers in their home. The method chosen was adopted after considering: i) meal patterns in the communities and the percentage of daily intake consumed at each meal; ii) the amount of cooperation that could be expected from the respondents; iii) the number and cost of interviewers required; and iv) the accuracy of the method. The latter was tested by a series of validation studies. The method combined recording by subjects, weighing by interviewers, and recall by mothers, i.e. it was a "recall/record/weighing" method.

A. Interview Structure and Administration

The full procedure spanned a three-day period each month to capture 48 hours of information. Interviews were conducted in the homes of study participants, with the female head-of-household as the respondent. The procedures outlined below for each component were repeated for two 24-hour periods. If it was not possible to conduct the second interview in the subsequent 24 hours, it was rescheduled for the appropriate weekday of the following week.

On Day 0, the interviewer went to the house between 10 a.m. and 4 p.m. to schedule visits to be made over the next two days. The household was provided with a form, prelabelled with subject's names, which had to be filled out for target subjects by a "recorder" in the family (usually the schooler, the father, or the mother if she was literate). The recorder listed the type and approximate amounts of food consumed after the main meal of the day (mid-afternoon) and before bed-time. These data were then used by the interviewer to prompt the respondent, eliciting more precise recalls on the following day. Unless such "prompts" were used, the respondents tended to forget what they had consumed on the previous evening; the evening meal is usually small and often based on left-overs eaten casually. The household was also given blank prelabelled forms onto which target subjects stuck red adhesive circles, one per tortilla consumed. The number of tortillas eaten per subject per meal was counted by the interviewer for each 24-hour period. This procedure improved the accuracy of subjects' reports of tortilla consumption.

In the afternoon of Day 1, at the end of the first 24-hour period, the interviewer arrived at the house and questioned the mother about her health. If the respondent was not well, the interview was either rescheduled or continued, if she was willing. Failure to consent to the interview because of illness was a rare event, and a record was made when this occurred The following four sections of the diet interview were then completed.

1. Meal Attendance. This form was completed once per 24-hour food intake period, in order to register the number of individuals at each meal and thereby obtain the denominator for household food intake. Before the interviewer went to the field, she filled out all names and identification codes of target subjects. Mothers were asked who had consumed each meal in the previous 24-hour period. This information was entered onto the prelabelled form and used to prompt respondents into recalling all individuals who were present in that 24-hour period. Infants were not identified on this form because their intake was assumed to be minimal. The identification number (ID) of the male head-of-household was entered on the form even if he was absent that day. If he had left the house for the day, then the notation "did not eat" was inserted at the appropriate meal times. Non-family members present at meals were always assigned an ID of 9999 or 0000, respecting the wishes of households who did not want their visitors identified. For each family member, the mother was asked the amount consumed per meal (nothing, little, or normal). (These data will be compared by health status (morbidity recalls) as an additional measure of the effect of illness on food intake).

2. List of Foods and Recipes Consumed. This form was completed once per interview period, either 24 or 48 hours. The mother was asked not only what foods were prepared for each meal, but also if the meal consisted of leftovers, the proportion of each recipe used per meal, and what proportion was left over at the end of the interview period. Recorded data included: the name of the recipe or food, a number assigned to the recipe or food item (numbered in order of preparation or consumption), the meal(s) at which it was served, and the proportion of recipe served per meal. Responses, based on respondent recall, were entered to the nearest 25% of the original recipe. The purpose was to keep a continuous check on whether or not 100% of a recipe or food was eaten during the interview period. This form, not used until September, 1984, helped interviewers to record difficult situations such as the use of previously prepared leftovers and portions of prepared recipes left over at the end of a collection period. The effect of adding this form on the measurement of nutrient intakes is discussed in Chapter 20, section II.

3. List of Ingredients and Amounts. The same foods and recipes listed in the second form (above) were described in more detail by the respondent. The cooking methods were also noted where relevant (boiled or fried, in the case of beans, rice, and pasta), and the weight of the foods and recipe ingredients in grams. This information was obtained by weighing ingredients when possible, and weighing utensils containing the amount used (Pelouze Scale Co., Evanston, IL). If the items were not available in the household then the size and type of the ingredients (e.g. fruits, vegetables, spoonfuls, etc.) were described by the respondent. These values were later assigned weights by referring to a table that

had been developed by weighing food items of various sizes available in the community. Ingredients and non-recipe foods were coded using the codes in the Mexican Food Composition Tables (6.1).

4. Individual Intake Form. On this form were listed, in grams, the amounts of recipes or food items eaten by each target individual. In most cases, these amounts were the portion size served by the mother. Preliminary studies of the validity of the food intake methodology showed that the mothers were remarkably accurate in their ability to demonstrate the portion size of a recipe that they served to each target individual, or that the target persons served to themselves. The monotony of the Solis diet is relevant in this regard. The mother usually had some of the recipe or foods left (since the interview was done just after the main meal of the day) and would provide a portion of the relevant size in the plate as served to each target. The interviewer then weighed the size of the portion. When no food preparation was available the bowl was filled with water to the level indicated by the respondent. The number of tortillas consumed was recorded from the "tortilla forms" and ten tortillas weighed each day so that an average weight per tortilla could be obtained for the family. Specific variables recorded were meal times, recipe codes, and weight in grams of consumed portions of each recipe or food. Also listed were the total amounts of non-recipe foods consumed by the entire family.

B. Interview Schedule

Interviewers went to each household on 3 consecutive days per month to obtain 48 hours of information. Fewer than 1% of the records were not obtained on consecutive days. A total of six different days of the week was included every three months. In virtually every case, each community was divided into three sectors for scheduling diet interviews, based on household location. For example, visits to houses in one sector were scheduled for Monday and Tuesday, in the second sector on Wednesday and Thursday, and the third, Friday and Saturday. This schedule was rotated monthly so that each household provided data covering Sunday evening through Saturday afternoon. In Phase I of the project, attempts were made to collect dietary data between Saturday evening and Sunday afternoon. However, the majority of households objected strongly to this intrusion. The main reasons for this were the presence of the male heads of households in the home on the weekends and the need for privacy on Sunday. Thus, the average nutrient intake values do not include intakes for that 24-hour period.

No other types of interviews were conducted on the same day as diet interviews except for occasional morbidity recalls. The nutritionists also made observations on sanitation and hygiene as described in Chapter 14.

C. Personnel Training and Supervision

The data were gathered by high school educated "auxiliaries" in 1984. The auxiliaries and new nutritionists underwent an intensive training period of one-to-two months duration, supervised by trained, licensed nutritionists. During this time, they learned all phases of methodology, which until October 1984 included hand-calculation of the weights of foods consumed by individuals. From January to December 1984, trained nutritionists supervised the auxiliaries in each community. This frequently involved accompanying the auxiliaries on their household visits, observing their interview techniques, checking interview forms on the same day as the interview, and listening to tape recordings of interviews when auxiliaries were unaccompanied. From January 1985 onward, auxiliaries were no longer used to collect dietary data. Instead, the trained nutritionists conducted the interviews. These interviewer changes were part of a general reorganization of the project intended to raise the morale of both the staff and the respondents. A licensed nutritionist was assigned to each household as the project staff member responsible for project-household communication. The nutritionists, several of whom had been supervisors during the previous year, were now supervised by the Chief Nutritionist, while the auxiliaries checked interviews for missing or miscoded information. Additional team members in Solis checked ID numbers against the sample census for each family and individual. The effects of these interviewer changes on nutrient intakes are presented in Chapter 20, section II.

IV. ADDITIONAL NOTES ON PROTOCOL

Because some of the frequently consumed Mexican dishes lose substantial but variable amounts of water during cooking, and the total volume of the cooked dish was not measured, it was not useful to ask respondents about the volume of water used in recipes. Specifically, such dishes are beans (boiled and fried), pasta, and rice (boiled and fried). For these recipes, we recorded only the weight and/or volume of all ingredients used except water. These values were later multiplied by conversion factors (CFs) to estimate the ingredient's wet weight in the cooking pot once cooking had been completed. This multiplication was done during the computer conversion to nutrients when the proportion of a recipe consumed by an individual was calculated.

The CFs were based on data obtained during a special sub-study designed for this purpose. An interviewer went to 32 households to observe the preparation of rice, pasta, and beans. After ascertaining the list of ingredients used in a recipe, the usual method of preparing the dish, and the presence of all the necessary ingredients, each item was weighed or measured during the recipe preparation procedure. The pot was weighed three times: empty, and with all ingredients both just prior to cooking and just prior to serving the prepared food. Approximately 100 g of well-mixed sample was taken from the pot immediately before serving. This was transported to the Solis laboratory in plastic bags, from which approximately 20 g (in duplicate from each sample) was placed into previously dried aluminum weighing pans. Each sample was then weighed and dried to determine water content. Although the percent water in each food sample was not necessary for computing the conversion factors, it was used to: i) compare the effects of various cooking procedures on water loss during cooking; and ii) measure the variability of water content among cooked food samples. The latter was surprisingly low, supporting the use of an average Conversion Factor for each type of prepared food.

No attempt was made to obtain multiple samples from the same household. While this may have identified some individual women who consistently cooked their recipes to the same water content, it was unlikely and unverifiable that all women would be consistent throughout the longitudinal study. Therefore, an average conversion factor was applied to each type of recipe, rather than using different conversion factors for each household.

Conversion factors were calculated from the following equation:

CF x Weight of dry pasta (or beans or rice) = (weight of pot + contents after cooking) - (weight of pot + weight of all other ingredients in the recipe except pasta or water).

Average (mean) CFs were calculated for three commonly eaten foods with varying amounts of water loss: for cooked beans, 3.69 (range 2.18-5.39); for pasta, 4.93 (range 2.47-7.49); and for rice, 3.58 (range 3.33-3.80). Values used formerly by INN were 3.57, 2.27, and 3.33, respectively.

V. DATA MANAGEMENT

A. Primary Coding of Data

ID numbers were entered in Solis or in the community office before interviewers went to the households with precoded forms. Food codes were entered by the interviewers when they returned to their respective community offices immediately after leaving the household. Descriptions of foods (e.g., one tablespoon, a medium orange, etc.) were converted to weights in the community offices, using a conversion table developed by weighing local foods. All other information was coded directly onto forms while interviews were being conducted.

B. Data Entry Procedures

From January to September, 1984, data were entered on Apple microcomputers in Solis. Individual intake of specific foods from recipes was calculated by hand and the food weights and codes entered onto a separate coding form. After

September, 1984, the data collection forms were revised (with no change in the food intake method) so that data could be entered directly into the computer, eliminating the need for any calculation of values in the field. After September, 1984, data were entered at Salud Publica in Mexico City, assisted by a data entry program that provided data entry fields for terminal operators, facilitated double entry of data, and prompted correction of key-punching errors.

C. Error Checking and Correction of Data

The error-checking team in Solis reviewed all IDs and names against a printout of the sample census, thereby identifying coding errors. These errors were marked on the printout after corroboration with the original interviewer, as needed. A complete listing of data entered in the computer was taken to Solis and inspected against the original interview forms to detect keypunching errors. These errors were marked directly on the printouts and returned to INN, so that the tape at IBM could be corrected. A series of computer-aided error-detection programs was developed in Mexico and used to detect additional errors. These errors, or questionable values, were returned to Solis after consultation with the head of the diet staff. The error-checking team in Solis then compared them against the original interview forms.

In Connecticut, extensive error-checking programs which focused on recipe name matching, food code name matching, range checking, and character string checking were developed. Supplementary checks were done to detect coding errors in recipes and amounts that appeared to be unreasonable, by examining the consistency among recipes.

From these programs two types of filters were developed -- one used for finding errors of all types, and a second, derived from the human review of the output of the first, for correction of the data when revised values were sent back from Mexico. Many of these programs were modified and used in both Mexico and in the US. These have been documented in a report that provides a description of the process, programs, and printouts. Errors and/or suspicious values detected using these programs were routinely recirculated to Mexico, where they were checked against original interview forms for coding and data entry errors. Corrections were recorded on the computer tapes at IBM Mexico and a new version of the tape returned to Connecticut. UConn programming personnel and Mexico programmers regularly worked in each other's computer facilities to coordinate the correction and analysis of this complex data set.

VI. DATA ANALYSIS

A. Food Composition Tables

The basic data bank for the conversion of foods to nutrients is that published and used by INN (6.2). The analysis of foods was done at INN, with additional values in the INN tables derived from the food composition tables of INCAP (Central America), INNE (Ecuador) and FAO (Food and Agriculture Organization). To the INN data base we (L. Allen at the University of Connecticut) added the nutrient content of an additional 67 foods. Of these, 25 were "prepared foods", such as cooked beans, cooked pasta, scrambled eggs, etc. A random sample of about 40 recipes from the community was used to generate the weights of each food used in a "standard recipe". The nutrients in the standard recipe were then calculated by adding the nutrient contents of the relevant weights of the specific foods. No subtraction was made for losses of vitamins and minerals that would occur during cooking. An additional 28 of the foods added were condiments, teas, and spices. The nutrient values for these were obtained from the USDA nutrient data base (6.1). The expanded nutrient data bank is now in use at INN.

The nutrient data base includes values for the following; edible portion (used to correct for the proportion of each food that is inedible), calories, protein, fat, carbohydrates, calcium, iron, thiamine, riboflavin, niacin, ascorbic acid, and retinol. Almost all of the foods in the data base are raw, so that nutrient content - especially of some vitamins and minerals - is overestimated in cooked dishes prepared from these foods.

The energy values in the tables were calculated by multiplying the protein, fat, and carbohydrate content by different factors for each food, depending on its digestibility, e.g. energy content of maize = (protein x 2.73) + (fat x 8.37) + (car-

bohydrates x 4.13) (6.1). In the case of maize, the energy factor for the carbohydrates in tortillas is certainly overestimated. The value for ground whole-ground cornmeal using the Atwater system (6.2) is 4.03 kcal/g (not 4.13 as used here). In addition, the Atwater value assumes a digestibility of 96%, which is also an overestimate, as will be discussed further in Chapter 20. Alcohol has an energy value of 7.10 kcal/g in the Mexican tables, slightly higher than the value of 6.93 kcal/g in the USDA tables. However, by far the majority of alcohol consumed in Solis is in pulque, which has only about 2% alcohol; most of the energy in this drink (which contains 43 kcal/dl) comes from carbohydrate (1.1 g/dl) and protein (0.4 g/dl).

B. Individual Nutrient Intakes

These were calculated for each target individual as a total per 24-hour period. A special Daily Summary was developed for each day of intake for each target individual. This analysis file contains all nutrients, as well as the daily intake of energy and protein consumed in defined food groups and specific food items. In addition, foods were categorized as being of "plant" vs "animal" origin and the individual Daily Summaries included the kcal count and grams of protein from plant and animal sources. "Animal" foods included: all foods in the INN tables with the food codes for meats, fish, eggs, dairy products, and chicken fat (rarely used); and those "prepared" foods that had animal products as a major constituent. There were relatively few foods in this latter group, but examples include: turkey with mole sauce, sausages, chicken, and beef broth. All other foods, including alcoholic beverages, were categorized as being of "plant" origin.

C. Family Food Intake Data

These values have not yet been calculated and are not presented in this report. In future analyses, it will be possible to calculate the relative food intake of each household, from the total consumption of food in each day corrected for (divided by) the number and size of persons who ate that food. Weights and heights of household members will be used to calculate their basal metabolic rate (BMR). Household energy intake will then be calculated as:

$$\text{Relative Household Energy Intake} = \frac{\text{Household Intake (kcal/d)}}{\text{HH BMR (kcal/d)}}$$

Age and sex of visitors could not be precisely determined, so these persons will be assumed to have a BMR intermediate between that of male and female values for adults (23-50 years old).

VII. VALIDATION OF FOOD INTAKE METHODOLOGY

A. Method

Initially, validation was conducted as two separate studies including 24-hour direct observations and weighing of food consumed, followed by the combined recall/record/weighing method (applied to the same 24-hour period) that was used throughout the study. Both validation studies were carried out by trained nutritionists on 30 families. As a result of the first validation study, modifications to the first method were made, including the use of the tortilla records. A third and final validation study was carried out in May and June 1986, at a time when both the families and the interviewers had become increasingly trained in gathering and recalling food intake data. The validation protocol was essentially the same for all three studies, and is described for the third validation as follows.

The 1986 validation study used 30 households, randomly selected from those still in the study as of March, 1986 or those who had been in the study until either November or December, 1985. In this way, it was possible to ensure that families used to validate the methods had not been out of the study for any extended period of time. In the evening of the first day, the nutritionist arrived at the household to observe, weigh, and measure all ingredients, foods and beverages prepared for consumption, and the amounts eaten by target subjects. Observations and weighings were made by the nutritionist who had been responsible for conducting the earlier diet interviews in that particular household. When leav-

ing, the nutritionist asked when the family was planning to eat the next morning, setting a time for her to begin observations the next day.

On the morning of the second day, the nutritionist again went to the household to observe, weigh, and measure all food and beverage preparations, and those items consumed by target subjects. That afternoon, she was relieved by a professional nutritionist from a different community who conducted the recall/record/weighing method that had been used during the study, collecting data on the same time period during which observations had been conducted. Nutrient and food intake were compared between the observation/weighing vs recall/record/weighing methods.

B. Results of the Validation Study

Mean calorie intakes of all target individuals combined were 2042 (observed) and 1902 (study method) kcal/day, and protein intakes were 55.3 (observed) and 50.6 (study method) g/day. These were not significantly different (T Test). There was no day-of-the-week effect on differences in intake.

Interviewer effects could not be analyzed since specific interviewers were scheduled either always on the first or second day. Thus, it is assumed in the subsequent analyses that interviewer effects are random.

Larger differences between the two methods occurred when intakes were higher. Scatter plots of the differences by type of individual indicate the expected unequal variance (Figure 6.1). Tests of difference were made on the ratios of method two (the Phase II method) to method one (observation and weighing) kcal and protein intakes (Figure 6.2) as well as the actual values of kcal and protein .

Difference Between Observation/Weighing (Method 1) and Recall (Method 2)

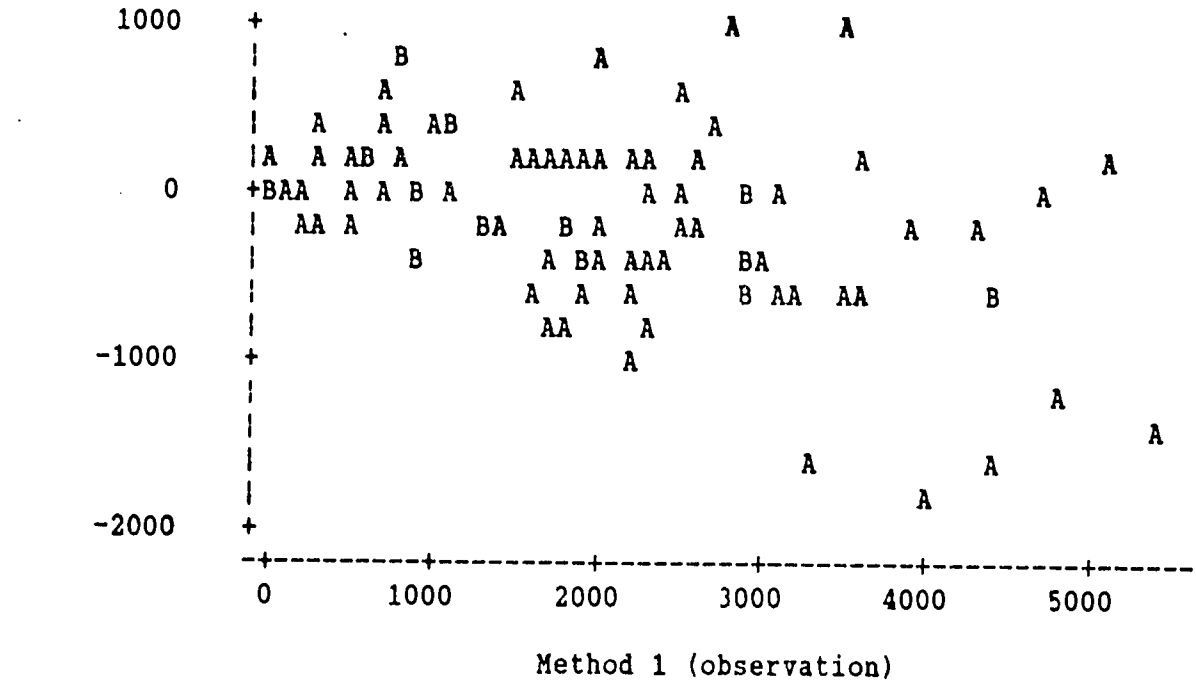
First, the actual difference in energy intake measured by the two methods was tested. A comparison of the difference between method 1 and method 2 is illustrated in Figure 6.1.

Since different subjects ate different amounts, the value of the actual difference in kcal has excessive variance, in that the subjects with larger values influence the estimates more than the subjects who eat less. Figure 6.2 illustrates the difference between the methods when it is expressed as the ratio of energy intake measured by method 1 vs method 2.

The ratio estimator appears to overcorrect slightly and does not have a normal distribution. Thus, two methods were used to analyze the differences in ratios; i) ignoring the bias, and testing whether the mean ratio was 1.0, and ii) subtracting 1.0 from the ratio and using a signed rank test of the hypothesis that this difference is zero. Table 6.1 provides a summary, by type of target individual, of the significance of difference between the two methods.

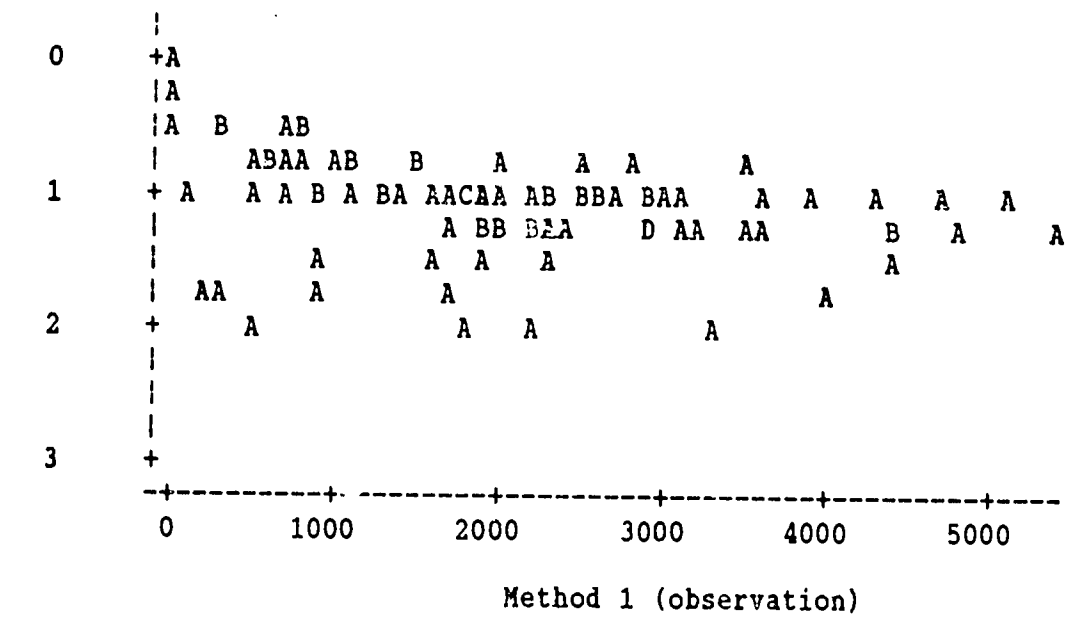
The conclusions are the same no matter whether actual difference, ratio, or (ratio - 1) are used as the basis of comparison. On average, compared to the observation method, the study method underestimated the energy intake of adults, but not of children. Eighty percent of subjects had recall values that were within 20% of those observed. Five of the adults (four men and one woman) had intakes that were about 1,000 kcal lower by the recall method. Closer scrutiny of their data showed that the difference was accounted for by underestimation of tortilla intake, and that these four persons consumed large numbers of tortillas, often two at once. Interestingly, there was no significant difference on average for any of the groups in the recalled vs observed number of tortillas consumed.

FIGURE 6.1: DIFFERENCE IN KCAL INTAKE BETWEEN METHODS 1 AND 2
ALL SUBJECT TYPES



LEGEND: A = 1 OBS, B = 2 OBS, ETC.

FIGURE 6.2: RATIO OF THE DIFFERENCE IN KCAL INTAKE, METHOD 1 vs 2
ALL SUBJECT TYPES



LEGEND: A = 1 OBS, B = 2 OBS, ETC.

TABLE 6.1
SIGNIFICANCE OF DIFFERENCES BETWEEN INTAKE METHODS

TYPE (n)	METHOD	KCAL/D	DIFFERENCE (p<) Method 2-1	MEANS OF RATIOS Method 2/1	RATIOS OF MEANS Method 2/1
ADULT M. (20)	1 (obs‡)	3144	- 312	.86	.90
	2 (rec§)	2832	(.05)	(.05)x	
				(.03)†	
ADULT F. (29)	1 (obs)	2766	- 224	.90	.92
	2 (rec)	2542	(.06)	(.02)*	
				(.04)†	
SCHOOLERS (11)	1 (obs)	1643	-105	.93	.94
	2 (rec)	1538	(.71)	(.40)*	
				(.45)†	
TODDLERS (18)	1 (obs)	1019	51	.98	1.05
	2 (rec)	1070	(.63)	(.85)*	
				(.86)†	
INFANTS (13)	1 (obs)	483	20	.91	1.04
	2 (rec)	503	(.67)	(.63)*	
				(.90)†	

* P value for test that ratio of recall/observation (method 2/1) is different from 1.0

† P value for test that ratio of (recall/observation - 1) is different from 0

‡ Observation Method

§ Recall Method

WEEKLY FOOD USE

I. PURPOSE

This questionnaire is unique to the Mexico project and has several purposes. It provides a semi-quantitative summary of foods purchased, grown at home, borrowed, or given away by the household during one week each month throughout Phase II. It can also be used to calculate household expenditures on food and to describe the food systems of the households. For those foods that are consumed infrequently (e.g. meat), data from this questionnaire may provide a better description of "usual" household consumption (amount per household per week) than the daily intake data.

II. DATA COLLECTED

Questions (referring to the previous week) elicited amounts of maize ground at the mill, each of a list of specific foods purchased, home-produced foods consumed, foods received as gifts, foods sold, borrowed foods that were returned, and foods given as gifts.

III. DATA COLLECTION PROCEDURES

The interview was conducted once per month, by a nutritionist, in the home of the target families. It was always done on a Monday or Tuesday so that purchases in the market (usually made over the weekend) would be recalled more accurately. The female head of household was the respondent.

IV. DATA ANALYSIS

These data have not yet been analyzed. Planned analyses include: total weekly expenditure on foods; per capita expenditures; dietary complexity; caloric and economic value of foods borrowed, given, home-produced, and sold; and per capita availability of foods.

FOOD PRICES

I. PURPOSE

The price of food was monitored on a monthly basis throughout Phase II in order to: i) convert reported expenditures on specific foods in the Weekly Food Intake to grams of food, and ii) examine the effects of food price changes on food purchasing, acquisition, selling, etc.

II. DATA COLLECTED

Prices of specific foods (those listed in the Weekly Food Intake questionnaire).

III. DATA COLLECTION PROCEDURES

Once per month, nutritionists went to a store in each community and to the government supermarket in town. They asked about the prices of the foods or recorded prices if shown.

IV. DATA ANALYSIS

These data have not yet been analyzed. They will be used to examine the effect of food prices on food-related behaviors.

REFERENCES

6.1. Hernandez, M, Chavez, A, Bourges, H. Valor Nutritivo de los Alimentos Mexicanos. Instituto Nacional de la Nutricion, Publicacion L12, 8a edicion, Mexico D.F., 1980.

6.2. United States Department of Agriculture. Composition of Foods. Agriculture Handbook No. 8 Series. U.S. Government Printing Office, Washington D.C., 1975-1986.

Chapter 7

ANTHROPOMETRY

I. PURPOSE

Anthropometric measurements were taken to assess the following: 1) child growth, 2) adult size, 3) body composition, 4) body changes during pregnancy and lactation, and 5) to create variables expressed per unit of body size (e.g., energy intake [kcal/kg] and RMR [kcal/kg/min]).

II. DATA COLLECTED

Anthropometric data include, weight (to 0.1 kg), height or length (to 0.1 cm), three circumferences, each to 0.1 cm (head, arm, leg), and four skinfolds, each to 0.1 mm (triceps, biceps, subscapular, and suprailiac).

III. DATA COLLECTION PROCEDURES

A. Structure and Schedule of Interviews

Anthropometric measurements were taken in the Solis clinic for male and female heads-of-households once every three months, and for any accompanying children. The adult measures were taken during the RMR protocol. In subjects' homes, anthropometric measures were taken on target individuals not attending the Solis clinic as follows: (a) adults, once every three months; (b) children, once per month; and (c) infants, at eight and 30 days, and then monthly. Measurements were taken of pregnant and lactating women, either in the clinic or at home, once per month. Newborns were measured at the Solis clinic. Additionally, all family members were measured in their home once, at the close of the study.

B. Personnel

A trained physician served as the Area Chief for Anthropometry and RMR, training and supervising two auxiliaries (one male, one female). The team of physicians and interviewers employed anthropometry data collection were trained under a physician from INN who was experienced in anthropometry. Training took a minimum of two weeks; the accuracy and precision of the staff, and intra- and inter-operator errors, were monitored by the method of Habicht (7.1).

C. Equipment and Methods

Weights of infants born in the Solis clinic were measured with a Salter infant scale. Older individuals, and infants in their homes, were measured on a battery-operated digital scale (Heathkit Co., Avon, CT.) accurate to 0.1 kg. Infants were held by their mother and her weight subtracted. The length of infants and toddlers was measured with a steel tape,

using wooden blocks to assist in the location of the top of the head and bottom of the feet. For older children and adults measured in the home, a plumb line was used against a wall to ensure that the steel tape was vertical. Subjects were asked to remove as much clothing as possible, and were usually weighed wearing pants, a blouse, skirt, etc. In all cases, shoes were removed. Circumferences were measured in duplicate with a flexible metal or plastic tape measure. Lange calipers were used to measure skinfold thicknesses in duplicate.

IV. DATA QUALITY CONTROL

To ensure accurate weighing of subjects, balances were calibrated before each set of measurements in a given locale. The Lange calipers were checked once per week with a calibration block. All skinfold and circumference measurements were taken and recorded in duplicate. Additionally, for every 10th schooler, all measurements were taken by one interviewer and then repeated by a second interviewer. (Because other individuals often refused to be subjected to repeat measurements, schooiers were the only subjects for whom such rigorous protocols were followed).

The Area Chief reviewed each completed data form with the auxiliary(s) who took the measurements. Data were checked by the Area Chief against previous values for the same subject and were flagged if there had been a reduction in height for infants, preschoolers, or schoolers since their last interviews, or if there had been an increase in height of 1 cm since the last interview. Any such suspect values were retaken within one day in the household by auxiliaries.

Precision and accuracy of measurements were calculated using the formula of Habicht (7.1). When needed, immediate retraining of auxiliaries/interviewers was conducted.

V. DATA MANAGEMENT AND ANALYSIS

A. Primary Coding of Data

No coding of anthropometric data was necessary because values were entered directly into the computer from interview forms.

B. Error Checking

Out-of-range values per measure were defined by subject type and were determined by a variety of processes, including referring to National Center for Health Statistics (NCHS) standards and selecting the upper- and lower-most percentiles. This, however, detected too many low values. Therefore, an iterative process was initiated whereby a value was judged to be reasonable if other measures from that particular individual confirmed its face validity, (e.g., a very short person would be expected to have a low weight, etc.). Of 6,774 measures, 88 out-of-range values were detected and returned to Mexico for correction against the original interview forms.

C. Conversion of Weights and Heights to Percentiles

An algorithm was obtained from the Center for Disease Control (Atlanta, GA) for the conversion of weights and heights of children to percentiles and Z scores. The Fortran program sent by the CDC was modified for our purposes, e.g. the original program produced values of "99.9" for missing values. These were recoded to missing values recognized by SAS. Using the modified program, the weights and heights of children were converted to percentiles and Z scores for the age of the child on the day of measurement. The percentiles and Z scores were those used by WHO, FAO and the NCHS (7.1).

REFERENCES

7.1. World Health Organization. Measuring change in Nutritional Status. WHO, Geneva, 1983.

Chapter 8

MORBIDITY

I. PURPOSE

Morbidity data were collected on a weekly basis from every member of the study households in order to estimate: 1) incidence of signs and symptoms and their duration, 2) the extent of incapacity, change in food intake and change in appetite associated with the symptoms, and 3) the type and adequacy of the medications employed to treat the illness.

II. DATA COLLECTED

At each visit the interview schedule was used to elicit the following information: 1) illness signs and symptoms, which were recorded using coding categories selected from a list of 99 signs and symptoms; 2) duration of symptoms, by respondent's report of when the symptoms began to date of termination, which was ascertained at a follow-up interview; 3) level of incapacity, based on a 3-point scale; 4) change of appetite, recorded for the day of the visit; 5) change in diet, based on a 5-point scale, and 6) treatment, judged in terms of appropriateness, also on a 5-point scale.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

Data on the presence of symptoms were collected once a week throughout the time that a household was in the study. The lead female was asked about the state of health of each family member on the day of the visit. When she replied that someone was sick, the interviewer asked a series of questions to obtain information on the items listed above. In the case of a positive response, the physician did a brief examination of the ill person to confirm the presence of the symptoms. At the next interview, a week later, the first questions were follow-up inquiries about the course of symptoms in the sick person. The termination date of the symptoms (if this had already occurred) was ascertained, after which the interviewer asked about current state of health of each family member.

In August, 1985, it was recognized that this method was different from that being used by the other two CRSP projects. In the latter, the interviewers asked about all illnesses that had occurred during the previous week, not only about illnesses present on the day of the visit. From September 1985 to the end of the project, the interviewers in Solis also asked about symptoms in the previous week, after the usual inquiry about current symptoms. Thus, the original format was maintained, with an additional set of questions. Comparison of the data from these two methods is provided in Chapter 22.

Visits were scheduled on the same day of the week for one month, and a different day of the week was scheduled for succeeding months. For example, a household visited every Monday in January received visits on Tuesdays in February, Wednesdays in March, etc.

B. Personnel and Training

Visits to the household were made by a team of two people -- a physician and a local health auxiliary. In Phase I, the feasibility of using community workers to collect the morbidity data was evaluated. The plan was for physicians to accompany the health auxiliaries for several weeks, after which the physicians would supervise, but only occasionally go on house-to-house visits. However, it became apparent that some women were reluctant to describe symptoms to the health worker, who was not regarded as a legitimate health professional. Also, the local workers did not readily recognize visible signs of illness and inquire about them if the mothers did not immediately mention the problem to the worker.

On the other hand, the presence of the local health worker often lent a feeling of informality and ease to the interview, which facilitated data collection. Therefore, the decision was made to use the MD-auxiliary team to collect data.

During Phase I, both physicians and health auxiliaries received training in interviewing about symptoms and the use of the recording forms. This training was provided by the Area Chief for Morbidity and the project field director, both physicians.

IV. DATA CODING AND QUALITY CONTROL

A. The Initial Recording Form

The form that the physician carried on the household visits was a matrix in which the days of the month were printed across the top, and the lines on which to record information about individual symptoms were printed vertically. There was a separate sheet for each household member. Thus, the same forms were used for four to five household visits.

On the original recording sheet, the interviewer wrote in the signs and symptoms in Spanish during the interview, as well as checking off the responses to the other questions concerning appetite, incapacity, etc. Then, at the end of the day, the numerical code for each symptom was put on the form. A second form was also completed at that time. This form summarized the information on the main recording sheet. It included only the identification information, signs/symptoms with their code, and medications with their codes.

A list of the 99 signs and symptoms utilized in the morbidity records is provided in Table 8.1.

B. The Coding Form

The raw data were recorded on a coding form, which combined the summary sheet on signs and symptoms with the data on characteristics of the illness episode, as well as the starting and ending date for each symptom. There was a separate code sheet for each individual, with the data for a calendar month. The sheet also included the information on the number of visits to the household during that month, so that a variable, "days of observation", could be calculated. The code sheet was designed by the field director, and coding was done by the physicians, under the direction of an M.D. supervisor. The transfer of data from the two original forms to a code sheet was checked by a field assistant prior to data entry.

TABLE 8.1
SYMPTOMS AND ILLNESS CODES

00 = Not ill
01 = Flu,Common Cold
02 = Conjunctivitis
03 = Pharyngo-tonsilitis,
Inflamed Throat, Herpes Bucalis
04 = Headache
05 = Phosphene
06 = Acouphone
07 = Nausea
08 = Dizziness
09 = Stomach Ache, Abdominal Pain
10 = Bitter Mouth Swallowing
11 = Sore Throat
12 = Irritability
13 = Cough
14 = Fever
15 = Sore Throat
16 = Eye Pain
17 = Diarrhea
18 = Traumatism
19 = Fetid Urine
20 = Vomiting
21 = Backache, Back Pain
22 = Dysuria
23 = Precordial Pain
24 = Asthenia, "Loss of Pep",
"Not Feeling Well"
25 = Facial Edema
26 = Rupture of Membranes
27 = Dysphonia
28 = Dysphagia
29 = Insect Bite
30 = Herpes Labialis, Mouth apthae
31 = Nasal Congestion, Stuffy Nose
32 = Hives, Rash, Allergy
33 = Phlegm
34 = Loss of Appetite
35 = Heartburn, Acidity
37 = Nasal Bleeding
38 = Ear Ache
39 = Back Ache
40 = Chills
41 = Vaginal Bleeding
42 = Chest Pain
43 = Lower Limb Edema
44 = Abdominal Distension
45 = Constipation
46 = Cloudy vision
49 = Otitis
50 = Upper Arm Edema
51 = Mumps
52 = Muscle Ache
53 = Aphtae in Mouth,
54 = Dspnea, Difficult Breathing
55 = Dismay, Asthenia
56 = Red Eyes
57 = Bronchitis
58 = Tooth Ache
59 = Expulsion of Parasites
60 = Odynophagia, Painful
61 = Refuses Feeding
62 = Dysentery
63 = Reddened Pharynx
64 = Tenesmus
65 = Anal Itching
66 = Reddened Tonsils
67 = Purulent Tonsils
68 = Dehydration
69 = Enlarged Lymph Nodes
70 = Hernia
71 = Ronchi
72 = Leukorrhea
73 = Clear Nasal Discharge
74 = Mucous Nasal Discharge
75 = Dry Cough
76 = Productive Cough
77 = Erythemia/Inflamed Nasal Mucosa
78 = Purulent Tonsils
79 = Abnormal Lung Sounds
80 = Lung Stertoris
81 = Abdominal Discomfort
82 = Abnormal Radiographic Signs
83 = Parasites by Lab Exam
84 = Itching
85 = Allergic Reaction
86 = Occular Congestion
87 = Abdominal Pain on Palpation
88 = Tympanism (Abdominal)
89 = Difficulty in Swallowing
90 = Hyperperistalsis
91 = Alcoholism
92 = Hypertension
93 = Abnormal Cardiac Sounds
94 = Reddened Ear Drum
95 = Enlarged Tonsils
96 = Pale Conjuctivas

TABLE 8.1 continued

47 = Leg/knee pain	97 = Enlarged Viscerae
48 = Chest Itching	98 = Respiratory Distress
	99 = Other

"Incapacity" was assessed as one of the following: not ill, no change, some incapacity, or bed-ridden.

"Change in appetite" was assessed as presence or absence of change.

"Modification in diet" was categorized as no change; had eaten food and caloric liquid; had eaten food and non-caloric liquid; ate no food but had caloric liquid; ate no food but had non-caloric liquid.

"Appropriateness of medication" was evaluated as adequate, inadequate, contra-indicated, without effect, no treatment, and a code for "don't know".

C. Illness Categories

The ninety-nine signs and symptoms were subsequently collapsed into six "illness categories" for purposes of analysis. The scheme for assigning signs and symptoms to categories was developed by Mexican physicians in the field and the new categories were created at UConn in raw data already transferred. The categores were derived as follows:

FEVER = Fever, not feeling well, chills

DIARRHEA = nausea, diarrhea, vomiting, dysentery, tenesmus, dehydration, hyperperistalsis

UPPER RESPIRATORY = inflamed throat, sore throat, dysphonia, nasal congestion, phlegm, painful swallowing, inflamed pharynx, inflamed or enlarged or purulent tonsils, dry or productive cough, and difficulty in swallowing

LOWER RESPIRATORY = cough, chest pain, bronchitis, abnormal lung sounds, lung stertorous

RUNNY NOSE = flu, common cold, clear or mucous nasal discharge

OTHER = all other symptoms.

D. ICD Codes

Subsequent to the Phase II data collection, project physicians in Mexico assigned ICD-9 codes (International Classification of Diseases, 9th Revision) (8.1) to the project's diagnostic codes (signs and symptoms). This mapping was sent to UConn for integration into the morbidity data already transferred.

V. DATA MANAGEMENT

The format for entering the morbidity monitoring data into a computer file was designed by the data management unit at INN, who supervised data entry at the computer center in the Dept. of Public Health. Printouts of these files were

then returned to Solis for visual checking against the code sheets. Keypunch errors were corrected before the tapes were sent to the University of Connecticut for range checking. Out of range values were recoded to missing.

REFERENCE

8.1 World Health Organization. International Classification of Diseases. 9th Revision. Clinical Modifications. Volumes 1 and 2. January, 1979.

Chapter 9

MORTALITY

I. PURPOSE

The purpose of this protocol was to record deaths that had occurred in households in the study during the previous five years (May, 1981 to May, 1986). It should be noted that all deaths of children born to women in the study, including still births, were also recorded in the clinical history of each woman. The questions about mortality were restricted to members of the household only; that is, to the individuals living under one roof and sharing common food and other resources. Since the sample of families in the study is not a random sample of all households in the community, the data from this protocol cannot be used to reconstruct community death rates.

II. DATA COLLECTED

The household mortality data include the name, age at death, and cause of death of any household members who had died in the five years prior to the interview.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

This interview was administered once to all families in the study in May, 1986, after the close of other data collection activities. Some families had, therefore, completed all aspects of the study six to eight months prior to this interview. Thus, the time frame covered by this inquiry is identical for all families regardless of when they entered or left the study.

All interviews were conducted in the home of the respondent, who was, in all cases, the mother. If the mother was not at home when the interviewer arrived, additional visits were made until she was personally available to answer the questions.

The interviewer first asked about deaths in the household and then asked to see a copy of the death certificate(s). In Mexico, burial cannot take place without an official death certificate, and every household has a copy. The certificate includes name, date of death, age at death, and cause of death. The death certificate is, by law, to be made out by either a physician or, in the absence of a medical doctor, by a community official. In the latter case, however, the information about cause of death is not highly reliable from a medical standpoint. The interviewer checked the mother's answers against the death certificate and any discrepancies were discussed.

B. Personnel Training and Supervision

All households were interviewed by the physicians who staffed the health posts in the community. The staff member (physician, member of the morbidity team), who designed the interview schedule, reviewed the procedures for data collection with the community physicians. The physicians were also given a two-page set of instructions for filling out the forms.

IV. DATA QUALITY CONTROL

A. Primary Coding of Data

Data were captured directly on the interview forms. At the time of the interview, the cause of death was recorded exactly as it appeared on the death certificate. On returning to the project office, the identification number of the individual was filled in (or assigned for individuals who had died prior to the study), using the data on the household available from the basic census. The physician then coded the cause of death, using the same morbidity codes that were used in the project's morbidity data.

B. Error Checking and Correction of Data

The coded data were entered directly from the original interview schedule into a computer file. A printout of the file was visually checked against the interview schedules and any errors identified were corrected.

Chapter 10

CLINICAL HISTORY AND PHYSICAL EXAMINATIONS

I. PURPOSE

All of the subjects in the study were interviewed and given a physical examination in order to obtain information on familial health history, their own past history, and current health status. Subsequent interviews and exams were for the purpose of monitoring health status during the course of the study.

II. DATA COLLECTED

Separate interview schedules and physical examination forms were used for adult men, adult women (with additional sections for women who were being followed through pregnancy and lactation), and children. For males, the clinical interview included questions on family health problems, respondent's previous and current health problems, alcohol and tobacco use, and personal hygiene practices. For women, there were additional questions on menstruation, reproductive history, obstetric history and problems, contraceptive use, and postpartum practices. During pregnancy, additional questions were asked concerning the development of the current pregnancy. The interview for children included questions on family health history, previous illnesses, mother's prenatal and obstetric history with the child, infancy feeding practices, and the age of achieving a series of developmental markers.

The physical examination included recording of vital signs, and data on nose, throat, chest, abdomen and genital system, as well as assessment of vision, hearing, neurological status, limbs, rectum, and clinical signs of nutrient deficiencies. Specific problems identified in the examination were also noted.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

All subjects were given an initial physical examination, which followed immediately after the interview, to collect health history and current health status data. The first physical was conducted upon entry into the study. Following the entry examination, adult men, non-pregnant women, school-age children, and pre-school children were reexamined every three months. Pregnant women were seen every month, a schedule that continued through the first six months postpartum. Infants were also examined once a month. Infants born in the Solis clinic were given their first physical within 12 hours of birth, while those born in the communities were first seen within 30 days of birth.

All of the interviews and examinations were conducted at the clinic in Solis by a physician. Two days prior to the scheduled visit, the community social worker (during 1984) or the nutritionist (during 1985-86) would visit the family

to arrange for transportation to the clinic. Initially, the social workers used the visit to explain the purpose of the examination. There were generally no problems in acceptance of this component of the study.

On the morning of the clinic visit, a project driver would bring the family to the clinic. The individuals included in the trip were the lead female, lead male, and the children who were subjects in the study. Other household members also accompanied them if they were ill or, in the case of small children, if there was no one with whom they could be left. Occasionally, the interview and examination of adult men had to be scheduled for a separate time, as was sometimes the case with men who migrated to work outside the area.

Interviews were conducted in the physician's office, after which the physical examination was carried out. Mothers provided the information for their children, although fathers also participated in the interview about children's health history and condition.

B. Development of the Instrument and Personnel Training

The format for the clinical history interviews and physical examinations was developed by the director of the Solis Clinic, who was a pediatrician and chief of the morbidity area for the study. For the development of the interview forms and physical examination forms, the clinic director was assisted by a second clinic physician, a specialist in internal medicine, as well as the field director. The content for the interview was based on the general guidelines established for the CRSP (by a technical advisory group convened by M.E.).

The interview and physical exam protocols were pre-tested during the pilot phase with individuals from a community located at some distance from Solis, which was not a study community. The pilot interviews and exams were conducted by two other clinic physicians who were also members of the morbidity team. Based on the results of the pilot, some revisions were made and final forms, which utilized pre-coded response categories, were constructed. They conducted the clinical interviews and exams during the pilot phase and the first year of the study. Initially, each observed the other's interviews and exams for a period of time in order to assure parallel interpretation of the items.

Later in the study, the responsibility for conducting the interviews and exams was assumed by two other clinic physicians. The second team of physicians was trained by the physicians who pretested and conducted exams during the first year. Training included observation of ten interviews.

IV. DATA MANAGEMENT AND CODING

Although many items were initially recorded on a pre-coded form, the data from the interviews were transferred to a code sheet. This included the pre-coded items, as well as items that were coded after the interview was completed. The data from the physical examination were transferred directly, without a code sheet. The interview coding form was designed by the field coordinator.

The interviews were coded by the physician who conducted the interview. The coding took place as soon as possible after the interview. Later, a research assistant checked every item of the code sheet against the original form and corrected any miscoded items.

The code sheet for the final section on current health problems, which was developed by one of the examining physicians, was designed to utilize information from the physical exam. The coding form was developed to take advantage of the narrative information in the clinical interview and the physical exam. A set of instructions was written and their clarity tested on a subsample of records. The coding was done by two of the team's physicians.

The procedures for data entry and cleaning followed the standard procedures for the project. Every code sheet was first checked in Solis by an assistant to assure that the identification number was correct. The sheets and physical examina-

tion forms were then brought to INN where the file designs were created by one of the personnel of the data management unit. The designs were then reviewed by a physician before the code sheets were sent for data entry to the computer center of the Ministry of Public Health. Printouts of the data files were returned to the field for visual checking against the code sheets. Errors identified in the field through this process of visual checking were corrected by the data management staff at INN.

Chapter 11

LABORATORY ANALYSES

I. PURPOSE

Several categories of laboratory analyses were performed. These included measurement of: a) fecal parasites in order to control for the effects of infestation on nutritional status; b) the physical, chemical and bacterial characteristics of urine in order to detect kidney disease, diabetes, and urinary infections; c) hematology for the detection of anemias and infections; d) nutritional status indicators in plasma; e) the percent fat in breast milk as a pregnancy outcome measure; and f) pregnancy testing to assist us in the early recruitment of pregnant women.

II. DATA COLLECTED

Fecal samples were examined for consistency, mucus, blood, parasites, protozoan trophozoites and cysts, parasite eggs, and helminth eggs. Urinalysis included: 1) smell, color, density, and pH; 2) semi-quantitative measures of protein, glucose, ketones, bilirubin, nitrites, and blood; 3) semi-quantitative description of cells, filaments, and crystals; 4) the presence of E. vermicularis, Trichomonas, or Candida; and 5) bacterial counts by plating. Hematological measures on whole blood were: red and white cell counts, hemoglobin, hematocrit, mean cell volume (MCV), mean cell hematocrit concentration (MCHC), and differential count. Plasma samples were analyzed for ferritin, prealbumin, complement C_3, transferrin, and IgA. Zinc analyses are pending. A subset of plasma samples were studied for T-rosettes and blastoid transformation. The fat content of human milk samples was estimated by centrifugation.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

The selection of families and dates for fecal and urine collections was programmed monthly. Scheduled families were given labelled containers in which to collect samples. In most cases, the subjects brought the samples to the laboratory early in the morning, at the same time that they were scheduled for some other test (e.g. RMR, clinical examinations, or blood drawing). If no clinic tests were scheduled, participants were provided with an ice chest and ice on the previous day so that samples could be stored until picked up by project personnel.

Schedules for blood collection for families were planned monthly. On the day prior to sampling, the nutritionist in charge of the relevant community reminded the family of the test, and advised them to avoid alcohol, and medications unless the staff were informed about these. It was emphasized that the provision of blood samples was in no way obligatory, and that unwillingness to provide samples would in no way affect their continuation as participants in the study. The subjects were driven to the Solis clinic where the blood was drawn.

Milk samples were collected in the Solis clinic at the same time as the clinical exam. Although the experimental design was to collect 5 ml at the beginning, and 5 ml at the end of a feed, in most cases it was impossible to control the time when the infant received its previous feed.

The frequency of sample collection was as follows.

i) Fecal samples: every three months for toddlers, schoolers, and non-pregnant/ non-lactating (NPNL) women; at five and eight months of pregnancy and at one, three, and six months of lactation; infants at 6 months; and adult males at the start and end of their period of study. About 210 families were studied, and 1,000 assays were performed, every three months.

ii) Urine samples: at the start and end of the study for adult males; every three months for NPNL women; and at five and eight months of pregnancy and one, three, and six months of lactation.

iii) Blood and plasma samples: once, on exiting from the study for all targets, except infants; and, at five and eight months of pregnancy and one, three, and six months of lactation. T-rosettes and blastoid transformation were measured only on toddlers and schoolers as they left the study, and lactating women at six months of lactation.

iv) Milk samples were collected at one, three, and six months of lactation. Initial plans to sample colostrum were not realized due to objections by the mothers.

B. Personnel

During the course of the project, fourteen technicians (including three paid by UNAM) were responsible for laboratory analyses. They were supervised by an experienced technician who had a graduate-level education. Most of the technicians had little or no previous experience at laboratory work, and some were from the Valley of Solis. A laboratory was built in an existing building at Solis and basic equipment was sent by the University of Connecticut. Some equipment was loaned by INN from previous projects, e.g. a Coulter counter that was used for hematology, and microscopes. Examination of urine and fecal samples, all pregnancy testing, and centrifugation of milk was done at Solis. Due to the difficulty of working with fluctuating voltage (even with a regulator), frequent power failures, and a dusty environment in the dry season, the hematological and biochemical analyses were done at INN in Mexico City. Blood and plasma samples were taken to Mexico City on the same morning that they were taken, while being stored on ice. Milk samples were frozen and transported later in batches.

Laboratory personnel scheduled the tests, and provided the nutritionist responsible for the relevant households with labelled supplies on a weekly basis. The nutritionist was responsible for explaining to the families how the samples were to be collected, and for scheduling the attendance of the subjects at the Solis clinic next morning, or for pick-up of the samples if the subjects were not scheduled to come to the clinic.

IV. ADDITIONAL NOTES ON PROTOCOL

On arrival at the lab, feces were visually examined for consistency, mucous, and parasites. A drop of diarrheal samples was mixed with polyvinyl alcohol, dried, and stained with Wheatley's trichrome stain prior to the microscopic examination of cysts, eggs, and leukocytes. A semi-quantitative analysis of the parasite load of each individual was achieved by centrifugation and flotation of protozoan cysts and helminth larvae with zinc sulfate.

After visual inspection of urine samples, density was measured with a refractometer, pH with a pH meter, and N-Multistix used to test for blood, protein, glucose, and ketones. From February to June, 1984, Microstix (Abbot Labs) were used to test for nitrites, total bacteria and gram negative bacteria. The Microstix gave results very similar to those ob-

tained by cultures and were cheaper and easier to use. However, after June of 1984 the Microstix became unavailable in Mexico and only cultures were used to count bacteria. For cultures, duplicate samples of urine were put into Blood Agar and Mac Conkey's agar at 1:1,100 dilution. Colonies were counted with a Colony Counter after a 24 hr incubation.

Approximately 3 ml blood was obtained by venipuncture using 21 gauge needles and EDTA as an anticoagulant. For children, finger puncture was sometimes used instead of venipuncture, using an Autolet (Ulster Scientific). Hematology and differential counts were made with a Coulter Counter (model ZF, Coulter Electronics, Hialeah, FL). Ferritin was analyzed by radioimmunoassay using a "Ferrizyme" kit from Abbott Laboratories (Berkeley, CA). Transferrin, prealbumin, complement C_3, and IgA analyses were made by laser nephelometry using a nephelometer loaned by Hoescht (Calbiochem-Behring). The nephelometer had an automatic cuvette transporter. Data were automatically transferred via a V-24 interface to a Hewlett Packard HP 9815A calculator for the calculation of concentration, and printout and storage of data. No other immunoglobulins were analyzed because levels of these are not clear indicators of nutritional status, and this was confirmed by the results of the Kenya project. Due to the high cost of these analyses, it had been agreed that Mexico would only run them if the results from the other CRSP projects were interpretable.

T-rosettes and blastoid transformation were analyzed by the Department of Ecologia Humana at the Universidad Autonoma de Mexico, Mexico D.F. Cells were separated using Ficoll Hypaque (Sigma, St. Louis, MO), washed with RPMI-1640 medium with added HEPES, gentamycin, fungizone, bicarbonate, and L-glutamine, without fetal calf's serum. Cells were counted by trypan blue exclusion, diluted, and sheep red blood cells added. After a 30 minute incubation, T-rosettes were read the following day, in duplicate, under magnification using a Neubauer counting chamber. For measurement of T-lymphocytes, after the cells were counted by trypan blue exclusion they were diluted in RPMI with added fetal calf's serum, HEPES, fungizone, gentamycin, bicarbonate and L-glutamine. Duplicates of this suspension were put into level well NUNC plates and stimulated with mitogens. These were phytohemogluinin (PHA) and concanavalin A (Sigma, St. Louis, MO). After incubation, radioactive thymidine was added (New England Nuclear Co., Boston, MA). After additional incubation, cells were washed, fixed, dried, and radioactivity counted in a Packard liquid scintillation counter. Controls included radioactive thymidine, cells without added PHA and concanavalin A, and a blank with scintillation fluid alone. The blastoid index is the ratio of stimulated CPM compared to non-stimulated controls.

Zinc analyses on serum will be run at the University of Connecticut using an atomic absorption spectrophotometer (Perkin Elmer model # 2380, Norwalk, CT) equipped with a teflon micro-cup. Plasma from healthy controls will be run at the same time as the Solis samples.

The "creamatocrit" method was used to estimate the proportion of fat in milk samples; a few ul of milk were run into a capillary tube and centrifuged. The proportion of fat was read with a hematocrit reader. The data obtained are of doubtful validity because we could not guarantee that milk was always taken at the same stage of breast-feeding events, and the percentage of fat in milk rises markedly towards the end of feedings. Milk samples are on hand at the University of Connecticut where they will be analyzed for amino acid profiles, and for vitamin A (corrected for fat content) and zinc. Immunoglobulin assays on milk were not run because of their dubious interpretability; it is important to measure only specific secretory immunoglobulins (an expensive procedure) and these respond more to infections in the mother than to her nutritional status.

V. DATA QUALITY CONTROL

A. Laboratory

For the fecal and urinary analyses, the supervisor reread at least 10% of the slides read by the technicians. Earlier in the technicians training, the supervisor checked 100%, and then 50%, of the technicians' slides. Sensitivity, specificity and predictive value of the technicians' readings were calculated every two weeks. Agreement had to be within 90% or

retraining was started immediately. Every day, 10% of the samples read were controls, introduced by the supervisor between the subjects' samples.

Daily comparisons of hematocrit and hemoglobin readings by the Coulter counter were made against those made in duplicate manually. More than a 2% difference between the methods was considered unacceptable. WBC and RBC counts were checked twice weekly against manual measures; permissible differences for values obtained with different dilutions were a 2% CV in the Coulter counter and 10% manually. Where the CVs obtained by technicians were unacceptable, assays were repeated by the supervisor, and either technician retraining or equipment calibration instigated as appropriate.

External quality control was achieved by sending samples on a weekly basis to the hematology laboratory at INN. Acceptable differences were >3% between laboratories. Data were rejected if they exceeded these acceptable differences; this occurred in less than 1% of the samples. Controls were run daily between samples. The controls were supplied by the hematology laboratory.

For the measurement of transferrin, prealbumin, and IgA, each run of samples was accompanied by standards and control (LN Protein Control Serum, Human) sera supplied by Behring. All readings were made in duplicate. Ferritin analyses were done in duplicate, and each run also contained samples of diluent and seven standards, each in duplicate.

B. Data

Laboratory values were transcribed onto computer coding sheets with one technician dictating the values, and the other recording. The transcribed data were checked against the original entries.

Printouts from the computer were all checked against the original computer entry forms for accuracy of data capture. Errors were noted on the printouts and returned to the Data Management team for correction on the tape at IBM.

VI. DATA MANAGEMENT AND ANALYSIS

The raw data were checked for outliers at Connecticut using univariate analysis. Outliers were sent to INN for checking against the original data entry forms, and corrections made at Connecticut where possible. Limits were obtained from the literature for "deficient" and "acceptable" values so that the percentage of individuals with low values could be identified. These results are provided in Chapter 24. Values were also used as continuous variables in analyses.

Chapter 12

RESTING METABOLIC RATE

I. PURPOSE

This protocol measured the resting metabolic rate (RMR) of adult and school-age target subjects in order to: 1) determine if marginal malnutrition affects RMR; 2) measure maintenance energy costs; 3) measure changes in RMR during pregnancy and lactation in relation to nutritional status; and 4) estimate "available energy" for activity and growth/accretion (energy intake - RMR). The data were collected after an overnight fast and therefore approximate Basal Metabolic Rate (BMR). However, since little control could be effected over environmental conditions (such as room temperature), the terminology "RMR" is used here.

II. DATA COLLECTED

Data obtained in this protocol included physiological state, health of the cardiopulmonary system, room temperature (in ^{o} Centigrade), barometric pressure (in mm Hg; collected only through May 1985), two samples of expired air (volume), and percent oxygen for each sample of expired air. Additionally, water vapor pressure (in mm Hg) was calculated from room temperature.

III. DATA COLLECTION PROCEDURES

A. Test Structure and Schedule

The RMR test was conducted in a special room at the Solis clinic. On the day prior to the test, a home visit was made to remind the subject of the scheduled test, and to ask that before the test no alcoholic beverages be consumed, no cigarettes smoked (for at least two hours prior to the test), nor anything eaten on the morning of the test. On the day of the test, the project driver went to the house to collect the lead males and females, and any young children they wished to bring to the clinic. At the clinic, the test procedure was explained.

RMR measures on schoolers were done once, near the end of the study (April and May, 1986). Prior to this time, the schedule for adults was such that the schedule for equipment use was fully booked every morning; RMR measures were only made on fasting subjects, in the mornings. Therefore, schoolers could not be scheduled at the same time as adults during the study. The method used for schoolers was the same as that for adults, except that a smaller face mask was necessary.

During the test, the subject lay down for 30 minutes, and then was linked to a Max Planck respirometer. An inflatable face mask was applied for three - four minutes and the first sample of 60 ml of expired air was collected, and its volume measured for the last minute the mask was worn. The subject was allowed to rest for three minutes before repeating

the expired air collection process. Two oxygen samples were taken from each air sample. Oxygen (in dried air) was measured with a Beckman OM2 oxygen analyzer within 0.5 hours of sample collection. After the RMR test was completed, anthropometric measurements were taken.

Tests were conducted once every three months on adult males and adult nonpregnant, nonlactating women. Pregnant women were measured at five and eight months, and lactating women at one, three, six, and eight months. School-age children were measured only once, at the end of the study. Any subject who did not arrive for the test was rescheduled for testing during the same month.

Although a second-hand, reconditioned Beckman Metabolic Cart (BMC1) was purchased for the purpose of measuring RMR in Solis, the instrument never measured volume accurately and numerous attempts to correct this problem all resulted in failure.

B. Personnel Training and Supervision

A physician or trained nurse was present during all RMR measurements. Two trained auxiliaries were also present to assist the key personnel. The assistants, also trained by the physician or nurse to take anthropometric measurements, were responsible for informing subjects on the day prior to the test. They also traveled to the homes to take anthropometric measurements on subjects who did not come to the clinic.

IV. DATA QUALITY CONTROL

The volume of expired air was measured and recorded in duplicate. If any duplicate oxygen measurement per sample had a >5% difference, it was not valid, and was repeated. Initial and final air volume measurements were recorded immediately. The volume meter was checked daily using a calibrated one liter syringe. On a monthly basis, the respirometer was taken to the physiology laboratory of UAM in Mexico City for drying and calibration against a spirometer. The oxygen analyzer was calibrated against dried room air (20.93% oxygen) before every reading, and against a standard gas (16.00% oxygen) every week.

V. DATA MANAGEMENT AND ANALYSIS

A. Primary Coding of Data

Data were recorded in a laboratory notebook during the test, and transcribed onto the computer data entry sheet immediately after the test. Notebook values were then dictated and checked against the values on the data entry sheet. Calculations from the primary data done in the field were a subtraction of the initial air volume from the final volume of expired air.

B. Error Checking and Correction of Data

At IBM, a frequency distribution of values was used to develop a program for computer-aided detection of illegal codes and out-of-range values. Suspect data were checked by the Area Chief against data entry sheets (for keypunching errors). Logical consistency was also checked (e.g., high RMR values, as kcal/24 h, are possible in taller subjects). On the printouts of suspect values, corrections were written. The corrected printout was returned to INN, where necessary changes were made on the RMR tape. The tape was duplicated, and a copy was sent to Connecticut.

Using an error-checking program for set ranges of upper and lower permissible values for each variable, based on expected values, almost all additional errors were corrected in Connecticut. Most of these errors were in the hand-calcu-

late[illegible] action of initial from final volumes of oxygen. Because the raw data were also in Connecticut, the true value wa[illegible]culated by computer and the tape corrected. Only one value in approximately 1,700 individual records was not correctable in this fashion. Both corrected and uncorrected values were sent to Mexico for verification against original records, and all corrections were proven to be valid.

Chapter 13

SOCIAL DATA

I. PURPOSE

Social data were collected for both individuals and households, using several different interview schedules. The data collection instruments were:

1) Socioeconomic characteristics of the household, including migration activities of household members.

2) Sociocultural characteristics, including social activities and behaviors, as well as attitudes and knowledge, involving both household-level and individual-level measures.

3) Agricultural productivity and activities of the household.

II. DATA COLLECTED

A. Socioeconomic Characteristics

This interview consisted of two parts. The first part concerned characteristics of the dwelling, including the flooring, roof materials, walls, etc., as well as ownership of household and agricultural goods. The second part of the interview focused on migration and wage labor of household members.

B. Sociocultural Characteristics

This interview was designed to gather information on social behavior, values, and aspirations, as well as knowledge, media exposure and related features. The sections of the interview included the following types of questions:

i) Aspirations for children's education and occupation.

ii) Frequency of travel outside the community.

iii) Radio and television exposure.

iv) Participation in family and community social activities.

v) Extent of utilization of social programs.

vi) Knowledge of community and external affairs.

C. Agricultural Activities and Productivity

This protocol was designed to collect information on farming practices and productivity. It includes information on land holdings, types of crops planted, labor and cash inputs into planting, field maintenance and harvesting, and harvest yields. It also included information on non-farm, income-earning activities of the household head and other household members.

As described below, there were two versions of this data collection instrument. The first version was administered during 1984; the second during 1985.

III. DATA COLLECTION PROCEDURES

A. Schedule and Structure

The development of interviews occured after a preliminary ethnographic phase between June, 1982 and September 1983. This phase was supervised by UConn personnel--Co-investigator Dr. P. J. Pelto and an anthropology doctoral student.

1) Socioeconomic Characteristics

This interview was administered twice to families; once at entry into the study, and once at exit from the study or after one year, whichever occurred first. The initial round of interviewing was carried out in November, 1983 in four communities with the first set of families recruited into the study. In November, 1984, a second round of interviews was carried out. For the initial households who remained in the study, this interview represented the second data collection; for many households (those who entered the study between January, 1984 and November, 1984), this was the first interview. When households from two additional communities were added to the sample, an initial round of interviews was carried out. As families left the study, a final interview with the SES intrument was completed.

The female household head was the primary informant for this interview. In many cases, it was also necessary to interview the male household head to obtain data on economic resources and migration activities.

Before the interviewer went to the house, the Area Chief filled out the front page of the form with the identification number of the family and the identification number of the interviewer. The socioeconomic interview was carried out without prior arrangement with the family.

In the Solis Valley, it is not customary to invite visitors into the house unless one knows them quite well. Thus, most of the socioeconomic interviews were carried out in the patio of the house. The interviewers were instructed to ask the questions standing with their back to the house. This was done to avoid the possibility that the interviewer would fill out items, such as characteristics of house construction, by observation rather than verbal report. At the completion of the interview, the fieldworker observed the house and yard and questioned any inconsistencies. For example, if a woman reported that she did not own a gas stove but gas tanks were visible in the yard, the interviewer questioned the purpose of the tanks.

A fieldworker was usually able to carry out between eight and ten interviews per day, depending on the distance between houses and the number of places where no female household head was home at the time of the initial visit.

As part of data quality control procedures, two interviews per day were recorded on a tape recorder by each interviewer and the tape returned to the Area Chief, together with the completed interviews at the end of each work day.

The fieldworkers for this interview were young men and women with either secondary school or high school-level training, all of whom came from the nearby town of Temascalcingo.

With the first round of interviews in November, 1983, the team of interviewers worked in one community at a time, completing all households in the sample before moving as a group to the next village.

2) Sociocultural Characterisitics

This interview was administered once to the lead female and once to the lead male. As with the socioeconomic interview, the initial set of families recruited in November, 1983 were interviewed during the first month of the study. A number of the male household heads who migrated to work outside the valley were interviewed somewhat later.

After the initial set of interviews, subjects were interviewed as time and the scheduling of other data collection activities permitted.

Sociocultural Interview

In parallel with the socioeconomic interview, the Area Chief filled out the identification numbers of the individuals to be interviewed for the fieldworkers prior to the daily round of interviews. Since it was preferable to interview an individual without the presence of the spouse, fieldworkers attempted to construct some measure of privacy. Interviewing women in the morning when their husbands were away, and men in the afternoon when their wives were busy with household chores was common.

Each interviewer tape recorded two of every ten interviews and returned the tape to the Area Chief, together with the completed forms at the end of each day. The team of fieldworkers who conducted the socioeconomic interviews also conducted the sociocultural interviews. The initial round of these interviews was conducted by moving the team of interviewers from one community to the next, as with the socioeconomic data collection.

3) Agricultural Activities and Productivity

In 1984, the first interview covered the harvest of the previous agricultural season, which took place in October through December of 1983. In most cases, the interview was conducted with the male household head. Occasionally, when the lead male was a migrant, the female household head provided the information. The second interview, which covered information on preparation of the field and planting, was conducted in May, 1984. The third interview, on the subject of weeding and irrigation, was carried out in August, 1984.

The revised version of the agricultural activities interview was first administered in January and February, 1985, covering the harvest of 1984. The second interview, conducted in July, 1985, contained information on planting for the current year. The final interview, on harvest activities and results of the 1985 agricultural cycle, was conducted in January and February, 1986.

The initial form of the productivity interviews was quite time-consuming for respondents, so in this interview the family was usually contacted a day or more before the interview was scheduled. The more compact version, administered in 1985, was often conducted without prior arrangement.

The agricultural activity interview was conducted by a small team of fieldworkers, a subgroup of those who were trained to carry out the socioeconomic and sociocultural interviews. While many of these interviews took place in the respondent's house or patio, they were occasionally carried out in the agricultural fields. In either location, fieldworkers were instructed to look for observable features to confirm the respondents' answers. As with the other social data collection procedures, a sample of each fieldworkers' interviews was tape recorded to permit checking the interviewer's questioning procedures and the correctness of his recording of responses.

E. Personnel Training And Supervision

The Area Chief for all social data, as well as for maintenance of the census, had secondary training in the city of Toluca (state of Mexico), followed by three years of technical training in the Toluca school of social work. Prior to beginning her work in the Solis area, she worked for a public health program in a crowded inner city neighborhood. At the time the project began, she had worked as a medical social worker in the Solis Valley for four years and had gained wide experience in the communities in which the project was carried out.

In the planning phase of the project, there was general agreement among the project staff that the social data could all be collected by individuals with secondary or high school level training. It was felt that it would be best not to use interviewers from the villages to gather economic information but that it was important for interviewers to be familiar with the local culture. Young people from the nearby municipal center seemed appropriate because many of them had experience with life in the villages (through friends and relatives), but they were not directly neighbors of the families they were to interview.

In September, 1983, the Area Chief contacted the faculty of the secondary school and the preparatory (high school) to announce the availability of employment in the project. Ten students, male and female, ranging in age from 16 to 21 years of age, responded to the request for field assistants.

The training of the fieldworkers, which was under the direction of the Area Chief, with the assistance of the Field Director and other senior staff, took place at the project headquarters in Solis. The first training sessions occurred in October, 1983. The area chief gave a series of classes that included description of the goals, purposes, and form of the project, interviewing techniques, and review of the interview forms.

The second stage of training involved practice sessions in which the fieldworkers took turns interviewing each other in front of the group. One individual was designated as "the interviewer", another as "interviewee", while the rest were observers who also filled in the interview forms as they listened. After each interview, the style of questioning was discussed and criticized and the recorded answers of everyone were compared. This training procedure was carried out initially with the socioeconomic interview schedule. Prior to the first administration of the sociocultural and agricultural activity interviews later in the year, this aspect of training was repeated.

The third step in training was introducing the fieldworkers to the community. They toured each community, learning the system of sectors and household mapping that was devised to assist project personnel in identifying study households.

The final step in training was learning to use the tape recorder in a fashion that didn't disrupt the flow of the interview.

The team of social data fieldworkers was very stable throughout the project. Of the original ten recruited in 1983, only one person left prior to the completion of data collection in 1986. He was replaced by another young man from the municipal center who received an individualized course of training by the Area Chief. Apart from their interviews with social data instruments, this group of fieldworkers also worked in the area of activity recall and dietary data collection during 1984. In 1985, they worked as assistants in data checking and management, except during the periods of social data collection.

IV. DATA MANAGEMENT AND ANALYSIS

A. Quality Control of Data Collection

The three areas of social data were subject to the same procedures of data quality control in data collection. At the end of each day, the interviewers returned their completed forms to the Area Chief. In the evening, she reviewed the completed forms, checking for two problems: missing data (items not filled in) and extreme values.

For the sample of tape recorded interviews, the Area Chief also checked respondents' replies against the filled-out form. Problems of missing data, highly unusual values, or other apparent errors were discussed the following day with the fieldworkers individually. The fieldworkers then returned to the respondents to obtain additional information or make the corrections. In some cases, for example, when the Area Chief felt there might be a problem of rapport between the interviewer and the respondent, she went back herself to collect the correct information. The following example illustrates this process:

Households normally have only a small number of draught animals. When an interview returned with a report of 42 oxen the Area Chief questioned the interviewer, who insisted that 42 was the number the informant gave. The area chief then went to the family for an explanation. The result was that the family was not the owner of the animals, but was maintaining them for the regional agricultural bank. This was a unique case as this type of arrangement was rare in the Solis area. The socioeconomic interview form was corrected to show that the household owned no oxen.

In the early months of the study, another method of quality control, in addition to tape recording a sample of interviews, was direct observation of the interviews by the Area Chief. For several weeks, she accompanied the fieldworkers on interviews, usually observing at least three - four interviews per week for each fieldworker. Any problems with an interviewer's style, interpretation of questions and responses, or method of recording were discussed immediately after the interview.

B. Coding The Social Data Sets

The data from the three social data instruments were transferred to code sheets. The decision to use an intermediate coding procedure was based on several characteristics of the interview forms themselves and the nature of the data being collected:

1) Although the general format of the social data collection instruments was based on categorical responses, many questions included an option to record an alternative answer.

2) Since the distribution of responses could not always be anticipated, questions were designed to maximize detail, with the expectation that the first level of data reduction would occur in transferring the responses to code sheets.

Designing the coding categories and testing coding reliability was a joint activity of one of the principal investigators and the Area Chief. To accomplish this, a large sample of completed interviews, was reviewed and frequencies of responses were hand tabulated. Decisions about combining items into a single code were based partly on frequencies and partly on logical or cultural considerations. To preserve richness of information, combining items into a single code was kept to a minimum.

Portions of the sociocultural interview required further work. A number of the questions were open-ended. Coding categories for these items were developed after reviewing a large number of completed interviews in order to assure that the categories covered the range of possible responses. Answers to a set of questions on "knowledge" (of local issues and the wider world) were coded in terms of the "correctness" of the responses. Since some of the items changed over time (e.g. "Who is the municipal president?"), the coding instructions were revised, as necessary, to reflect such changes.

All coding was done by the Area Chief. Approximately 50% of the socio-cultural interviews, 25% of the socioeconomic, and 10% of the agricultural interviews were also coded by principal investigators. There were virtually no coding disagreements between the coders.

C. Data Entry and Cleaning

The coded data were entered on tape at the Computer Center at Salud Publica (Public Health) in Mexico City. The Area Chief was present at the data entry session to assist the computer center personnel chief in training the data entry clerks. Entry was screen prompted, and there was duplicate entry of every code sheet.

Printouts of the raw (coded) data were sent back to Solis for hand checking against the original data. After correction of identified errors, the data were sent to Connecticut for range checking. Items that failed to meet the qualifications were returned to the Area Chief for further checking against the original interview schedule. Errors were corrected or, very rarely, the value of an item had to be "flagged" as a questionable or bad value.

Chapter 14

SANITATION DATA

I. PURPOSE

Sanitation data were collected to assess the sanitary and hygienic conditions in the home in general, and specifically in relation to child care.

II. DATA COLLECTED

Observations were made of the following: condition of the patio (including type and quantity of waste, presence and number of animals); living quarters (waste on floors, walls, presence of animals); kitchen (type, quantity, and location of waste, presence/number of animals, and location/care of food); other household characteristics relevant to sanitation (water source, waste disposal); and physical appearance of family members.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

Interviewing about sanitary conditions and hygienic practices during Phase I revealed the difficulty of getting accurate information directly from respondents. Therefore, we decided to measure sanitation and cleanliness based on observer ratings. The development of the observation protocol involved a number of steps:

1) Ethnographic work yielded information on which parameters were most readily observable and the catalog of values or characteristics one could expect to find within the valley communities. For example, the various sources of water (piped into the house, yard or neighborhood, taken from well or spring) were identified through a combination of interviewing and observation.

2) Meetings were held with small groups of project fieldworkers, approximately two - four individuals at a time. They were asked to identify individuals and households from the community sample who typified different levels of personal appearance. Generally, our informants had no difficulty in making these identifications. We then asked them to describe the bases for their ratings. From these discussions, we derived some criteria for assessment. We also ascertained that the fieldworkers could distinguish between appearance with respect to "cleanliness" and with respect to wealth indicators. That is, the concept of a clean but poor house, and a well-built, well-furnished but dirty house could be readily recognized. From our meetings with several groups of fieldworkers, we determined that the rating task "made sense" and could be carried out by all of the personnel with whom we discussed it.

3) A preliminary draft of an observational protocol was drawn up and pretested in one of the communities. On the basis of this pretesting, several items were modified and some were dropped. When a final version was ready, the observation protocol was incorporated into routine data collection procedures. At every visit to each household by nutritionists, psychologists, physicians, and social data collectors, the interviewer completed the standard observation protocol. Over the course of a year in the study each household would have approximately 24 observations made by the nutritionists, as well as several observations by other project personnel.

B. Personnel Training and Supervision

Although most of the staff participated, to some degree, in the initial protocol development, all staff members were given a short training session in the use of the protocol, and new personnel were also given a training session. All of the training was supervised by the Area Chief for social data, who also had responsibility for periodically checking the completed data sheets.

IV. DATA QUALITY CONTROL

A. Primary Coding of Data:

The sanitation form included a checklist of the household and personal sanitation indicators which were observed. Data (assessments following the checklist) were coded directly on the observation sheet.

B. Error Checking and Correction of Data

Data were entered into a computer file directly from the original observation sheets at the Data Processing Center at Salud Publica. No additional coding was necessary. After data entry, a printout of the results was visually checked against the original data sheets by Solis field staff. Corrections were made by staff in Mexico City before the data tape was sent to Connecticut for range checking.

A number of composite variables representing environmental and personal sanitation were constructed from the data for descriptive and analytic purposes. Their derivations are described in Chapter 26.

Chapter 15

PSYCHOLOGICAL DATA

I. PURPOSE

A large body of psychological data was obtained from infants, preschoolers, school-age children, and adults in order to assess the relationships of food intake to cognitive performance and social-emotional behavior. This chapter provides the following types of information about the methodological aspects of this research area of the project:

a. Section II describes each of the research instruments, some of which are standardized psychological tests and some of which were developed or adapted especially for this project. The listing and description of the instruments is given by subject type, beginning with infants.

b. Section III describes personnel training and supervision.

c. Section IV explains data collection and coding procedures.

d. Section V describes data management and analysis procedures.

II. TYPES OF DATA COLLECTION INSTRUMENTS

A. Infants

The psychological data on the infant involved two general categories: neuro-motor development, as assessed by the Brazelton Neonatal Assessment Scale and the Bayley Scales of Infant Development (Mental and Motor Scales), and social-emotional development, as assessed through observation, with concomitant assessment of the mother.

1. The Brazelton Neonatal Behavior Assessment Scale (BNAS)

The BNAS is an assessment instrument developed by Dr. T. Brazelton, which uses "behavioral items to assess the infant's responsiveness to external stimuli, his motor organization, and his ability to modulate his state of consciousness. These behavioral items reflect the integrity of the infant's central nervous system, and the infant's capacity to elicit caretaking from an adult" (15.1). The examination consists of 48 items that include assessment of the newborn's reflexes, movements, reactions to light, sound and tactile stimulation, as well as a few items on the tester's global evaluation of alertness, motor tone and maturity.

2. The Bayley Scales of Infant Development (Mental and Motor)

The Bayley Scales of Infant Development measure a number of characteristics that may be affected by marginal malnutrition. The Mental Scale is "designed to assess sensory-perceptual acuities, discriminations and the ability to respond

to these; the early acquisition of 'object constancy'and memory, learning and problem solving ability; vocalizations and the beginnings of verbal communication and early evidence of the ability to form generalizations and classifications, which is the basis for abstract thinking" (15.2). The Motor Scale is intended 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. As the Motor Scale is specifically directed toward behaviors reflecting motor coordination and skills, it is not concerned with functions that are commonly thought of as 'mental' or 'intelligent' in nature" (15.2).

In our study, for the Mental Scale at 6 months of age, a total of 51 items from the original scale were utilized. These were numbers 40 - 90 inclusive. From the motor scale a total of 26 items from the original scale were selected -- those numbered 14 - 40, inclusive.

3. Bayley Infant Behavior Record

The Infant Behavior Record, which is completed by the examiner after the Mental and Motor Scales have been administered, is a standard part of the Bayley Infant Assessment. It provides an assessment of the child's social and objective orientations toward his environment. The assessment is based on both specific observations and qualitative judgments on the part of the examiner. Each dimension or quality is rated on a scale of either five or nine points.

In this study, we included a total of nine behaviors from the original check list: 1) responsiveness to examiner, 2) cooperativeness, 3) general emotional tone, 4) responsiveness to objects, 5) goal directedness, 6) attention span, 7) reactivity, 8) large motor coordination, and 9) fine motor coordination.

4. Mother-Infant Interaction Observations

Dr. Field designed a structured observation situation in which mothers and their infants are observed in face-to-face play, using a 15 second time sample unit coding methodology. Nine infant behaviors were coded, as follows:
1) looking at mother, 2) smiling, 3) cooing, 4) laughing, 5) yawning, 6) frowning, 7) fussing, 8) bicycling limbs, and 9) squirming.

Mothers' behaviors are classified in eight specific categories: 1) looking at the child, 2) smiling at the child, 3) vocalizing to the child, 4) touching the child, moving the child's limbs, 6) imitating the child's sounds, 7) playing games with the child, and 8) "infantized behavior".

In addition to the categories above, there is also a set of ratings made by the psychologist. These will be referred to as the Interaction Rating Scales, based on the mother's and infant's behavior during the observation. The Interaction Rating Scale for the infant is comprised of seven items, rated on a three point scale. The mother's scale is comprised of 10 items, rated on a three point scale. For the infant, the scale uses: 1) state, 2) activity, 3) orientation, 4) looking, 5) facial expressions, 6) agitation, and 7) vocalization.

For the mother, the evaluation scales were: 1) state, 2) activity, 3) orientation, 4) looking, 5) silences, 6) expressions, 7) vocalizing, 8) infantized behavior, 9) contingent responsiveness, and 10) plays with child.

B. Preschool Children

The psychological data on the preschool child involve two broad categories --cognitive performance and social-emotional characteristics and behaviors. These data were collected by means of the Bayley Scale of Infant Development, including the Infant Behavior Record, described above; and observation of behavior in a standardized play situation, which yields measures of affect, activity, and verbal behavior of the child, as well as parallel measures on the mother.

1. The Bayley Mental Scale

The complete scale, for use from birth to 30 months of age, consists of 163 individual items, graduated from most simple to increasingly more complex or advanced responses.

Since the scale includes items for testing very young infants, there were items that all 18-month-old children would be expected to pass. Therefore, for greater efficiency of test administration and recording, Dr. Field, the co-investigator in the area of preschooler psychological testings, eliminated the simplest items, selecting 54 consecutive items for use in testing the preschoolers at 18 months and adding an additional 10 to the test for children of 24 and 30 months. In the Bayley Scale format, these are items numbered 100 to 153 and 100 to 163, respectively.

2. The Bayley Motor Scale

In exact parallel to the Mental Scale, the items of the motor scale are structured in increasing order of difficulty based on developmental norms established with a large U.S. sample. The full battery, applicable from birth to 30 months, consists of 81 items. For the application in the Solis sample, Dr. Field reduced the total number of items, selecting those that are appropriate for the 18 - 30 month preschooler. For the 18-month-old, the exam included 12 items (numbers 47-52, and 57-65 in the original Bayley format). At 24 months, an additional five items were added, including Numbers 47-52, 57-61, 65, 68, 70, 71, 73 and 75 of the original format. At 30 months, 22 items were included in the examination, using 47-52, 57-61, 65, 68, 70, 71, 73, 75-79, and 81 from the original format.

3. The Bayley Infant Behavior Record

The content of the IBR form used with preschool children was identical to the form used for infants, as described above.

4. Structured Toy Play

Dr. Field designed a structured toy play situation in order to observe interaction behaviors of preschoolers and their mothers. These were classified generally in terms of levels of affect, activity, and verbal output, and specifically, in terms of the following behaviors for children: 1) constructive play, 2) fantasy play, 3) looks at mother, 4) talks, 5) smiles, 6) play together (with mother), 7) seeks help or instructions, and 8) fussing or crying.

For mothers, the coding dimensions were: 1) constructive play, 2) fantasy play, 3) contingent responsiveness, 4) looks at child, 5) talks, 6) smiles, 7) demonstrates with verbalization, 8) coaxes child to try, and 9) gives commands.

C. School Age Children

As with the preschool child, the psychological data on school-age children cover two main categories – cognitive development and social emotional functioning. For the child of seven to nine years, the instruments that were used to collect data consisted of a cognitive test battery, a self-drawing task, observation on the playground and in the classroom, and teacher rating of child characteristics.

1. Cognitive Test Battery

The tests of cognitive functioning were drawn mainly from the Wechsler Intelligence Scale for Children (WISC-R) (15.3) with some additional measures. The components were as follows:

From the WISC-R:

1) Digit Span Task, in which the subject is asked to repeat sequences of numbers, first in the order they are presented to the subject, then in reverse order.

2) The Block Design Task that requires the subject to copy designs presented pictorially with a set of blocks.

3) The Arithmetic test, in which the problems to be solved arepresented in verbal form.

4) The Maze test, which requires the subject to trace a path from the center of a maze to a final outlet.

From other sources:

1) An "Attention Span" task, designed by Dr. Finley, in which the subject is asked to place a mark across rows of lines, working as rapidly as possible. The performance is scored in terms of the amount of time required to "cross off" all of the lines, and the number of lines crossed per second.

2) Raven's Progressive Matrices task,(15.4) in which the subject is presented with a pattern in which a piece is missing and asked to identify the part that is required to complete the pattern from a set of shapes, only one of which is correct.

3) Peabody Picture Vocabulary Test (15.5), in which the subject is asked to identify pictures that illustrate specific words.

2. Self Drawing Task

In this measurement, the child is presented with a set of colored crayons and a blank sheet of paper, 8.5 x 11 inches, with the request that he or she draw a self-portrait.

3. Playground Observation

This instrument is based on the observational framework developed by Drs. Barrett and Yarrow, and originally used to assess children's activity in Guatemala (15.6). The child's observed behavior during school recess is classified in relation to three general categories: 1) "Activities Toward Other Children," 2) "Relationship with Adults," and 3) "Relationship to Physical Environment." Within these categories, behavior is described with respect to a series of specific characteristics, such as "friendly," "aggressive," "seeking physical contact with adults," and so forth. Behavior is also classified by "level of activity" and "type of emotion."

4. Classroom Observations

The format for observing and recording the child's behavior inside the classroom consisted of four categories. At regular intervals, the child is coded as exhibiting one of the following behaviors: "talking," "playing," "off-task", or "out of the room."

5. Teacher Rating of Child Characteristics

The teacher ratings of the school-age children included two checklists. The first, based on the Behavior Problem Checklist developed by Peterson and Quay, is a list of 50 characteristics, such as "cries easily," "poor attention span," "often sad," and so forth. The child's teacher is asked to mark all of the items that apply to the child.

The second checklist, developed by Buck, consists of 25 additional characteristics that are explicitly designed to provide a basis for an "introversion-extroversion" score. For each characteristic, the teacher is asked to rate the child on a 5 point scale, in terms of its applicability to the subject.

D. Adults

The psychological data on the adult were limited to an assessment of cognitive performance, using a test battery that parallels that used for school children. In the case of women who are mothers of infants and preschool children in the sample, the mother's social-emotional behaviors in the social-interaction "tasks" were also assessed. The categories for maternal assessment are listed above under "Mother-Infant Interaction Observations" for infants and under "Structured Toy Play" for preschoolers. The tests with adults are identical to those described above for school age children.

III. PERSONNEL TRAINING AND SUPERVISION

The development, pre-testing, and supervision of data collection on cognitive performance in adults and school children was under the direction of Dr. Gordon Finley, Professor, Florida International University. Dr. Tiffany Field, Professor, University of Miami, had parallel responsibilities for the observational components of school child testing, and all aspects of infant and preschool testing, including observation of mother-infant interactions.

A. The Area Chief

The Area Chief for psychology joined the project staff in July, 1983. She received her licenciatura in psychology from the University of Morelos, and completed a year of postgraduate work at the Universidad Nacional Autónoma de Mexico (UNAM). She also had some field experience prior to joining the CRSP project

B. Fieldworkers: Recruitment and Training

The Area Chief had the primary responsibility for recruiting and training the staff for the psychological training. In September, 1983, she contacted the technical school for training social workers in the town of Acambay, a municipal center in a region close to Solis. From this school, five staff members (three men and two women) were recruited. Their educational background consisted of three years of secondary school training and three years in the social work technical school. A local school teacher was also recruited. His prior education included secondary school, four years of normal school, and summer courses to qualify as a secondary school teacher. Three high school students from Temascalcingo were also hired, bringing the initial staff of the psychology group to nine.

A North American graduate student in psychology, who had been hired by Dr. Field to help the Area Chief in the early phase of testing and training, arrived in Solis in the late summer of 1983. He and the Area Chief began training the fieldworkers with the cognitive tests for school age children in September, 1983. Children from Solis, not from the study communities, participated as subjects for the training.

The training procedure was as follows:

1. The Area Chief administered the test to a school child while the fieldworkers watched and filled out (coded) the examination sheet.

2. The coding was reviewed and problems were discussed in the full group.

3. One at a time, each fieldworker administered the test to a school age subject, while the others watched and filled in their code sheets. The coding was then reviewed and discussed.

4. Training of the fieldworkers for the school playground observations was carried out by Dr. Field's assistant. He took the fieldworkers (in smaller groups) to learn the procedures for the observational

study of schoolyard activity. Comparison of coding was the main way in which problems were discussed and observations standardized.

In October, 1983, the fieldworkers did trial studies of cognitive testing of school age children and school yard observations in another community in the Solis region, which was not one of the study communities.

In January, 1984, the Area Chief went to Miami to work with Dr. Field and her assistant, Ms. Nitza Vega-Lahr, on administration of the Brazelton examination on newborns and the Bayley Scales in infants and preschoolers. After her return, in February, 1984, she began training several of the fieldworkers in the application of tests for preschoolers. However, in March these fieldworkers, together with the other social workers who had been trained in the psychological testing procedures left the project. The Area Chief took over the preschooler testing for several months.

In June, 1984, Ms. Vega-Lahr visited Solis for two weeks and assisted in the training and supervision of field workers on Brazelton, Bayley, and behavioral observations.

In August, 1984, three psychologists from the University of Morelos joined the project as fieldworkers. They had completed all of their formal training for the licenciatura, except for the thesis and social service internship. After a brief period of training (following the procedure described above), they began testing preschool and school-age children.

Two of the three psychologists left in December, 1984 and in January, 1985, two psychologists, one from UNAM and the other from the University of Morelos were recruited. The Area Chief made a second trip to Miami to review the previously collected data and data collection procedures. In her absence, the new psychologists were trained by the fieldworker who remained with the project. A third university-trained student was recruited in March, bringing the staff to six, three of whom had university training and three with secondary school training. In the final months of data collection, a psychologist trained at the Universidad Autonoma Metropolitana (UAM) in Mexico City joined the staff, when one of the other psychologists indicated he would be unable to remain through the end of the project.

IV. DATA COLLECTION AND CODING PROCEDURES

In the discussion that follows, the information is organized by subject type. The schedule and procedures for administering the tests and observations are described first, followed by a description of coding procedures.

A. Infants

The Brazelton Neonatal Behavior Assessment Scale was given once, usually within 24-72 hours of birth. In a small number of subjects, who were not born in the health clinic in Solis, the examination was administered when the infant was brought to the clinic for a first medical examination. This event occurred between eight and 28 days after birth.

The Bayley Mental and Motor Scales were administered once at six months of age. The assessment of the child's performance by the psychologist, the Infant Behavior Record, was also filled out in conjunction with the administration of the Bayley.

The Mother-Infant Interaction Observation was conducted twice, once when the infant was three months of age and once at six months.

1. The Brazelton Neonatal Behavior Assessment Scale

All Brazelton exams were conducted in the Solis Clinic, where they were administered by the Area Chief or one of her assistants who had also received training in its administration. The psychologists followed the protocol initially

designed by Dr. Brazelton, proceeding through the numbered items in sequence, with appropriate pauses (as necessary) to allow the newborn to return to an alert state.

2. Bayley Scales and the IBR

The full battery of testing procedures on the infant at six months of age was scheduled to be administered in a single session. Usually, two psychologists (or a psychologist and a community assistant) went to the house together, so that the second person could attend to other young children and permit the mother to give her undivided attention to the testing.

The examiner began with items of the Bayley Mental Scale, followed by the items of the Motor Scale. The items of the Infant Behavior Record were filled out before the psychologist proceeded to the mother-infant interaction. If the infant appeared to be very sleepy or was crying hard and could not be readily calmed, the examiner stopped the testing procedure and returned on another day.

3. Mother-Infant Face-to-Face Interaction Observation

For this testing procedure, the mother was asked to sit on a bed or chair and to hold the infant facing her, supporting the baby's upper body and head. The psychologist asked the mother to play freely with the baby. The observer sat at a ninety degree angle to the mother and infant and recorded their behaviors on a form that included the items described above. The observation schedule was to observe for 10 seconds and record for five seconds, for a period of five minutes.

4. Coding The Brazelton Neonatal Behavior Assessment Scale

The coding system used in this study to classify the Brazelton items is the standard system developed by Lester (15.7). This produces seven subscales: 1) habituation, 2) orientation, 3) motor development, 4) range of states, 5) regulation of states, 6) autonomic stability, and 7) reflexes.

The Area Chief coded all of the Brazelton examinations, following the instructions on the use of the Lester system prepared for her and translated by Dr. Field and Ms. Vega-Lahr.

5. Coding the Bayley Scales and the IBR

The Bayley Mental and Motor Scale results are reported as the total number of items passed.

Two factors from the total IBR were utilized. To construct a score for a factor, the values for the individual items that comprise a factor were summed. Thus, the "cognitive factor" is the sum of the scores on: 1) orientation (with a range from 1-9), 2) direction (with a range from 1-9), 3) attention (with a range from 1-9), 5) reactivity (with a range from 1-9), 5) gross motor coordination (with a range from 1-5), and 6) fine motor coordination (with a range from 1-5).

Similarly, the three observation items that make up the extraversion factor are: 1) orientation (with a range from 1-5), 2) cooperation (with a range from 1-9), and 3) emotional tone (with a range from 1-9).

The Area Chief coded the IBR records to create the scores for the two factors.

6. Mother-Infant Interaction Observation

To derive a score for each of the classes of behaviors coded in the observation check list, the check marks in each row were summed and recorded at the end of the line. This addition was done by the observer and reviewed by the area chief. The interaction ratings on mother and infant (each of which was rated on a three point scale) were recorded directly in the data file.

B. Preschool Children

The project design called for the administration of the Bayley testing procedure to preschool subjects at three ages: 18 months, 24 months and 30 months. This schedule was generally followed, but a number of factors affected the exact date of testing. Children were not tested when they were ill, as judged by the presence of fever or the mother's report that the child was sick to the point that activity was altered. This delayed testing in some cases. The most common reason for a testing delay was the temporary absence of the family from the house or community. A third factor, which mainly affected testing at 18 months was temporary non-availability of a trained examiner, as a consequence of staff turnover.

The full battery of testing procedures on the preschoolers was scheduled to be administered in a single session. Prior to the test day, the mothers were contacted by the psychologists, the testing procedure was explained, and a time for the test was set up. An effort was made to schedule the testing session for the morning. For most families, the outside patio is a primary living area, and it was usually in the patio that the testing was conducted. In bad weather, the testing took place inside.

Typically, the preschoolers, especially at 18 months, were extremely shy. Frequently, they hid behind their mothers, and they often cried. Sometimes the examiners needed a first visit simply to establish rapport with the child, and testing would be delayed for a few days. More often, the test could be administered at the first visit.

1. Bayley Mental and Motor Scales

The examiner began with the items of the Bayley Mental Scale and then proceeded to the Motor Scale Items. If the child was cooperative, the testing then proceeded to the observation of Mother-Child Interaction. If the child was tired, cross, or otherwise not cooperative, the examiner stopped the testing procedure and returned another day.

Many of the test items require the tester to interact with the child about an object, such as a cup, colored boxes, rings, cubes, a doll, and so on. The objects are all included in the standard Bayley tester's kit, which resembles a large briefcase. The testing kit, with its standard items, was used by the examiners for all of the subjects in the Solis sample.

Before continuing with the structured observations, the psychologist filled out the Infant Behavior Record form.

2. Structured Toy Play: Mother-Child Observations

Following the Bayley, the observations began with the psychologist taking out a set of "Lego Blocks," colored plastic blocks that can be fitted together to make three dimensional objects or forms. The psychologist showed the mother how to manipulate the blocks to create objects, using both verbal instruction and demonstration. When it was clear that the mother understood the task, the psychologist asked the mother to show the child how to use the blocks. He or she then observed, without recording, for three minutes.

Following this trial period, the psychologist began recording the interactions on a check list that contained the categories described above. The procedure was to observe for 10 seconds, check the appropriate boxes for both mother and child and return to 10 seconds of observation until 60 observation units were recorded. During the interaction period, the psychologist also recorded verbal behavior on an audio tape recorder.

3. Coding the Preschooler Instruments

The results of the Bayley examination are normally presented in the form of the Mental Development Index (MDI) and the Psychomotor Development Index (PDI), which are standardized scores (15.2). Since they measure developmental processes, the assessment of an individual child's performance can be expressed as his/her achievement (at a given age) of behaviors that are normatively characteristically achieved by children of a given age. Population distributions are

this the yardstick of measurement in a manner that parallels the use of percentiles of weight-for-age or height-for-age to assess anthropometric performance.

However, while there is a theoretical, as well as an empirical basis to justify the use of an international standard for anthropometry, this is more problematic with respect to psychological development. When we examined the pattern of passes and fails on specific items in the CRSP sample, we found that the Mexican children apparently do not follow the same developmental sequence as that of the U.S. children. Some low numbered (hence "easier") items were failed by a large percent of the children in the Solis communities, while some very difficult ones were passed by most of them. This pattern of responses suggests one should be very cautious about using the standard scores even for intra-group analysis.

Given the difficulties of interpreting the standard MDI and PDI, the Bayley results were coded as a simple, additive score of "total number of items passed." Since every child was exposed to all the items in the test battery, these scores can be used to compare or rank the performance of all children in the sample.

The Mental Scale was obtained by counting the total number of items the child passed. The Motor Score was derived in an identical fashion.

4. Infant Behavior Record

As previously noted, the IBR is completed by the examiner, following the administration of the mental and motor scale items. Nine items from the IBR are used in the construction of the extraversion and cognitive factor scores: 1) responsiveness to examiner, 2) cooperativeness, 3) general emotional tone, 4) responsiveness to objects, 5) goal directedness, 6) attention span, 7) reactivity, 8) gross motor coordination, and 9) fine motor coordination. The individual items of the IBR require no further coding decisions after the psychologist fills out the form.

5. Coding the Mother/Child Interaction Records

At the conclusion of the observation session, the psychologist marked a code sheet, recording his/her judgments about the level of affect, activity and verbal behavior of the mother and the child on a three point scale.

On the observation sheets, the number of entries in each category are summed and recorded. The Area Chief reviewed all of the forms, checking for addition errors and missing data.

At a later date, the Area Chief scored the verbal material on the tapes, using the following coding categories: 1) total number of words spoken by the child during the ten minute interval of the interaction, 2) total number of times the child spoke during the session, 3) number of different words spoken by the child, 4) total number of words spoken by the mother during the ten minute interval of the interaction, 5) number of times the mother spoke during the session, 6) number of phrases spoken by the mother, and 7) number of commands given by the mother.

C. School Age Children

Four of the five types of measurements on school children were carried out twice – the cognitive test battery, self-drawing, classroom, and playground observations. The teacher assessment ratings were completed only once for each child. The first round of measurement on the children was begun in early 1984. The second measurement series took place in the fall of 1985, 15 to 18 months after the original measurement.

1. Cognitive Test Battery

In each community, the school administrator was asked to provide a room where the testing could be conducted without distraction. In all cases, the testing involved only the presence of the test administrator and the subject. When the community school could not provide a quiet place, the Area Chief secured a room in a nearby house. The testing took place

during the school day and the children were brought from the classroom to the testing room. Children who were not enrolled in school were tested in their home.

During the training period for the psychology staff, the importance of strict adherence to standard procedures was stressed repeatedly. For the components taken from the WISC, the instructions to the subject were translated from the English manual into Spanish. In the case of components not part of the WISC, Dr. Finley wrote the sentences that introduced the specific test and provided instructions to the subject.

2. Self-Drawing

Upon completion of the cognitive test battery, the psychologist put aside the materials used for that testing and produced a box of crayons, a pencil, and an 8.5 x 11 in. sheet of paper. The child was asked to make a drawing of himself/herself. When the child announced it was complete, the psychologist removed the crayons and pencil and then reviewed the drawing with the child, asking for a description or clarification of elements in the drawing. For example, if there was a dot in the mid-body the interviewer queried the child about its significance and noted the response directly on the drawing. In no case were additional details added to the drawing during this period of explanation.

3. Classroom and Schoolyard Observations

The same procedure for data recording was used in the classroom and schoolyard observations. The Area Chief prepared the forms for the observer, filling in the identification numbers of the children who were scheduled for observation on a given day. The full observation on a child was completed before a second child was studied. The observer, equipped with clipboard and watch sat in an unobtrusive spot, inside the classroom or at the edge of the playground. He or she then alternated 10 second intervals of observation with 10 seconds of recording the child's behavior, placing a check mark in the appropriate box in the matrix. For the three or four children who were not enrolled in school at the first measurement period, there are no records for classroom or schoolyard observations.

4. Teacher Ratings

Near the end of the school year in 1985, the Area Chief visited each schoolteacher who had contact with children in the study. The teacher was given a set of forms to fill out, with the individual child's name and identification number already placed on the form. A short time later, the Area Chief returned to the schools to collect the completed forms. These were reviewed with the teachers to check for completeness.

5. Coding The Cognitive Battery

At the time the cognitive data collection instruments were pre-tested, Dr. Finley wrote coding instructions, including translation of the relevant sections of the WISC-R manual into Spanish. The Area Chief's coding of trial testing during Phase I was reviewed by Dr. Finley. After the first round of testing was completed, the Area Chief met with Dr. Finley in Miami where they reviewed her scoring of a sample of data. All of the scoring of the cognitive test components was carried out by the Area Chief. Dr. Finley also reviewed the "acceptable ranges" for the computer range checking program prior to its use on raw data.

The coded scores were recorded on a separate coding sheet, from which the data were entered into computer files at the Salud Publica computer center.

6. Coding The Self-Drawing Test

The self-drawings of the school children were sent to Dr. Field for scoring. Dr. Field and her assistant rated the drawings on two factors, as follows:

1) Cognitive Factor, which assigns one point for each of the following characteristics: missing facial features, missing body parts, distorted body parts, displaced body parts, and disproportion.

2) Affective Factor, which assigns one point for each of the following characteristics: sad expression, mad expression, agitated appearance, small size, and animal-like characteristics.

7. Coding The Playground and Classroom Observations

As described above, the Barrett-Yarrow observation protocol involves a series of categories, grouped into three general classes. There are a total of 25 behavior categories. In each 10 second observation period, only one category is marked. The scoring requires a simple summation of the number of observation units for each of the 25 categories. The theoretical range for any one category is from 0 (that behavior never occurred) to 60 (the behavior occurred during all observation units) to be scored in each of the 60 observation periods.

The classroom observation scoring procedure is very similar to that used for the schoolyard observations. However, the summed scores are limited to the four categories described above.

At the end of the day, the psychologist who made the observations summed the number of check marks in each row and wrote these in a final column on the original form. The Area Chief later checked the coding. In Connecticut, the raw scores for each item were transformed into "percent of total observations".

D. Adults

The cognitive test battery was applied once to each adult in the study. Efforts were made to conduct the testing within a few months of entry into the study. In a few cases, however, mainly with men who are frequent migrants, the testing could not be completed until near the end of the family's participation in the study.

All testing of adults was carried out in the home. Several days before the scheduled test date, the Area Chief visited the family to explain the purpose of the testing and introduce the family to the psychologist(s) who would conduct the interview. The preferred procedure was to make an appointment to test both parents in the same visit, working with the mother first, then the father.

The psychologists usually went to the house in a team of two. One individual administered the test, while the second took care of small children, talked with other adults, and generally tried to prevent distractions and interruptions to the testing. In some homes, it was possible to carry out the testing in a separate room. In many cases, however, the testing was done in the patio.

The coding procedure for the adults was identical to the procedures used to code the cognitive battery for the school age children.

V. DATA MANAGEMENT AND ANALYSIS

A. Data Quality Control

For several of the testing procedures -- the cognitive tests on preschool, school-age, and adult subjects and the mother-child observation studies -- tape recording the interviews was an appropriate means of assessing quality of data collection. As each new procedure was put into place, or as new fieldworkers began working independently, tape recordings of every interview were made for at least two months. In the case of mother-child interactions, all interviews were tape-recorded throughout the project in order to code verbal behavior.

The Area Chief reviewed each tape, checking the manner in which fieldworkers gave instructions and asked questions. To the extent possible, the coded responses were also checked.

A primary mode of maintaining data quality was observation of testing by the Area Chief. Throughout the study she regularly attended testing situations, including the playground and classroom observations. In turn, she reviewed her own testing procedures by comparison with Dr. Field's assistant, both in Miami and in Solis. When problems were identified, the issues were discussed with the individual fieldworkers or, as relevant, in group meetings of the psychology field team.

B. Data Coding, Entry, and Checking

Coding procedures and data quality control of coding are described in the sections on tests for subject types. Data entry for all psychological measures was done at the Public Health Data Center, using the standard project procedures. Data cleaning and correction also followed the standard routine of: 1) visual checking of raw data printout against the original coding forms, followed by correction of errors; 2) range checks for illegal and out-of-range values; and 3) range checks for 5th and 95th percentiles, followed by correction from original data or flagging of bad or suspicious values, as necessary.

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Chapter 16

ACTIVITY STUDIES

I. PURPOSE

Three different protocols were utilized for activity studies, each focusing on a different target group (adults, mothers and their preschool-age children, and families). The first protocol assessed time allocated by adults to various activities on a daily basis, over the study period between January and December, 1984, in 5 communities (San Miguel, Cerritos, San Nicolas, and San Antonio for the full period; July - December in Calderas). Data were also collected on sleep and relaxation patterns, female participation in agricultural/food gathering activities, adults' participation in social and childcare activities, and household distribution of activities for target families. These protocols were designed to explore the relationships of time spent in different types of activities, with nutrient intake and nutritional status.

The second protocol was carried out from February, 1985 through May, 1986 in three communities (Cerritos and San Nicolas for the full period; May, 1985-May, 1986 in San Antonio). This protocol was designed to examine the social costs of marginal malnutrition in terms of its effects on activity patterns, social interactions, and behaviors/emotions of mothers and their preschool-age children. Additionally, activity levels of subjects were estimated with actometers, the hygiene of individuals and their environment was observed, and women's participation in harvest activities was assessed (with special attention to differential time allocations to childcare, domestic, and social activities by women in association with male migration). Seasonal variations in activity patterns of women and their preschoolers were also examined. Finally, this information was integrated with data from other areas of the Phase II study, determining predictors of activity patterns and social interactions of women and preschool-age children.

The third protocol examined the distribution of activities in the family during school and vacation periods. One questionnaire was administered to each family in the study during April, May, or June of 1986. Data were collected on family and community organization of tasks (domestic work, childcare, animal care, agricultural activities, home improvement, and income-generating activities) and the frequency with which these were carried out. These data were integrated with information from other areas of the CRSP. They will be used to examine the potentially confounding effects of intra-familial task allocation, in analyses of the relationships between nutritional variables and activity patterns of individuals.

II. DATA COLLECTED

A. Adult Men and Women

All target adult males and females in the sample during 1984 were included in the adult activity study. Data were collected by interviewers (auxiliary workers) using 24-hour recalls of activities. Minutes of sleep and total minutes in each activity over the 24-hour period were recorded. Additional data on sleep and relaxation patterns of the adults interviewed, their participation in social and childcare activities, and the participation of women in agricultural/food gathering activities were also collected. In addition, household distribution of activities of these families was examined.

B. Women and Toddlers

The sample included all women aged 18-25 years who had toddlers (18-30 months), were residents of Cerritos, San Nicolas, or San Antonio, and were already participating in the larger CRSP study (n=49). Forty-one (85%) of these mother-toddler pairs successfully completed the study. Three pregnant women from San Antonio, without toddlers, were also observed. All completed the study, increasing the total number of women observed to 44.

Data were gathered by observers during a series of 10-minute observations (11 observations, one per hour, during consecutive hours over a 10 hour period) on an observation day. Data observed and recorded included: locations, body positions, activities, social interactions, presence of other persons not in interaction with subjects, and behaviors and emotions for each target individual. Observations were made upon entry of the observer to the home each hour and then recorded for the continuous 10-minute period. The initial activity of each hour was identified as the "spot" observation, assuming that this activity was less influenced by the presence of the observer. Additionally, "principal activities" (in terms of time) performed during the 10-minute timeslot, perceived influence of the observer's presence on observed activities and behaviors in the 10-minute spot, and cleanliness (of individuals and their clothes, if the toddler had been changed/cleaned since prior observation, and cleanliness of home and patio) were recorded.

Actometer measurements were taken from toddlers and mothers, simultaneously when possible, but at least on the same day. The watch-like instruments were placed on the wrist of the nondominant arm to measure frequency of movement. Actometer readings were taken hourly after the spot observations. The total movements per 10 hours were then used to estimate activity levels. Quantitative and qualitative data were also obtained on women's observed participation during the harvest period of 1985-86. The lead female was asked to recall her participation in various harvest activities, what assistance she received, time spent performing these tasks, and the amount of fatigue experienced. Also recorded was the involvement of other family and community members. Lastly, the participation of the mother and other family and community members in domestic, childcare, and social activities during that time period was examined.

C. Family Distribution of Activities

Data on family distribution of activities were collected from all families who either had completed the CRSP study or were presently active participants. Data recorded on family distribution of activities included individual(s) responsible for each activity, the frequency with which it was carried out by the individual(s), individual(s) assisting the "responsible" person(s), and the frequency with which the person(s) assisted. Differences in household distribution of work had been noted to change with vacation and school periods. Therefore, data were collected for both time periods.

III. DATA COLLECTION PROCEDURES

A. Interview Structure and Schedule

1. Adult Activities

Community social workers notified target households, prior to the scheduled interview date, that an auxiliary worker would be interviewing subjects. Individuals were interviewed either in their homes or elsewhere in the community at the scheduled interview time. In this protocol, questionnaires were administered on two consecutive days each month for the duration of the study; for a total of 24 interviews per adult subject in four communities and 12 per adult in the fifth community.

Interviews were conducted on all days but Sunday, rotating days by months. For example, females who were interviewed on Monday and Tuesday in January might be interviewed on Wednesday and Thursday in February, and Friday and Saturday in March. The cycle was then repeated. This provided a total of four interviews per day of the week. Be-

cause families in the community of Calderas did not enter the study until July, 1984, only two interviews per day of the week were obtained from adults in these families.

2. Women and Toddlers

Women aged 18-45 with toddlers were included in the study, regardless of the physiological status of the mother (pregnant, lactating, or not). Spot and hourly observations, as well as data from actometer readings, were conducted from 8:00 a.m. to 6:00 p.m. once a month, for a total of 13 months. Observations were conducted on all days of the week except Sunday. One day of observations was carried out per month for 13 months. The day of the week was therefore not repeated until the latter half of the study, when all six days had been included. The 13 total observations per target individual included two on each day of the week (except Sunday), plus the initial observation. The first day of observations for each family, however, was not included in analyses because both the observers and target individuals were not yet familiar with the study. No interviews were conducted in August, 1985 because observers were on a month-long holiday. Harvest-activity information was collected with a separate interview form administered once to each family, on the day the family was scheduled for observation during February or March, 1986.

3. Family Activities

The questionnaire was administered to the lead female in her family home. Women were notified in advance of the scheduled interview. All women participating in the CRSP were interviewed, although the questionnaire was not administered to families in one community (San Jose Solis). This questionnaire was administered once to each family, following the spring school vacation. Families in the Mother/Toddler Observation study were interviewed during April or May, 1986; all other families were interviewed in June, 1986.

B. Personnel Training and Supervision

Between January and June, 1984, fieldworkers administering the questionnaires from the Adult Activity Recall were trained and supervised by a physician specialized in human physiology (the first Activity Study Coordinator). Subsequently (July - December, 1984), fieldworkers were supervised by community nutritionists who were under the supervision of a second Study Coordinator, a doctoral student in the UConn Nutritional Sciences program. Although a comparison study has not been performed, we expect that the supervisor change had no effect on data collected since the same auxiliary workers interviewed families between January and December of 1984. During their respective halves of the study, both the Study Coordinator and community nutritionist randomly accompanied auxiliary workers (the interviewers) to the households.

Technical-level social workers were trained for the mother-toddler study by the Second Coordinator. Accuracy of the mother-toddler observations was assessed by having both the Coordinator and fieldworker perform observations for the first few months of the study. Both sets of observations were recorded without exchanging information during the process. The two observations were later compared and differences, if any, were discussed. This continued, though less frequently (approximately 33% of the observations), during the second half of the study. However, all observations were reviewed by the Study Coordinator. The Coordinator also accompanied observers during all the harvest activity interviews. All completed questionnaires were then reviewed by the Coordinator and respective observers prior to data coding.

Interobserver reliability for mother-toddler observations was measured at the initiation of the study and again during the final months. Reliability calculations were carried out for approximately 10% of all observations by having two observers simultaneously carry out the observations over an entire day. The Coordinator later coded the recorded observations of each fieldworker, and then calculated interobserver reliability by comparing differences between the two coded forms.

Observers working with families participating in the Mother/Toddler Observation study were recruited to administer the Family Activity questionnaire to those families. Interviewers for all other families included in the Family Activity

portion of the protocol were nutritionists, who interviewed families from whom they had previously collected nutritional data. The Study Coordinator trained the observers from the Mother/Toddler study on their use of the Family Activity questionnaire, accompanying the observers on half of the family interviews. She later trained the nutritionists in administering the questionnaire, supervising its administration in the five communities. The Coordinator did not accompany the nutritionists when they administered the family questionnaires because additional project responsibilities did not permit her direct involvement. She did, however, review all of the questionnaires administered by nutritionists and observers.

IV. DATA MANAGEMENT AND QUALITY CONTROL

A. Primary Coding of Data

Questionnaires on adult activites (1st protocol) were coded on the original interview forms. Codes were established for 174 activities (e.g. making tortillas, harvesting, lying down, etc). Data from the 24-hour recall sections were later transferred to intermediate code sheets by Auxiliary Workers, who calculated the number of minutes spent in each activity. As of September 1984, the questionnaires were coded by nutritionists trained by the Coordinator. In the first half of the study, the Coordinator coded all questionnaires. This function was taken over during the last six months by the nutritionists for their respective communities, with the Coordinator reviewing each coded form and conferring with nutritionists on detected errors.

The codes for variables in the women and toddlers observations were formulated by the Coordinator, based on a code book devised after review of hundreds of field observations. Observers coded only standard project identification, form of application (noting departures from the protocol) and actometer data in the field on the original interview forms. These were reviewed by the Coordinator prior to data entry. The Coordinator and her co-worker (a university-educated nutritionist trained by the Coordinator) coded observations on separate coding forms, utilizing the forms on which the observations on the household had been recorded in the field. Codes were established for 44 activities (e.g. sleeping, active play with objects, interacting verbally with family member, etc.), each with 15 identifying attributes (e.g. demanding attention) and 21 behaviors (eg. smiling, crying). All information not reducible to a code (qualitative data) was also attached to the observation and coding sheets.

Inter-coder reliability between the Coder and the Coordinator was calculated based on several hundred observations coded independently by both women. During the latter part of the study inter-coder reliability between the Coordinator and the coder was calculated for 10% of the observations. In this way, consistency in the interpretation of recorded observations was assured. At the completion of coding, a final review of coded data was performed by the Coordinator prior to microfilming coded forms. These microfilms were sent to Mexico City and data were entered into the computer by personnel at Salud Publica. All harvest-participation questionnaires were coded by the Coordinator using a separate code sheet to transfer the data. Questionable data were reviewed by her with the observers. A final review of the coded forms was performed by the Coordinator prior to computer entry of data.

Codes for variables on the family questionnaires (protocol 3) were formulated by the Study Coordinator, as were codes for the other two instruments in this protocol. The family activity data required 76 codes for different activities. Information recorded on the family interview schedules was coded onto a special coding form, identical in structure to the questionnaire (with additional spaces allotted for recording codes). The Coordinator coded the questionnaires administered to the 45 families in the Mother/Toddler Observation study; the nutritionists coded the other questionnaires. The Coordinator reviewed all coded interviews prior to computer entry of data.

B. Error Checking and Correction of Data

From January through June of 1984, the first Coordinator reviewed each completed Adult Activity Recall questionnaire with the interviewer who had administered it. These data were later recoded by the second Coordinator due to an al-

teration in the study protocol. Questionable data were discussed and verified, which sometimes required the fieldworker to return to the target household to readminister the instrument. This function was taken over during the last half of the study by the nutritionist. The Coordinator, at that time, reviewed all questionnaires, consulting with the nutritionists about suspect data. Two auxiliary workers and the Coordinator reviewed code sheets against original questionnaires. Archive personnel in Solis checked identification data on the coded sheets against sample census data.

Coded data for the Activity Recalls were then entered onto computer tape and brought to the IBM Scientific Center. Using SAS, a frequency distribution of every item was made to assist computer-aided detection of illegal codes and out-of-range values. A program was also written to sum the number of minutes individuals spent per activity, creating the "total minutes in activity" variable. The value for the variable "total minutes of sleep" per individual was added to his or her score. If the two did not equal 1,440 (total number of minutes in a 24-hour period), the code sheet and original questionnaire were again reviewed and all values recalculated.

A third Coordinator for the Adult Activity segment of the study, employed from August through December, 1986, reviewed frequency distributions, marking all out-of-range values. A computer program was written, printing out data for all suspect variables, as identified above. This printout was referred to the Coordinator, who worked with auxiliary workers in Solis to identify and correct errors. First, code sheets were checked for keypunching errors, identifying and noting corrections. If no keypunch errors were detected, the original interview schedules were checked for coding errors during the transfer of data to the code sheet. Such errors were also identified and noted. If information was inconsistent, the Coordinator or auxiliary worker then corrected these values. If such corrections were not possible, codes were changed to "missing."

The data correction form was then returned to INN with the computer printout of suspect cases. Corrections were reviewed with the data management person responsible for correcting the data tape. Corrections were made in the activity data on tape, a copy of which was forwarded to Connecticut. As with the adult activity recall data, values for coded mother-toddler observations were examined with a SAS program. Frequency distributions were reviewed by the Study Coordinator who marked all out-of-range values. Suspect data were printed and checked against the code sheets for keypunching errors. Any such errors were identified and corrected. If none were found, then original observations and interviews were checked for errors occurring during data transfer to code sheets (this did not apply to identification, form of application, or actometer data, for they were coded on the original forms). Errors detected on original forms were identified and noted. This process was also utilized for harvest questionnaire data. Any inconsistencies between information on original forms and code sheets were corrected by the Coordinator, if possible. When corrections were not possible, codes were changed to "missing." Data correction forms and the computer printout of suspect data were reviewed by the Study Coordinator, who entered corrections onto tape at Connecticut. This tape was duplicated and a copy sent to INN in Mexico City.

Any questionable data on the Family Activity forms coded by the nutritionists were reviewed by the Study Coordinator with the nutritionists. The Coordinator did a final review of all questionnaires, checking for errors. Coded forms were then microfilmed and sent to Mexico City to be entered by personnel at Salud Publica. The error-checking procedure described above (using frequency distribution to check for errors, etc.) was employed to check these data as well. Any noted errors were corrected, if possible, by the Coordinator, or changed to "missing" values. The final corrections were entered onto the tape at Connecticut and copies sent to INN.

Chapter 17

DATA MANAGEMENT

I. INTRODUCTION

The term 'data management' is a somewhat imprecise term often used to cover a wide variety of data-related activities. In the case of the Mexico Nutrition CRSP, the range of activities included under this gloss are somewhat broader than commonly used. We use the term to describe activities related to: (a) the management and archiving of completed research instruments, including the revising of original forms prior to data entry, (b) the establishment of protocols for data entry, (c) the preparation of collected data for data entry, (d) the screening of entered data prior to extensive data processing, (e) the transfer of computer-usable data from INN to the University of Connecticut, (f) computer-aided detection and processing of suspect data, (g) the preparation of data for statistical analyses, (h) the transfer of data to INN, (i) the transfer of data to the statistical staff at the University of Massachusetts, and (j) the transfer of data to the M.E. A schematic of the various pathways through which data flowed during the project is provided in Figure 17.1 at the conclusion of this chapter.

II. THE PROCESS OF DATA MANAGEMENT IN THE MEXICO NUTRITION CRSP

A. Management and Archiving of Completed Research Instruments

The numerous questionnaires, recalls, and other measurements administered by the research project required methods for tracking each piece of paper generated. As each questionnaire was completed, it was given to the appropriate area chief for review. Once reviewed, the forms were then given to the data management unit at Solis, where a record was made of the receipt of the form. The completed forms were then reviewed by a team of workers for completeness of the information on the front page of each questionnaire (subject, household, and community identification numbers, interviewer identification numbers, date of application, etc.). Forms were stored in plastic bags in Solis organized on the basis of data area, month of application, and community.

In 1986, all the original forms, questionnaires, etc. were microfilmed as a lasting record of the original, raw data.

B. Establishment of Protocols for Data Entry

During Phase I, each item on a research instrument was numbered in order to facilitate data entry. However, a number of these early protocols were flawed for a variety of reasons. All of these research instruments were constructed with the idea that data entry would be done by professional keypunchers located at modern facilities in Mexico City. Early in Phase II (January, 1984 - May, 1985), access to professional keypunching facilities was unexpectedly unavailable (see below, Developing a Data Management System). As a result, data entry was performed using text editing software run on Apple II microcomputers. Given the limitations of a hastily designed Apple II-based data entry system, many existing data entry protocols were modified so as to restrict the data entered to that deemed most essential.

Later in Phase II (June, 1985 - May, 1986), access to professional keypunching became available. All large data sets, even those previously keypunched using Apple IIs, were subsequently re-punched by professional keypunchers using a two-pass data entry system. However, most original data entry protocols were altered. Some alterations were simply a continuation of protocols established for use with the Apple II's. Other protocols reflected the concern for reducing the amount of data to be entered (e.g. Morbidity). A few areas of inquiry lacked data entry protocols, and forms and codebooks were developed during Phase II.

C. Data Entry

1. Preparation of Data

In most areas, the data keypunched came directly from the original research instrument. In other areas, the original data were recoded using Hojas de Vaciado (codesheets). Areas which were recoded include Morbidity and some areas of Psychology. In the area of Psychology, well established and complex methods have been developed for the derivation of standard scores from the many items in the research instrument. It was believed by project psychologists that these data sets were more amenable to coding by hand than by coding by computer. In the area of Morbidity, the recoding of data was necessary given the research instrument, which was poorly designed for large-scale keypunching.

2. Keypunching

Nearly all areas of data were keypunched by professionals at the Mexican Public Health Department's (Salud Publica) two-pass data entry system. In a few data areas, small data sets were keypunched on Apple IIs and IBM compatible microcomputers using word processing software. This method was employed because the design of the research forms was not amenable to large-scale data entry systems, requiring specially trained personnel for data entry.

D. Screening and Correction of Entered Data in Mexico

A labor intensive method of screening data after keypunching was employed by the Mexico Project. After data entry, listings of the keypunched data were generated and returned to the field headquarters at Solis. Teams of local workers were employed to check each line of data against the original form used by the keypuncher. When errors were detected, the problem was circled and the correct figure written in the margin. These listings were then returned to Mexico City where copies of the keypunched datasets were edited, the corrected value replacing the value in error. Corrections were done using text editors operating on a minicomputer installed at INN, and a mainframe computer located at Mexico IBM's Centro Cientifico (Scientific Center).

The labor intensive method of data screening employed in Mexico proved to be highly effective. Data sets cleaned using this method are generally quite clean, with the number of out-of-range values well below 1%.

Since the screening process occurred in a rural setting (Solis), the monetary cost to the project was quite modest, while local youths were provided with employment. Hand-screening of data was clearly slower than computer-aided range-checking procedures, but errors were detected which computer-aided methods would likely have missed. Moreover, the employment of computer-aided data screening methods would have required additional Mexican personnel for computer programing and would have competed with limited access in Mexico to powerful mainframe or minicomputers.

E. Transfer of Computer-Usable Data to Connecticut

As stated above, the first 18 months of Phase II were marked by data entry based on Apple II microcomputers. Data were transferred to Connecticut via diskette where they were transferred to the university computer via modem. Demands on microcomputer resources were such that screening and correction of data were impractical. Over 120 diskettes were sent by INN to Connecticut and transferred to the University's mainframe computer.

Once data were keypunched at Salud Publica, data were sent to Connecticut recorded on magnetic tape. A few data sets keypunched on microcomputers were initially sent to Connecticut on IBM PC format diskettes. These datasets were then transferred to the University mainframe computer using a dedicated phone line and a high speed modem.

In the early and middle periods of Phase II, data were sent to Connecticut before data screening and data correction in Mexico. Later, as data sets were screened and corrected, updated versions of the data were sent to Connecticut. By mid-1986, data sets were sent to Connecticut only after screening and correction at Solis.

Nearly 1 million lines of data were transferred from INN to Connecticut during Phase II. This number does not take into account data sets which were sent in various versions to Connecticut. Data set sizes range from nearly 500,000 lines of data for Food Intake to a few hundred lines for files such as Climate and Mortality (see Table 17.1). The final versions of these data sets arrived in Connecticut during the period December, 1986 through May, 1987.

F. Computer-aided Detection and Processing of Suspect Data at Connecticut

The detection of suspect data at Connecticut occurred by both intentional and inadvertent means. During the first 18 months of Phase II, suspect data were detected during the course of normal data processing activities, e.g. the preparation of annual and semi-annual reports, as well as materials to be presented at SCB meetings.

Early in Phase II, suspect values were sent back to Mexico for scrutiny and possible correction. However, the demands of data entry and limited computer resources made responses to Connecticut's queries extremely difficult.
During the summer of 1985, once data were being keypunched and INN had access to a mainframe computer, the first range-checking programs were written in SAS by Connecticut-based staff working in Mexico City. However, the correction of errors detected by the screening of data in Solis, and the preparation of data sets for transfer to Connecticut fully occupied INN's data management resources.

During the summer of 1986, once Connecticut had begun to receive data sets in relatively final form, U.S.-based staff began to systematically screen data sets, using SAS programs specifically designed for this purpose. This screening always employed some kind of range-checking. In some cases this range checking might be bivariate or multivariate. For most data sets, range-checking was univariate. Suspect values were referred to INN for scrutiny and possible correction. Because of the continuing demands of data entry and correction in Mexico, responses to Connecticut's queries became a common event only in the spring of 1987.

G. Preparation of Data for Statistical Analyses

University of Connecticut data management staff did most of the preparation of data for statistical analyses. Connecticut-based staff performed the following tasks:

1. **Modifying suspect values**: When Connecticut data management staff detected an error or suspect value, the original value was recorded in a special SAS data set containing data records with errors. The suspect value changed in the main SAS data set to one of SAS's special missing values (i.e. .A or .B). In cases where the correct value could be determined with reasonable certainty, a line of SAS program code was written which "corrected" the error and documented the correction.

2. **Creating derived variables**: A large number of derived variables were created. These ranged from variables which are computationally simple to create, such as weight-for-height, to more difficult variables such as the nutrient and morbidity variables. In the case of anthropometry, data management staff adapted, for use at Connecticut, the Center for Disease Control's FORTRAN program for generating age-standardized measures of weight and height.

3. **Defining target households and subjects**: In a few cases, a small amount of information was collected on an individual. For statistical and data management purposes, the Mexico project defined

two subsets of subjects with some data: the relatively unrestrictive (in terms of the amount of data collected on the subject) "cross-sectional sample", and the more restrictive "longitudinal" sample. Data management staff wrote a series of programs which gathered the information necessary for defining targets, and then generated a SAS targets data set containing variables such as ID's, sex, birthdate, and "window" dates determining whether a measurement fell within a "legal" time period. This data set became one filter through which all data were passed prior to statistical analyses.

4. **Creating "analysis" datasets:** University of Connecticut data management staff created nearly all data sets containing data generated by different research instruments. A few data sets analyzed by INN-based staff were created by INN-based data management staff using IBM Centro Cientifico's mainframe computer. These "analysis" data sets were sent from Connecticut to the University of Massachusetts and to INN for statistical analyses. This was done because of Connecticut's superior computing facilities, and the concentration of experienced SAS programers available at Connecticut. Also, the centralization of data manipulation, prior to statistical analyses, was seen as essential to coordinating statistical analyses occurring at three different sites: the University of Connecticut, the University of Massachusetts, and INN.

H. Transfer of Data to INN

As described above, the first data transferred to Connecticut during Phase II were recorded on floppy diskettes. These data were transferred to Connecticut's mainframe computer and then recorded on magnetic tape. A copy of this tape was then sent to INN. Once INN had acquired a mainframe computing capacity, the following data were sent to Mexico: (a) data sets containing derived variables, such as the nutrient variables, and (b) copies of all analyses data sets sent to the University of Massachusetts.

In addition, a number of programs were sent from Connecticut to Mexico. Of note were the Connecticut-written nutrient conversion program, the Center for Disease Control program for generating age-adjusted measures for weight and height, and a program for computing the physiological status of women (including day of pregnancy and day of lactation) for any date in the study.

I. Transfer of Data to Massachusetts

The Department of Biostatistics at the University of Massachusetts School of Public Health at Amherst was the site of most statistical analyses, which were supervised of Dr. Edward Stanek. After a brief experiment using Massachusetts' mainframe computer, a decision was made to conduct all statistical analyses at the University of Massachusetts, using SAS for the microcomputer. As a result, Connecticut created special "analyses" data sets which were then transferred to Massachusetts on diskettes. The data on each diskette was accompanied by a SAS program for creating a SAS data set, allowing the user to exactly duplicate the SAS data set available on permanent disk at Connecticut. Each data set also contained notes on the background of each data set, the nature of its creation, caveats, etc. Two copies of each of these diskettes were kept at Connecticut.

J. Transfer of Data to ME

As data arrived in Connecticut, preparations were made for the transfer of these data to the M.E. for archiving. With rare exceptions, the data sent to the M.E. were exact copies of data as sent from Mexico. These data were recorded on standard label tapes. Documentation was prepared in Connecticut to accompany the tape. As a general rule, documentation was as follows:

1. a table listing each file on the tape, the file's format, and the number of the codebook associated with the file,

2. notes and comments on each file,

3. computer generated output (from SAS's PROC TAPELABEL) showing the contents of the tape, and

4. a set of English codebooks associated with the included files.

Later, when several generations of some datasets had been sent to Connecticut, a table was included which listed the current data files and the tapes on which these data sets could be found.

In a few cases, SAS data sets were sent to ME. It was hoped that Connecticut would have the time and resources to send all data sets to ME in SAS format, using the guidelines defined in the document Nutrition CRSP Basic Data Set (September, 1984). However, with one exception, anthropometry, this proved impractical.

III. FINAL ARCHIVING OF DATA AND DATA MANAGEMENT MATERIALS

In the final months of the Mexico Nutrition CRSP, plans were developed for the final archiving of materials of future use to the Principal Investigators and others interested in using Mexico project data. To be archived are:

1. a set of tapes containing all the final versions of raw data received from INN,

2. a complete set of Spanish codebooks accompanied by their English translations,

3. documentation linking each raw data set with its associated codebook,

4. a set of tapes containing all significant SAS data sets created by Connecticut-based staff,

5. a set of tapes containing all programs used to generate significant SAS data sets,

6. documentation explaining the purpose of each archived SAS program and any information necessary for interpreting the SAS code. The sequence of activities necessary for recreating each archived SAS data set will be fully documented.

7. manuals for each of the data areas detailing procedures for data collection, coding, error detection and correction.

Data files archived at UConn and transferred to the M. E. for archiving are listed in the following table.

TABLE 17.1
MEXICO CRSP DATA FILES ARCHIVED AT U CONNECTICUT AND UC BERKELEY

AREA	NUMBER OF LINES
ACTIVITY	
Women (84)	56,276
Men (84)	111
Men	6,675
Family	13,846
Obs./Women	65,076
Toddlers	
Harvest	259
ANTHROPOMETRY	
Targets	6
"	367
"	3,695
"	1,135
"	810
"	682
Family	699
Schoolers	56
BLOOD ANAL.	2,828
BASAL CENSUS	5,361
CLIMATE	1,151
CLINICAL HISTORY	
Women	10,621
Preg/Lact	33,003
Men	9,796
Pediatric	39,334
Subsequent Ped. Hist.	850

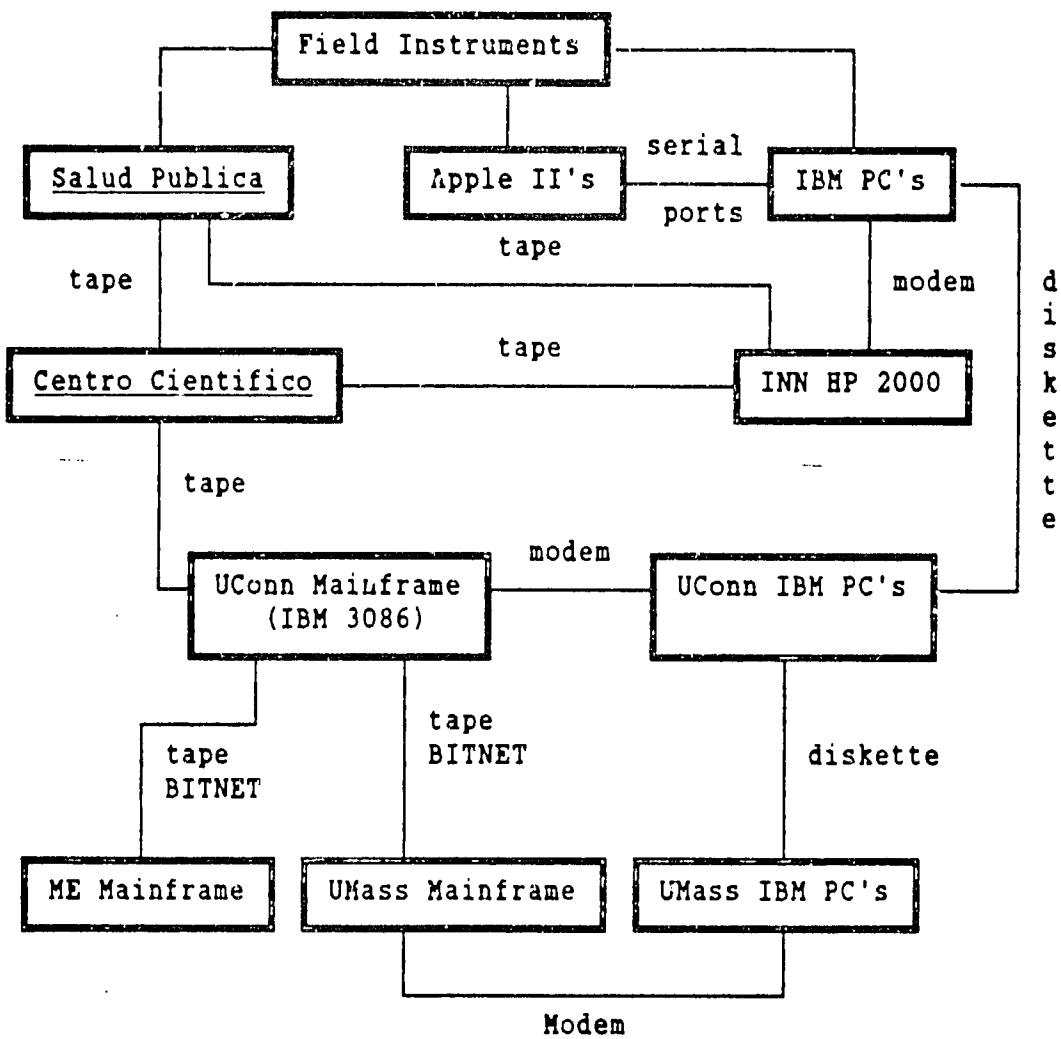
AREA	NUMBER OF LINES
DIET	
(Version 1)	49,681
"	48,383
(Version 2)	51,175
"	38,524
"	52,794
"	46,670
"	21,877
"	68,189
DIET SUBSTUDY	4,723
	2,504
	2,227
FECAL ANALYSIS	2,618
MILK	
Creamatocrit	253
Milk Collection	272
MORBIDITY	
Mexico Meth.	36,522
M.E. Method	5,872
MORTALITY	603
PHYSICAL EXAMS	
Adults	17,841
Women with newborns	6,040

TABLE 17.1 (CONTINUED)

AREA	NUMBER OF LINES
PRODUCTIVITY	
Past Harvest	212
Part I (84)	324
Part II (84)	582
Part I (85)	1,224
Part II (85)	1,406
Part III	597
PSYCHOLOGY	
INFANTS	
Brazelton	61
Infants/3m	95
Infants/6m	99
Mother/Child Interact.	97
Bayley Mental	97
Bayley Motor	97
IBR	97
TODDLERS	
18 months	
Bayley Mental	94
Bayley Motor	94
IBR	94
Toddler/18m	101
24 months	
Bayley Ment.	117
Bayley Motr.	117
Bayley Lang.	117
IBR	117
Toddler/24m	118
30 months	
Bayley Ment.	96
Bayley Mot.	96
Bayley Lang	96
IBR	96
Toddler/30m	96

AREA	NUMBER OF LINES
PSYCHOLOGY	
SCHOOLERS	
Teacher Eval	188
Int/Ext	188
Observations	113
Classroom	213
Playground	203
Cognitive	292
ADULTS	
Cognitive	452
RMR	1,934
SANITATION	9,378
SES/MIGRATION	1,088
SOCIOCULTURAL	588
URINALYSIS	
Part I	1,995
Part II	5,095
Part III	1,995
WEEKLY HOUSEHOLD FOOD USE	86,474
FOOD PRICES	7,907

FIGURE 17.1: DATA FLOW PATTERNS IN THE MEXICO CRSP



PART III

RESULTS

Chapter 18

PHASE II DESCRIPTIVE DATA AND PRELIMINARY ANALYSES--INTRODUCTION

Descriptive data from Phase II of the Mexico CRSP are provided in the 10 chapters which follow (19-28). These are generally organized according to data area (food intake, anthropometry, etc.) with the various target groups as subunits of analysis, a format which reflects the structure of data entry and management of the Phase II data sets. The final three chapters in this section report preliminary analyses of relationships of food intake, morbidity, and toddler growth (29); food intake and toddler psychological development (30); and food intake and pregnancy outcome (31).

The data sets from which these descriptive data have been generated require some clarification. Most importantly, cross-sectional and longitudinal target samples were derived according to specific criteria from the raw data entered in Mexico. The necessity for these refinements of the data sets and the criteria employed are outlined below.

I. PHASE II DATA

Data, in some form, from virtually every interview or measurement made in the project was entered into computer files and sent from INN to Connecticut. This inevitably led to transfer of significant amounts of data which could not or should not be utilized in the project's analyses. For accuracy, clarity, and consistency, therefore, these problematic data had to be excluded before analyses could proceed. Problematic data that had to be addressed included the following:

1. Data collected on families who dropped out of or were dropped from the study, after a relatively short involvement,

2. Data collected on non-target subjects, or data on target subjects collected at a time when they were outside of target "windows" (e.g. an infant who was followed beyond his or her 9th month of age, etc.),
3. Records with miscoded or missing data critical for creation of analysis files (e.g. birthdate, sex, or other identification information, etc.).

In the case of missing, apparently miscoded, or out-of-range data, efforts were made to update data sets by referring error lists to the field for correction (see quality control sections of methodology chapters and Chapter 17). Data sets were updated with these corrections as much as possible prior to generation of the descriptive analyses for the final report.

II. CROSS-SECTIONAL AND LONGITUDINAL DATA

With regard to the descriptive data and analyses presented in this report, the strategy has been to create two samples: a "cross-sectional" sample and a "longitudinal" sample of subject types (targets). The purpose of the cross-sectional

sample was to preserve as much data as possible for use in some analyses, such as description of a population at a specific age, etc. The longitudinal sample was derived by applying additional criteria to the cross-sectional samples in order to create data sets which could support longitudinal, multivariable analyses.

The cross-sectional and longitudinal samples were selected according to the following criteria:

Cross-sectional Sample Type

Cross-sectional target children had to meet the following minimum criteria:

1. At least one diet or anthropometry measurement during the study period (01/01/84 - 05/31/86);

2. A valid birthdate and sex from the Census file;

3. birthdates which fell within the following "windows":

   * for INFANTS: a birthdate which fell between (a) 254 days before the beginning of the project, and (b) the end of the project.

   * for TODDLERS: a birthdate which fell between (a) 997 days before the beginning of the project, and (b) 533 days before the end of the project.

   * for SCHOOLERS: a birthdate which fell between (a) 3653 days before the beginning of the project, and (b) 2192 days before the end of the project.

Cross-sectional target adults had to be identified as the parents of a target child. Two mothers of target children were not identified. Four fathers of target children were not identified.

Longitudinal Sample Type

Members of the longitudinal sample are persons in the cross-sectional sample who met the following additional criteria:

LEAD MALES:
1) at least 2 anthropometry measures during the study period, and
2) at least 2 diet measures during the study period, and
3) at least 8 morbidity visits during the study period.

LEAD MALE WINDOW: 1/1/84 - 5/31/87

LEAD FEMALES:
1) at least 2 anthropometry measures during the study period, and
2) at least 8 diet measures during the study period, and
3) at least 8 morbidity visits during the study period.

LEAD FEMALE WINDOW: 1/1/84 - 5/31/87

SCHOOLERS:
1) at least 2 anthropometry measures during the schooler window, and
2) at least 8 diet measures during the schooler window, and
3) at least 8 morbidity visits during the schooler window.

SCHOOLER WINDOW: The measurement occurred while the child was aged 7 or 8 years.

TODDLERS: 1) at least 4 anthropometry measures during the toddler window, and
2) at least 8 diet measures during the toddler window, and
3) at least 8 morbidity visits during the toddler window.

TODDLER WINDOW: The measurement occurred between
(a) 30 days before the child turned 18 months,and
(b) the end of child's 30th month (using 30 day 'months').

INFANTS: 1) at least 4 anthropometry measures during the infant window.
2) at least 8 morbidity visits during the infant window.

INFANT WINDOW: The measurement occurred between
(a) five days before the record date of birth in the Basal Census, and
(b) 270 days after the recorded date of birth (9 thirty day "months").

The "cross-sectional" and "longitudinal" sample sizes by target type are provided in Table 18.1.

TABLE 18.1
PHASE II TARGETS CROSS-SECTIONAL AND LONGITUDINAL SAMPLES

	Cross-Sectional	Longi-tudinal
INFANTS	134	102
Males	67	53
Females	67	49
TODDLERS	158	110
Males	78	57
Females	80	53
SCHOOLERS	198	130
Males	102	66
Females	96	64
ADULT FEMALES	290	226
ADULT MALES	288	142
	Target Households* 290	

* At least one cross-sectional target child in the household.

Unless indicated otherwise, the data described in the following chapters are drawn from the longitudinal sample. Data analysis was conducted with mainframe and microcomputer versions of SAS (18.1).

REFERENCE

18.1. SAS Institute, Inc. SAS User's Guide: Basics, Version 5 Edition. Cary, NC: SAS Institute Inc., 1985.

Chapter 19

HOUSEHOLD DEMOGRAPHIC, SOCIAL, AND ECONOMIC CHARACTERISTICS

The data in this chapter have been extracted from several sources. The demographic information on family structure and characteristics comes primarily from the Basic Census, described in Chapter 5. The data on economic and social characteristics were collected using the interview schedules described in Chapter 13.

I. DEMOGRAPHIC CHARACTERISTICS

Demographically, the households in the Solis Valley have many characteristics commonly seen in developing countries. Families are large and the intervals between births are short. The modal size of households in the study is 10 people, with a range from 3 individuals (5 families) to 19 people (1 family). Table 19.1 shows the distribution of total household size.

TABLE 19.1
TOTAL HOUSEHOLD SIZE OF STUDY FAMILIES

Size	Number	Percent
< 5	20	6.9
5 - 7	87	30.2
8 - 10	115	40.0
11 - 13	51	17.7
14+	15	5.0

Further details concerning household composition are presented in Table 19.2, with respect to age and sex distribution.

TABLE 19.2
AGE AND SEX DISTRIBUTION IN STUDY HOUSEHOLDS: PERCENT OF HOUSEHOLDS

Number	Children < 6 yrs	Children 6 - 12 yrs	Males > 12 yrs	Females > 12 yrs
0	—	16.3	---	---
1	25.4	14.2	42.3	42.0
2	31.6	29.5	25.7	24.3
3+	43.1	39.9	31.9	20.7

Household structure is, of course, affected by both biological and social parameters. Chapter 23 provides information on parity, use of contraceptives, and related biological/behavioral characteristics. Infant mortality remains high in comparison with wealthy, industrialized countries. However, only one-third of the women in the sample reported a previous child death, whereas the comparable figure in 1970 was over 50% (19.1). One household in 4 have lost one child and 10% have experienced two or more child deaths. Thus, child mortality is playing a role in the household structures reflected in Table 19.2, although not as devastatingly as in earlier periods.

A. Marriage and Family Structure

As in all communities the world over, there is a considerable variety in the types of households in the Solis Valley. There are individuals living alone, nuclear families consisting of a married pair and their dependent children, and many different forms of complex and extended families. Of these, the most common is the three-generation family with an older couple, their son or daughter and his/her spouse, and their children. There are a number of other types as well, including siblings and their spouses, nuclear families with grandchildren, and nuclear or extended families with nieces and nephews.

In the study families, the great majority of households (72%) are nuclear in structure, while 28% represent an alternative household organization. Of these 80 households in the latter category, the most common structure is a three-generation extended family. The distribution of household types in the sample reflects sampling criteria, which included the stipulation that all target children must have both father and mother present in the household.

Family structure is, in part, a function of family cycle. Typically, a newly married couple joins the household of the groom's parents (patrilocal residence pattern), and much less often, the household of the bride's family. After the birth of the first or second child, young couples with the means to do so establish an independent household. However, often the eldest son remains in the parent's house, eventually becoming the "household head," with primary control over the economic resources of the household.

In contrast to many societies in which primogeniture is rigidly adhered to, the situation in the Solis Valley is much more flexible. Thus, while there is a strong tendency to patrilocal residence after marriage, matrilocal households also are formed. A younger son, rather than an older one, may remain with his parents, eventually becoming the family head. Some young couples establish an independent household immediately at the time of marriage, while others remain in the parental household for many years.

As is characteristic of highland Mexico, household structure in the valley tends toward patrilocality; that is, the woman is living with the family of her husband. For the sample of households in which a preschooler was being studied, the characteristic of "locality" was examined. Patrilocality was coded when the lead male and female were living with the male's relatives or when the couple lived in the community in which the lead male but not the lead female was born.

Conversely, a matrilocal coding was given when the couple lived with her relatives or in her, but not his, community of birth. All other cases were coded as neolocal. In 96 households with preschoolers in the longitudinal sample, 48 percent are neolocal, 37 percent are patrilocal and 16 percent are matrilocal.

There is a very strong tendency for people to marry within the community or within the valley. In the sample of study households, a whole 66 percent of the couples are from the same community or the Solis valley, while one third represent marriages in which one or both of the parents are from outside the Solis area. In the majority of these latter cases, one of the pair is from the community in which the family presently lives.

B. Kinship Patterns

Kinship patterns among Mexican rural populations, particularly mestizo communities, have generally been described as bilateral; and there are no strong corporate kin groups with formal economic, political, or social functions beyond the household units. This does not mean that kinship as such is unimportant -- is simply means that ties of relationships beyond nuclear families are flexible, social bonds of support, assistance, and sociability that consists of networks of individuals and families.

The potential for social support from kin is apparent from the following figures. Eighty five percent of the lead men and 64 percent of the lead women have a parent living in the same community and more than 50 percent of both have siblings in the community. Typically, these kin are visited 5-6 times per week, both for general "socializing" and for more work-oriented activities.

II. SOCIOECONOMIC CHARACTERISTICS

In some areas of Mexico, social stratification, involving a merging of prestige and economic status, is referred to by the concept, categoria. In rural areas, people with more education, land, or income are said to have "high categoria," while landless, uneducated, poor people are low in this trait. Although this term was not widely used in the Solis Valley, economic and social differences within the communities are readily acknowledged and recognized. Perhaps prior to the major land reform, the line between "the wealthy" and the poor, peasant farmer was more sharply drawn, with relatively few people in an intermediate position. However, in the communities of the valley today there appears to be increasing economic differentiation.

As described in Chapter 2, wage labor has become an important factor in family economic management. Despite this "monetarization," most respondents either cannot or are reluctant to provide an accounting of their economic situation in terms of cash income. The management of household finances is mainly by men, who give their wives money for purchases. Ethnographic interviewing during Phase I demonstrated that questioning about income violated cultural norms and could not be used as a basis for assessing socioeconomic status. As a result, our assessment of economic status is derived from data that reflect economic resources.

Specifically, we inventoried household characteristics that reflect economic resources expended on household goods and housing conditions. Data were collected twice from each family during the year in the study. From these we initially constructed two scales -- a material-style-of-life scale (MSL), based on ownership of household goods, and a house value scale (CASA), based on characteristics of the physical structure in which the family lives. The rationale for initially creating two scales rather than one is that household goods are portable items that can be transported from one location to another and that require cash for their acquisition; whereas, some improvements of the basic living structure involve an investment of non-cash resources and imply a willingness to commit resources on a more permanent basis. Nonetheless, both of these imply consumer expenditures in a manner that in Mexico, as elsewhere, is very widely, if not universally seen as an expression of economic status.

The selection of items for the MSL scale was derived from ethnographic work to identify items that represented different degrees of household material conditions. The items in the scale are ownership of: gas stove, television, radio, tape recorder, tape player, food blender, electric iron, sewing machine, wardrobe for clothes storage, kitchen table and chairs, dish cabinet, and refrigerator.

The items in the CASA scale are: composition of the floor, roof and walls, whether the walls are plastered and painted, the number of rooms, number of windows, number and type of doors, and number and type of beds.

For the MSL scale, each item was assigned a value based on the market price of the item in 1983. For the CASA scale, each item was coded on a three-point scale based on level of desirability. For example, a door frame without a permanent door had a value of 1, a wooden door received a value of 2, and a metal door was assigned a score of 3. As might be expected, given the differences in scoring procedures for the two scales, the CASA scale had a normal distribution; whereas, the MSL was skewed to the left, with a long "tail" of the few families with a considerable number of possessions.

For multivariate statistical analyses, it is useful to have a single variable of SES. Since the MSL and CASA scales are strongly correlated, they were combined into a single measure in which each scale was given equal weight. To construct the combined scale, the households were first ranked separately on the MSL and CASA scales; then the households' ranks on each scale were summed, to create a measure referred to in this report as SES. The scaling procedure was carried out twice: once with the data from the first interview and a second time with the final household interview. Thus, there are two variables recorded: SES1, which is taken from the first household interview and SES2, which comes from the second measure.

Table 19.3 shows the mean, standard deviation, and range for SES1 and SES2.

TABLE 19.3
SOCIOECONOMIC STATUS OF STUDY HOUSEHOLDS

	N	Mean ± S.D.	Range
SES1	260	205 ± 112	5 - 414
SES2	224	209 ± 111	5 - 416
Difference	208	0.1 ± 61	-260 - +212

For the 208 households on which we have two SES interviews, the correlation between SES1 and SES2 is $r = .85$ ($p = .0001$). The stability of the measure, which is also reflected in the high correlation coefficient, is indicated by the fact that the mean difference is very close to zero (0.1).

On the other hand, there are some households that showed a sharp change between the first and second interviews, as can be seen in the range. Over the course of a year, there should be some changes in household material conditions as new items are added and old ones become dysfunctional. However, very large differences may indicate problems in the validity of respondents' reports. Fortunately, the great majority of households had very similar scores on the first and second measures. In the case of highly discrepant measures, the second is probably better since this represents the time when the family had been in the study for many months and was well known to the interviewers. In the multivariate analyses, the SES measure used was the closest temporal measure to the other variables.

III. OTHER SOCIAL CHARACTERISTICS

In the past, educational resources in the valley were very limited, with the only secondary level school located in the town of Temascalcingo. In recent years, primary schools have been built in nearly every community and Solis itself has acquired a secondary school.

The number of new schools built in the area during the past decade reflects the ideologies of Mexican governmental policy-makers, but it also indicates the growing realization in rural populations that one important road to economic and social development is through schooling. Even people with no specific career track in mind have become increasingly aware of the need for literacy and general knowledge of the world, in connection with the variety of governmental policies, programs, and other situations that require complex decisions and responses from individual families. However, because of the paucity of past resources, educational levels are quite low Chapter 27 presents the data on formal schooling of the adults in the sample.

Although the level of achieved schooling by the parents in the sample is relatively low, it is interesting to see that many families have high aspirations for their children's schooling. Only 20 percent of men and 21 percent of the women feel that their children should stop school when they have completed the primary grades, whereas 30 percent of the men and 17 percent of the women would like to see their children acquire an university-level education. There are no statistically significant differences between men and women in their educational aspirations for their sons compared to their daughters. However, there is a tendency for fathers to have higher educational and occupational aspirations for their children (male and female) than do mothers.

One of the most telling results of the social interviews are the responses to the question of what individuals would do with an extra 5,000 pesos, which was approximately $50.00 U.S. at the time the question was posed. Table 19.4 shows the responses.

In Table 19.4, it is apparent that women are more concerned about improving the interior of their homes than are men. Men are more involved with agriculture, although a sizeable proportion of women are also interested in raising animals. It is noteworthy that few people, men or women, see any value in improving their agricultural implements, while investment in animals reflects a perception that this is an activity in which there is some profitability.

TABLE 19.4
USES OF AN EXTRA 5000 PESOS†: PERCENT OF RESPONDENTS*

Use	Women (N = 252)	Men (N = 240)
Buy Food	41	40
Buy Clothing	43	38
Buy Home Furnishings	28	7
Physical Improvement to the House	13	11
Improve Agricultural Implements	1	6
Buy Animals	19	38
Start a Small Business	4	4
Save	6	8

* Includes those with more than one response

† Equivalent of $50 US

IV. AGRICULTURAL CHARACTERISTICS AND ACTIVITY

In Chapter 13 there is a description of the series of interviews that were conducted over the course of the study to collect information on agricultural activities in the households. The data from these interviews on economic and agricultural activities are intended to serve several purposes in the context of the CRSP goals:

(1) One primary purpose is to improve the sensitivity of our assessments of household economic status. As noted earlier, respondents were reluctant to provide total income figures; however, they were willing to discuss their agricultural activities and investments of time and other resources. The measures of socioeconomic status described above capture some key elements of household economic characteristics -- those that are reflected in lifestyle conditions. From the data on agricultural investments, we expect to derive other dimensions of economic status. (The development of these measures will be undertaken in future analyses.)

(2) In communities that are primarily dependent on agriculture as the major economic activity, the productivity of households can be regarded as a kind of functional indicator of economic success. As conceptualized in the CRSP documents, "work capacity" and "activity level" can be seen as biological and social outcomes that are influenced by nutritional status. Agricultural productivity is, of course, determined by multiple factors including access to land, quality of land, economic resources for investment, and political relationships. The capacity and motivation for labor input is, thus, one of a number of contributing factors.

In communities such as those of the Solis Valley, where agriculture is one component in a complex economic system, the interpretation of productivity in relation to marginal malnutrition is still more difficult. Nonetheless, in view of the substantial scientific and policy interest in the relationship between nutrition and productivity, the assessment of the situation in the households in the CRSP study seems highly desirable.

(3) The data on household production provide a source of information for cross- validation of the household-level intake data with respect to home produced foods. At the monthly household food acquisition-expenditure interviews, the lead female is asked to identify the source of each food item (home-produced, gathered, purchased, or borrowed). The agricultural output from the interviews with males will permit comparison between the two data sets.

(4) Finally, the data from the productivity interviews, in connection with the information on non-farm economic activities and food acquisition patterns, provides the basis for future analyses of the relationships of food availability to intra-household food distribution and marginal malnutrition.

The data in the section that follows are from the "productivity" interview schedule, particularly from the interviews in the calendar year of 1985, for which the data are most complete.

TABLE 19.5
PERCENT OF HOUSEHOLDS ENGAGED IN PRODUCTION OF SPECIFIC CROPS

Crop	1984 (N=203) Percent	1985 (N=199) Percent
Maize (Corn)	73.4	79.9
Beans	9.9	4.0
Fava Bean	5.4	13.6
Wheat	3.0	6.6
Barley	3.9	9.0
Oats	2.0	4.5
Fodder	1.0	6.5
Garden Vegetables	0.0	2.0

The importance of maize as the primary agricultural crop is dramatically clear in the preceding table. In the sample of 203 households, there were 22 percent who did not own land, and an additional 7 households did not plant their fields. Thus, we see that all of the households who were agriculturally active grew maize. A parallel situation held for the following year. The data in the table also document that the great majority of farmers are devoting their small land holdings almost exclusively to the production of maize. (The relationship of size of land holdings and other socioeconomic characteristics to agricultural decisions, including types of crops grown, will be explored in future analyses.)

Animal husbandry, as a commercial activity, is relatively rare, as seen in the following table, which summarizes the data on active buying and selling of animals for the 203 households interviewed during 1985. The column on the far right shows the percent of households that own the various types of animals, which contrasts markedly with the active trading figures. Non-commercial use of animals include their utility in agricultural work and home consumption. They also represent a form of "savings," since an animal can always be sold should a sudden need for cash arise.

TABLE 19.6
PERCENT OF HOUSEHOLDS ENGAGED IN BUYING AND SELLING ANIMALS IN 1985 (N=203)

Type	Percent Bought	Percent Sold	Percent Owned
Mules	2.0	0.5	21.0
Bulls	4.0	4.9	11.5
Cows	5.9	8.4	44.0
Horses	5.9	1.0	49.5
Burros	5.0	2.0	39.5
Pigs	3.6	7.9	26.0
Goats	0.5	3.0	6.0
Sheep	7.4	9.4	71.5
Turkeys	7.4	3.4	81.5
Chickens	14.7	0.5	89.5

Table 19.7 lists the days of work for the main agricultural tasks that men carried out in their own fields in 1985 with respect to the cultivation of maize,the primary crop. The figures are based on the 75% of household heads who engaged in some agricultural activity during that year.

TABLE 19.7
DAYS OF WORK IN SPECIFIC AGRICULTURAL TASKS BY ADULT MEN ON THEIR OWN LAND IN 1985 (N=151)

Task	Mean Days	S.D.	Range Days
Cleaning Fields	6.9	6.6	1 - 30
Plowing	4.1	4.3	1 - 30
Irrigating	2.9	3.6	1 - 30
First Harrowing	1.6	1.9	1 - 20
Second Harrowing	4.5	2.8	1 - 9
Sowing	2.5	3.1	1 - 30
Weeding	3.1	3.3	1 - 20
Fertilizing	2.3	2.2	1 - 14
Second Weeding	2.4	2.6	1 - 25
Spraying	5.9	5.4	1 - 30
Harvesting	7.4	7.1	1 - 60

In addition to investing the labor of the male household head, the families in the sample also hire labor, as well as utilizing the labor of other family members. Table 19.8 shows the percent of households that used hired workers and family members for various farming tasks during the 1985 agricultural cycle.

TABLE 19.8
PERCENT OF HOUSEHOLDS USING HIRED WORKERS AND FAMILY MEMBERS FOR SPECIFIC AGRICULTURAL TASKS IN 1985 (N=200)

Task	Percent Hiring Workers	Percent Using Family Workers
Cleaning Fields	31.0	69.0
Plowing	35.0	16.0
Harrowing	27.0	19.5
Sowing	41.5	26.5
Weeding	27.5	31.5
Fertilizing	22.5	37.5
Harvesting	41.9	59.1

The results in Table 19.8 suggest that family labor is most important with respect to harvesting and cleaning the fields after the harvest. Harvesting is a time when many households hire additional help, as is also the case for planting.

The quantity of maize produced by households in the six communities varied widely, from as little as 35 kilos to as much as 60,000. The distributions of values for the size of the household harvests in 1984 and 1985 are shown in Table 19.9.

TABLE 19.9
SIZE OF HOUSEHOLD MAIZE HARVESTS: PERCENT OF SAMPLE

Quantity in Kilos	Percent of Households			
	1984	(N=149)	1985	(N=159)
	N	%	N	%
< 1000	27	18.1	38	23.9
1000-1999	23	15.4	31	19.5
2000-2999	19	12.8	36	22.6
3000-3999	21	14.1	22	13.9
4000-4999	15	10.1	8	5.0
5000-5999	10	6.7	10	6.3
6000-9999	25	16.8	12	7.5
10,000+	8	5.5	2	1.3

The harvest in 1985 was very poor throughout the central Mexican highlands. Rains were late in coming and rainfall level was low in the early part of the summer, which was followed by very heavy rains later in the summer that left fields disastrously flooded (see rainfall data in Chapter 2). The effect in the Solis Vailey is visible in a comparison of 1984 and 1985 figures in Table 19.9.

From the first productivity interview in 1984, of the sample of 101 respondents, 18.8 percent reported that they sold maize from the preceding (1983) harvest. From the 1984 harvest, only 29 households (14.3%) sold maize after the harvest. Unfortunately, the question about amount of maize sold from the poor 1985 harvest was omitted from the final interview in early 1986 because the fieldworkers felt the subject was too sensitive to ask. However, it is likely to have been even less than 14%.

From the figures on the percent of households that sell maize, as well as the data on buying and selling animals, it is apparent that the production of agricultural products is not a primary source of cash income for the majority of the households in the study. While there are a minority of farmers who engage in production agriculture as a commercial activity, for most households the food produced is for home consumption. The need for cash income is met through other economic activities.

A. Agricultural Day Labor for Wages

One source of cash income is agricultural wage labor in the local area. Apart from, or in addition to, work on their own land, two-thirds of the male household heads (n = 129) reported they had engaged in agricultural labor for someone else in the month preceding the first 1985 interview in early spring. At the second interview in late summer, the proportion of household heads reporting agricultural labor for pay in the preceding month was 50% (n = 100), and in early 1986, 60% of the 199 household heads also reported working in other people's fields for pay. Table 19.10 shows the mean and standard deviation for the number of days worked in the preceding month, excluding those who did not carry out such work.

TABLE 19.10
DAYS OF AGRICULTURAL WAGE LABOR IN PREVIOUS MONTH BY ADULT MEN

	N	Mean	S.D.	Range
Spring, 1985	129	6.6	5.6	1 - 30
Summer, 1985	101	8.1	8.1	2 - 30
Spring, 1986	116	16.6	10.4	1 - 30

From these data, it appears that agricultural wage labor plays a role in the economy of many of the households in the communities. While it is certainly not a primary source of income for most households, a high and relatively steady proportion of adult men engage in some wage labor of this type.

V. WAGE LABOR IN NON-AGRICULTURAL ACTIVITIES

Wage labor outside the agricultural sector is the primary income source for many of the families in the sample. At each interview concerning agricultural activities, the household head was asked whether he had engaged in non-agricultural work in the past month, and, if so, the number of days spent in non-agricultural work for wages.

TABLE 19.11
WAGE LABOR ACTIVITIES OF ADULT MALES IN PRECEDING MONTH

Interview Period	No		Yes	
	N	%	N	%
Summer, 1984	58	(60)	38	(40)
Spring, 1985	100	(49)	103	(51)
Summer, 1985	71	(36)	129	(64)
Spring, 1986	74	(38)	125	(62)

TABLE 19.12
DAYS OF WORK OF ADULT MALES IN PRECEDING MONTH IN SAMPLE WHO ENGAGED IN NON-AGRICULTURAL WAGE LABOR

Interview Period	Days of Wage Labor Activity							
	1-5		6-10		11-15		16+	
	N	%	N	%	N	%	N	%
Summer, 1984 (n=39)	4	(10)	29	(74)	2	(5)	4	(10)
Spring, 1985 (n=103)	9	(9)	73	(71)	4	(4)	17	(17)
Summer, 1985 (n=129)	29	(23)	92	(71)	3	(2)	5	(4)
Spring, 1986 (n=125)	6	(5)	9	(7)	6	(5)	101	(83)

From Table 19.11 we see that between 40 and 60 percent of adult men were involved in wage labor at the time of the interviews in early spring and late summer. During the year from the summer of 1984 to the summer of 1985, the majority of men who sought wage labor outside agriculture carried out such activities an average of two weeks per month. (Note that this generalization is limited to the months for which the data were gathered.) However, in 1986 there is a sharp change in the direction of much greater investment of time in non-agricultural wage labor.

Future analyses will explore the relationships among wage labor patterns and food use.

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Chapter 20

FOOD INTAKE DATA

I. INTRODUCTION

The first section of this chapter describes the effects on estimated food intake of two protocol changes that occurred during the study. These changes, and the reasons for them, have been described in Chapter 6. This analysis is followed by a description of the intake of specific nutrients and foods by target individuals after January 1, 1985. Finally, weaning patterns are described.

II. EFFECTS OF THE MID-PROJECT PROTOCOL CHANGES ON ESTIMATES OF FOOD INTAKE

The following summarizes the effects of two changes in the diet collection protocol on estimates of food intake of lead females, toddlers and schoolers. The first modification of the interview protocol was an interview form change that occurred on October 1, 1984. The new form was designed to record family, as well as individual, intake data, and to eliminate field-level calculations prior to data entry. The second was a change in interviewers and interview rotation that occurred on January 1, 1985. This change was part of a project reorganization to improve relationships with target households.

Similar analytic techniques were used to quantify the effect of both changes on estimates of energy intake, although each change was investigated separately. The time line below displays the three-month intervals used in these analyses. The three intervals that are grouped and named Period-1 were used to explore the hypothesis that the October, 1984 form change altered the recording of diet information. Similarly, the intervals of Period-2 were used to evaluate the effects of the January 1, 1985 interviewer changes.

FIGURE 20.1: TIME LINE OF METHOD CHANGE INTERVAL COMPARISONS

April-June 1984	July-Sept 1984	Oct-Dec 1984	Jan-Mar 1985	April-June 1985
INTERVAL-1	INTERVAL-2	INTERVAL-3	INTERVAL-4	INTERVAL-5
	PERIOD #1			
		PERIOD #2		

All analyses for a particular change were restricted to subjects who had data in all three intervals for that Period, to avoid problems due to using different subjects in each interval. Different numbers of observations were reported for different subjects, thus a data set containing a mean for each subject by interval was created. The resulting number of subjects available for each analysis (Period by Subject Type) is as follows:

	Preschoolers	Schoolers	Lead Females
Period-1	32	71	101
Period-2	58	108	169

Each subject had to have at least one reported food intake record in each of three consecutive three-month intervals to be included in the analysis. Since the subject's diet intake was averaged in each interval, the study design corresponded to a complete repeated measures design with three time points. A simple randomized block ANOVA was used for much of this analysis. Using mean KCAL (energy intake, kcal/day) as the dependent variable in this example, the model is:

$$Y(ij) = u + a(i) + b(j) + e(ij);$$

where Y(ij)=mean KCAL, u=mean KCAL for all individuals, a(i)=subject effect, b(j)=interval effect, and e(ij)=random error.

Because there is only one observation per subject per interval, the subject by interval interaction is used as an error term in testing hypotheses. Using this model, three contrasts for each of the two investigations were of interest. These contrasts can be defined in terms of u(j), the mean (KCAL) intake for subjects in the (j)th time interval, j=1,...5. For the first diet change contrasts that were estimated are:

1) u2-u1: change in intake between 1st and 2nd interval
2) u3-u2: change in intake between 2nd and 3rd interval
3) (u2-u1)-(u3-u2): difference between (1) and (2).

For children, assuming no seasonal effects on diet, the first contrast can be interpreted as the change in intake with maturation. Similarly, the second change can be interpreted as the change in diet with maturation plus a change due to the different diet methodology. The contrast of most relevance with respect to the change in methodology is the third contrast, because in the absence of seasonal effects, this contrast should estimate the methodological change directly. Similar contrasts were constructed to examine the second change in diet methodology in Period-2.

It is important to note that the interpretation of the contrasts depends upon the assumption of no seasonal effects. For example, if food is more scarce in the second time period (j=2), then the interval-2 minus interval-1 estimate may be zero (or negative) because the lack of available food may offset normal increases in intake due to maturation. Unless seasonal effects can be estimated, it is not possible to separate normal increase in intake due to maturation. However, the third contrast is still interpretable as an effect due to a change in methodology if the impact of season is the same between intervals-1 and 2 as it is between intervals-2 and-3.

Four dependent variables were studied: total kcal, total protein, kcal from meat, and kcal from tortillas. Except for kcal from meat, the results were similar. Due to the extreme variability inherent in kcal from meat, significance was never apparent in any contrast. As a result of the similarity in the other variables, only results for total kcal will be presented in this summary. Additional analyses examined possible effects by sex and community (except for preschoolers, whose small numbers did not allow community specific tables). The sex specific tables failed to show any important differences between males and females and the detailed results are not included. The community specific tables did show significant variations in the Period-2 analysis.

A. Initial Description of Mean Kcal by Period and Individual Type

Figure 20.2 presents a plot of mean kcal by subject type and illustrates the general pattern in reported intake. Mean kcal intake for subjects included in cohorts for each of the defined investigations are given in Table 20.1. The means for the first two intervals appear to be similar across each of the subject types. An increase can be noted during intervals-3 and -4 with a leveling off observed in interval-5.

B. Results of the October Form Change

Table 20.2 summarizes the results of contrast estimates (and tests of hypotheses of zero contrast means) for the October form change.

TABLE 20.1
MEAN KCAL INTAKE FOR SUBJECTS BY THREE MONTH TIME PERIODS (SD)

		1984			1985	
Suoject type	N	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Preschooler						
	32	540	636	877		
		(228.9)	(197.4)	(273.6)		
	58			829	1025	1059
				(268.0)	(302.5)	(327.3)
Schooler						
	71	1439	1421	1627		
		(459.5)	(392.9)	(463.4)		
	108			1591	1883	1829
				(462.7)	(488.4)	(457.8)
Lead Female						
	101	1871	1941	2256		
		(612.2)	(656.6)	(636.2)		
	169			2273	2563	2510
				(667.7)	(716.5)	(676.0)

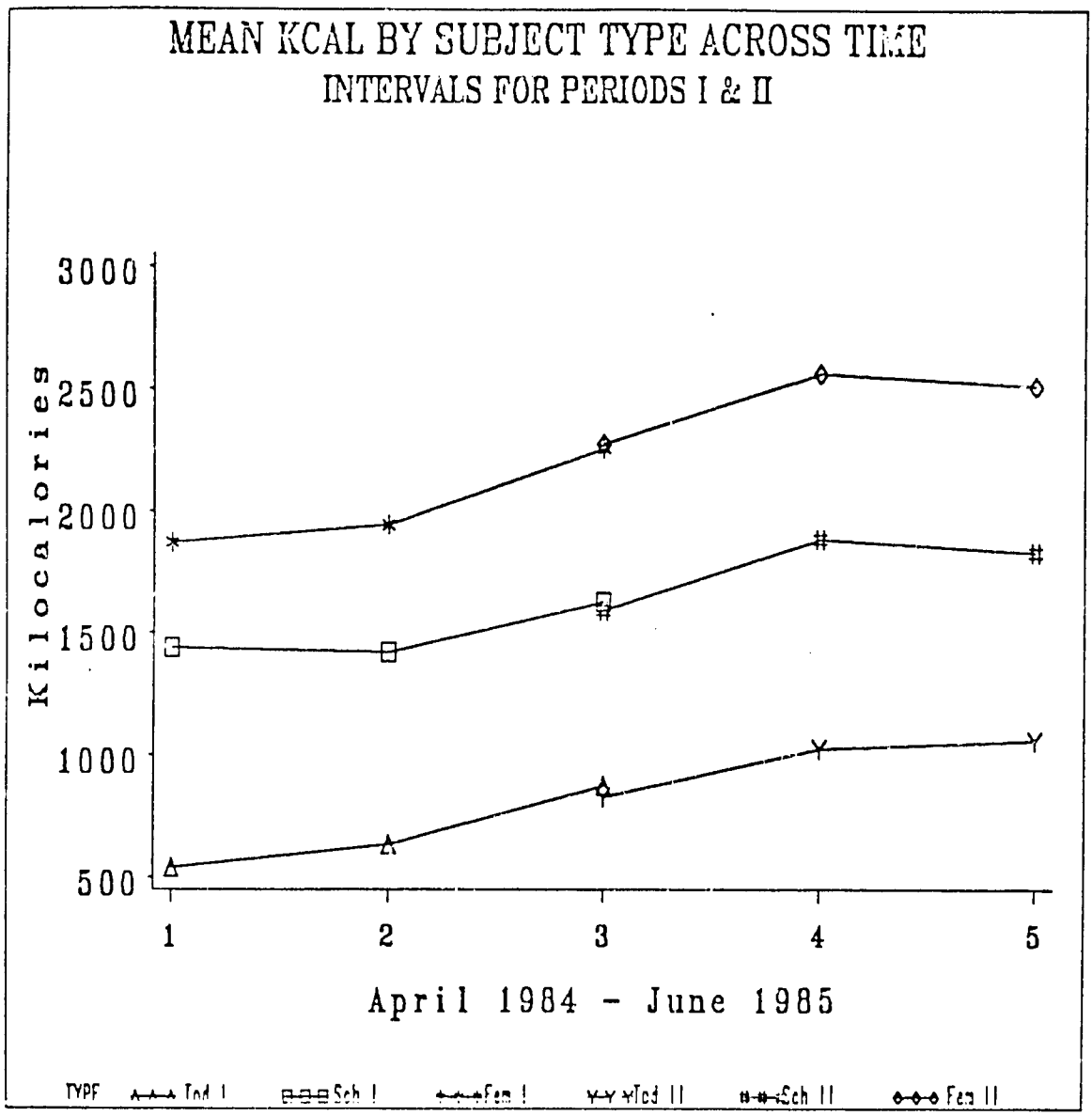

Figure 20.2 is a plot of mean KCAL by subject type across three month time intervals from April 1984 to June 1985. The means for the first two intervals appear to be similar across each of the subject types. An increase can be noted during intervals-3 and -4 with a leveling off observed in interval-5. Intervals 1-3 represent Period I from April 1984 to December 1984, and intervals 3-5 represent Period II from October 1984 to June 1985.

TABLE 20.2
CONTRAST ESTIMATES OF KCAL INTAKE AND P-VALUES FOR OCTOBER FORM CHANGE BY TYPE OF SUBJECT

		Estimated Difference In Kcal Intake (P-value)		
	N	u2 - u1	u3 - u2	(u2 - u1) - (u3 - u2)
Pre-schooler	32	96.1 p=.018	241.0 p=.0001	-144.8 p=.04
Schooler	71	-17.5 p=.73	206.0 p=.00001	-223.8 p=.01
Lead Female	101	69.8 p=.22	314.9 p=.0001	-245.2 p=.01

As indicated in Table 20.1, illustrated in Figure 20.2 and confirmed in Table 20.2, there were no significant differences in kcal intake between intervals-1 and-2 (Apr-Jun and Jul-Sep) in 1984. However, there was a significant increase from interval-2 to interval-3 (contrast u3-u2) of 38%, 15% and 16% for preschoolers, schoolers, and lead females respectively. The differences for all subject types were statistically significant (contrast-2). Although an increase in intake due to maturity may be expected for preschoolers, a 38% increase over three months is much larger than expected due to maturity alone. However, the increase may also be attributable to the October form change, and/or seasonality.

The third contrast was formed to isolate the effect due to the October form change by eliminating the effect of maturation. This contrast is interpretable under the assumption of equal seasonal effects between the first and second intervals, and the second and third intervals. The increase of kcal intake from interval-2 (Jul-Sep) to interval-3 (Oct-Dec) was larger than the change from interval-1 (Apr-Jun) to interval-2 (Jul-Sep). Contrast-3 indicates that this increase was significant for all subject types.

C. Results of the January Methodology Change

Table 20.3 summarizes the results of contrast estimates (and tests of hypotheses of zero contrast means) for the January methodology change.

TABLE 20.3
CONTRAST ESTIMATES FOR JANUARY METHODOLOGY CHANGE

		Estimated Difference In Kcal Intake (P-value)		
	N	u4 - u3	u5 - u4	(u5 - u3) - (u5 - u4)
Pre-schooler	58	196 p=.0001	33 p=.43	162 p=.03
Schooler		292	-28	320
(Male)	52	p=.0001	p=.57	p=.0003
(Female)	56	294 p=.0001	-80 p=.16	373 p=.0002
Lead Female	101	290 p=.0001	-53 p=.26	343 p=.001

A significant increase in reported kcal intake was evident for all subject types between interval-3 (Oct-Dec) and interval-4 (Jan-Mar). The reported increase was 24% for preschoolers, 17-20% for schoolers, and 13% for lead females. Assuming no seasonal effects, these increases could be attributable to maturation for preschoolers and schoolers but not for lead females. The January methodology change is a more likely explanation. A similar comparison between interval-5 (Apr-Jun) and interval-4 (Jan-Mar) indicated no significant differences for any of the groups, suggesting that the change reported in the first contrast was due to the change in methodology. With the assumption of no seasonal effects, the change in methodology was isolated in the third contrast. For all subject types, the significant increase following the January change (interval-4 minus interval-3) was not observed in the subsequent contrast (interval-5 minus -4). Contrast-3 indicates that the difference between these two comparisons was significant for the all subject types.

D. Analysis of Changes by Community.

Additional analyses investigated these differences by community, for the January 1984 interviewer change. Community 6 was not included in this analysis because data were not collected there until after the interviewer change. Tables 20.4 and 20.5 show these results for schoolers and lead females (sample sizes for preschoolers were too small). An ANOVA was performed on contrast-3 across communities. Results of the Tukey post-hoc analysis for schoolers indicated that communities 4 and 5 were significantly different from communities 1, 2 and 3 ($p<.05$). No other statistical differences were observed. Thus, the overall significant effect of contrast-3 for schoolers (Table 20.3) may be due primarily to communities 4 and 5.

In the case of lead females, Tukey post-hoc analysis found no significant differences for contrast 3. Thus, an overall significant effect for contrast 3 was found (Table 20.3), but no community differences were observed. However, Tables 20.4 and 20.5 indicate that the reported intakes for communities 4 and 5 show the most marked change across the January intervention (u4-u3), especially in community 4. This pattern was consistent for schoolers and lead females, and significant for schoolers.

E. Comparison of 1985 and 1986 Data

A difference of means test was used to compare the intakes of various nutrients and foods during January to March, 1985 and January to March, 1986. The analysis was done for adult females who had at least one measure in each of the

six months (N=260). There were no significant differences in the intakes of (1985 and 1986 values respectively) kcal (2609 and 2681), fat (39 and 44 g), carbohydrate (463 and 463 g), protein (75 and 77 g), cereals of all types (1885 and 1868 kcal), legumes (114 and 154 kcal), tortillas (1726 and 1740 kcal), pasta (38 and 32 kcal), pulque (144 and 146 kcal), or animal products (99 and 140 kcal). Thus, data appear to be remarkably consistent during this 15 month period.

TABLE 20.4
MEAN KCAL INTAKE REPORTED BY COMMUNITY WITH CONTRASTS FOR JANUARY METHODOLOGY CHANGE

	SCHOOLERS					
Community	Oct-Dec'84	Jan-Mar'85	Apr-Jun'85	(u4-u3)	(u5-u4)	(u4-u3)-(u5-u4)
#1						
Mean(n=19)	1626	1732	1635	106	-97	203
(SD)	(517.2)	(432.0)	(423.7)	p=.19	p=.23	p=.15
#2						
Mean(n=21)	1577	1652	1563	76	-89	165
(SD)	(419.4)	(424.2)	(416.2)	p=.22	p=.15	p=.13
#3						
Mean(n=18)	1754	1969	2124	215	155	61
(SD)	(458.7)	(555.2)	(486.0)	p=.02	p=.10	p=.70
#4						
Mean(n=28)	1411	2055	1953	644	-102	747
(SD)	(516.2)	(546.3)	(437.8)	p=.0001	p=.17	p=.0001
#5						
Mean(n=22)	1669	1946	1849	277	-97	373
(SD)	(327.8)	(356.5)	(333.50)	p=.0002	p=.16	p=.003

TABLE 20.5
MEAN KCAL INTAKE REPORTED BY COMMUNITY WITH CONTRASTS FOR JANUARY METHODOLOGY CHANGE

			LEAD FEMALES			
Community	Oct-Dec'84	Jan-Mar'85	Apr-Jun'85	(u4-u3)	(u5-u4)	(u4-u3)-(u5-u4)
#1						
Mean(n=34)	2184	2270	2187	86	-83	169
(SD)	(567.8)	(575.9)	(539.8)	p=.37	p=.38	p=.30
#2						
Mean(n=27)	2407	2382	2219	-26	-162	136
(SD)	(734.6)	(620.8)	(622.6)	p=.78	p=.08	p=.40
#3						
Mean(n=33)	2460	2663	2620	203	-43	246
(SD)	(636.9)	(821.2)	(788.2)	p=.035	p=.65	p=.14
#4						
Mean(n=44)	1941	2685	2736	744	51	693
(SD)	(679.3)	(735.6)	(655.8)	p=.0001	p=.60	p=.0001
#5						
Mean(n=31)	2526	2763	2677	237	-86	323
(SD)	(536.7)	(693.1)	(558.6)	p=.03	p=.41	p=.08

E. Conclusions

In communities 3, 4 and 5, the interviewer changes in January of 1985 were associated with higher reported energy intakes, especially in community 4. That community had the lowest intake prior to the interviewer change. While the interviewer changes were made because of a crisis in the community/project relationship, the change to professional nutritionists apparently produced higher estimates of energy intake. Most project measures were made after the interviewer change.

In the following descriptions of food intake, and for the more in-depth longitudinal analyses in later chapters that relate functional outcomes to nutrient intake, only food intake data collected after January 1985 have been used. The reasons for this decision include:

i) these data were collected by the most highly-trained, professional nutritionists,

ii) averag nutrient intakes collected by weighing and observation (described in Chapter 6) are similar to those obtained after January 1, 1985,

iii) there were no significant differences between the intakes of target individuals during January to March 1985, compared to January to March 1986, suggesting that the higher estimates of intake after January 1985 are not a temporary phenomenon.

iv) most of the January 1985 change occurred in Community 4, where the intakes seem unreasonably low prior to this time.

The limited time and resources available for the preparation of this report did not permit a thorough examination of the reasons for the method effects on estimates of intake. It is probable that many of the data collected prior to January 1, 1985 can be used in future analyses. For example, methodology did not significantly change intake estimates in all communities and it is possible that data from those communities in which intake estimates were stable can be used longitudinally. Interviewer bias must also be examined in 1984 and may reveal interviewers that produced very low estimates of intake. Finally, the interviewer change did not appear to affect the intake estimates for different foods differentially - the effects were proportionally similar over all types of foods. Thus, estimates or rankings of dietary quality might be useful over the entire study, if the number of diet measures in each period is controlled in analysis.

III. ADEQUACY OF DIETARY ENERGY AND PROTEIN INTAKES

The following descriptions of the nutrient intakes of target individuals are based on food intake data collected after January, 1985. The average energy and protein intakes of target subjects, per day, per kg mean body weight, and per cm mean height, are shown in Tables 20.6 and 20.7. The data from infants are not interpretable as most of them are obtaining at least some calories and protein from breast milk; they are shown here as an indication that energy intake from supplemental foods is minimal on average. Preschooler data are described for "all" in this group, and separately for those who were weaned. As anticipated, the recorded intakes of unweaned children are slightly lower than those who are completely weaned, due to the unmeasured contribution of breast milk in the former group.

Compared to the recommended dietary intakes for Mexicans (20.1), preschoolers' average daily intakes in Solis are too low by 130 kcal, while for schoolers they are 150 kcal/d lower than the 2,000 kcal recommended. If the National Academy of Sciences Recommended Dietary Allowances (RDAs, 20.2) are used as the basis of comparison, energy intakes of preschoolers are too low by 180 kcal, and of schoolers by 550 kcal. Adult males achieve their recommended energy intake.

Non-pregnant, non-lactating women consume 371 kcal/d more than the recommendation of 2000 kcal; this group contains women who are older and heavier than the pregnant and lactating groups, so that their total daily energy intake is higher on a total daily basis but not on a per kg body weight basis (Table 20.6). The Mexican recommendations are to increase energy intake by 200 kcal/d in pregnancy and 1,000 kcal/d in lactation. The equivalent RDAs are +300 and +500 kcal/d respectively; the US-RDAs for lactation assume the availability of 300 kcal/d from maternal fat stores deposited during lactation, while the Mexican values do not. Compared to intakes in the first trimester, intakes of the Mexican women do not appear to increase during pregnancy but remain close to the recommended level. However, this needs to be confirmed using a longitudinal data set of the same women studied before and during pregnancy. Compared to early pregnancy, average daily intakes rise by about 340 kcal in the first three months of lactation, and by 430 kcal during months 3-8 postpartum. On average intakes in lactation are 400 kcal below the Mexican recommendations, but similar to the US-RDAs.

On a body weight basis, recommended energy intakes (kcal/kg) are (Mexican and US values respectively in each case): preschoolers, 90 and 100; schoolers, 76 and 86; adult males, 38 and 38; adult females, 36 and 36. Intakes per kg are on average more than adequate for all groups, using either Mexican or US recommendations. As discussed further below, these high intakes may be explained by an overestimate of the availability of dietary energy from tortillas.

The Mexican recommendations for protein consumption are approximately 50 percent higher than those of the USA because of the poor quality of the maize protein that constitutes the major source of dietary protein. The average daily intakes of preschoolers, schoolers, and adult males and NPNL females are close to the Mexican recommendations (which are 27, 52, 83 and 71 g/d for each group respectively). Intakes did not increase substantially in pregnancy, so that consumption was 20 g/d less than the Mexican recommendation of 81 g/d and about 15 g/day less than the United States

RDA of 76 g in pregnancy. Intakes increased by about 10 g/d in lactation but were still 30 g/d less than Mexican recommendations (101 g/d), although they exceeded the US RDAs slightly (64 g/d).

While average intake data such as these do not permit the estimation of the prevalence of inadequate intakes in the target groups, the following generalizations can be made. The groups at greatest risk of energy deficiency appear to be preschoolers and schoolers (although not on a kg weight basis) and perhaps lactating women. In contrast, pregnant and lactating women consume on average less protein than recommended.

TABLE 20.6.
MEAN ENERGY INTAKE BY TYPE OF INDIVIDUAL
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	N*	Kcal/d	N*	Kcal/kg Body Weight	N*	Kcal/cm Height
Infants (all)	95	176 ± 200	95	31.5 ± 36.2	95	2.9 ± 3.0
Preschool. (all)	119	1085 ± 442	119	101.3 ± 31.2	113	13.4 ± 3.8
Preschool.†	96	1118 ± 309	95	103.6 ± 31.8	-	-
Schoolers	116	1858 ± 609	115	84.7 ± 20.4	116	15.5 ± 3.6
Adult males	139	3029 ± 1151	139	47.4 ± 12.4	119	18.5 ± 4.6
Adult females						
Nonlactating						
NPNL	98	2371 ± 833	98	40.9 ± 10.8	98	15.7 ± 3.5
Tri I	27	2139 ± 844	27	41.4 ± 15.2	27	13.2 ± 3.7
Tri II	59	2208 ± 851	59	42.1 ± 16.3	59	13.7 ± 4.1
Tri III	87	2230 ± 876	87	42.8 ± 16.7	28	13.9 ± 4.8
Lactating						
0-3 mon‡	102	2476 ± 933	102	46.6 ± 17.2	102	14.6 ± 4.6
3-6 mon‡	106	2573 ± 925	106	48.1 ± 17.4	106	15.2 ± 4.7
6-8 mon‡	108	2567 ± 991	108	48.6 ± 17.8	108	15.4 ± 5.0
Tri I	12	2375 ± 870	12	40.0 ± 8.9	12	15.2 ± 3.7
Tri II§	9	2041 ± 618	9	36.9 ± 8.1	9	15.0 ± 3.4

* # of individuals

† means for a non-breastfed subset used in longitudinal analysis

‡ Lactating but not pregnant

§ There were no Tri III women lactating.

TABLE 20.7.
MEAN PROTEIN INTAKE BY TYPE OF INDIVIDUAL
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	N*	G/d	N[i]	G/kg	N[†]	G/cm
Infants (all)	95	5.1 ± 7.2	95	0.89 ± 1.26	95	0.08 ± 0.11
Preschool. (all)	117	32.8 ± 14.5	117	3.04 ± 0.92	113	0.40 ± 0.11
Preschool.[‡]	96	33.2 ± 8.8	95	3.08 ± 0.89	-	-
Schoolers	116	54.9 ± 20.1	115	2.50 ± 0.62	116	0.46 ± 0.11
Adult males	139	82.7 ± 32.8	139	1.29 ± 0.31	119	0.50 ± 0.11
Adult females:						
Nonlactating:						
NPNL	98	68.6 ± 27.4	98	1.18 ± 0.31	98	0.45 ± 0.10
Tri I[§]	27	58.6 ± 25.1	27	1.17 ± 0.39	27	0.43 ± 0.11
Tri II[§]	59	60.6 ± 24.6	59	1.20 ± 0.41	58	0.46 ± 0.13
Tri III[§]	87	64.1 ± 28.3	87	1.22 ± 0.39	87	0.39 ± 0.14
Lactating:						
0-3 mon[‡]	102	68.1 ± 27.4	102	1.30 ± 0.42	102	0.48 ± 0.13
3-6 mon[‡]	106	72.3 ± 29.2	106	1.38 ± 0.44	106	0.50 ± 0.13
6-8 mon[‡]	108	71.5 ± 28.9	108	1.36 ± 0.42	108	0.50 ± 0.14
Tri I	12	67.7 ± 27.0	12	1.17 ± 0.29	12	0.44 ± 0.12
Tri II	9	60.3 ± 23.3	9	1.06 ± 0.23	9	0.43 ± 0.10

Legends as for previous table.

TABLE 20.8.
MEAN DAILY NUTRIENT INTAKE BY TYPE OF INDIVIDUAL
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	Fat (g) S.D.	CHO (g) S.D.	Ca (mg) S.D.	Fe (mg) S.D.	Thiamin (mg) S.D.	Ribo. (mg) S.D.	Niacin (mg) S.D.	Ascorbic (mg) S.D.	Retinol (ug RE) S.D
I*	5.6	26.7	106	1	0.1	0.2	0.5	3	97
	± 8.1	± 30.1	± 209	± 1	± 0.1	± 0.4	± 0.6	± 7	± 216
T*	22.0	189.3	501	11	0.8	0.5	5.1	15	176
	±14.2	± 83.2	± 268	± 6	± 0.4	± 0.3	± 2.7	± 19	± 229
S	29.4	344.0	857	21	1.4	0.8	8.9	21	245
	± 17.1	± 117.0	± 385	± 8	± 0.5	± 0.4	± 4.6	± 27	± 426
AM	41.9	494.0	1360	36	2.2	1.4	16.9	88	337
	± 25.1	± 191.0	± 658	± 17	± 0.9	± 0.6	± 8.7	± 87	± 479
AF:									
NPNL	36.8	415.3	1100	28	1.8	1.1	12.6	50	324
	± 21.9	± 157.1	± 496	± 13	± 0.8	± 0.5	± 6.3	± 49	± 401
P†	38.4	430.6	1129	28	1.8	1.1	12.2	44	309
	± 22.6	± 142.9	± 546	± 10	± 0.7	± 0.5	± 5.1	± 47	± 354
L‡	42.2	482.0	1259	31	2.0	1.2	13.8	50	328
	± 23.8	± 162.0	± 534	± 13	± 0.8	± 0.5	± 6.6	± 54	± 438

* Includes those children receiving some breast milk.

† Pregnant, nonlactating.

‡ Lactating, nonpregnant.

Number of observations: "I" = Infants (522), "T" = Preschoolers (1917), "S" = Schoolers (1771), "AM" = Adult Males (2956), "AF" = Adult Females: "NPNL" = Nonpregnant, Nonlactating (1234), "P" = Pregnant (838), "L" = Lactating (1511).

TABLE 20.9. PERCENT TOTAL ENERGY INTAKE OF PLANT ORIGIN*
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	All	Tortil.	Legume	Bread	Pasta	Rice	Oils	Pulque	Veg.	Fruit	Cult‡
I†	74	12	4	2	6	2	9	1	1	6	<1
T	88	50	6	7	3	2	7	1	1	1	<1
S	93	65	5	5	1	1	5	1	1	<1	<1
AM	93	59	5	3	1	1	5	12	1	<1	<1
AF:											
NPNL	92	60	5	5	2	1	5	6	1	<1	<1
P	94	64	5	4	1	1	5	5	1	<1	<1
L	94	64	4	3	2	1	5	5	1	<1	<1

* Number of observations: "I" = Infants (522), "T" = Preschoolers (1977), "S" = Schoolers (1771), "AM" = Adult Males (2956), "AF" = Adult Females: "NPNL" = Non- pregnant, Nonlactating (1234), "P" = Pregnant (858), "L" = Lactating (1511).

† Supplemental foods fed to infants. See text for comments on sugar intake.

‡ "Cultivated" fruits and vegetables include those seasonally available from home production, and wild gathered plant foods (see text).

TABLE 20.10.
PERCENT TOTAL ENERGY INTAKE OF ANIMAL ORIGIN*
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	All	Meat	Dairy	Eggs
I	26.5	2.1	17.6	6.1
T	1.9	3.1	5.3	2.8
S	6.9	2.6	2.0	1.8
AM	6.6	2.8	1.8	1.4
AF:				
NPNL	7.8	3.1	2.6	1.3
P	6.5	2.6	1.9	1.5
L	6.5	2.5	2.0	1.6

*Number of observations: "I" = Infants (522), "T" = Preschoolers (1917), "S" = Schoolers (1771), "AM" = Adult Males (2956), "AF" = Adult Females: "NPNL" = Non- pregnant, Nonlactating (1234), "P" = Pregnant (838), "L" = Lactating (1511).

TABLE 20.11
PERCENT OF TOTAL PROTEIN INTAKE FROM VARIOUS SOURCES*
DATA COLLECTED AFTER JANUARY 1, 1985

Subject Type	CLASS				FOOD TYPE					
	Plant	Animal	Tortil	Legume	Bread	Pasta	Rice	Meat	Dairy	Eggs
I	56	44	13	6	3	11	3	4	28	11
T	74	26	46	11	6	3	1	9	9	7
S	83	17	60	10	5	1	1	8	4	5
AM	83	17	58	9	3	1	1	9	4	4
AF:										
NPNL	81	19	63	8	4	2	1	7	4	3
P	83	17	60	9	3	2	1	9	5	3
L	83	17	56	10	4	2	1	8	4	4

* Number of observations: "I" = Infants (522), "T" = Preschoolers (1917), "S" = Schoolers (1771), "AM" = Adult Males (2953), "AF" = Adult Females: "NPNL" = Non- pregnant, Nonlactating (1234), "P" = Pregnant (838), "L" = Lactating (1510).

IV. ADEQUACY OF OTHER NUTRIENTS IN THE DIET

In the Solis diets, approximately 14% of the dietary energy is contributed by fat, and 75% by carbohydrate (including alcohol) (Table 20.8). Equivalent values in the United States are 42 and 46% respectively. The Mexican diets are relatively low in fat and high in carbohydrate. The main source of calcium is tortillas, the calcium being added as lime during the soaking of maize prior to grinding at the mill. Surprisingly, the calcium intake of preschoolers is lower than US (800 mg/day) recommendations. Other target groups receive sufficient calcium on average.

Iron intakes are about 50% higher than recommended, because of the high iron content of tortillas (1 mg per tortilla or 1.1 mg/100 kcal) and beans (about 2 mg per serving). However, the availability of the iron in these foods is low due to their high fiber content and the form of the iron (non-heme). In the absence of meat or ascorbic acid, absorption is about 2.5% from beans and maize (20.3, 20.4). Ascorbic acid intakes are very low: less than one half of recommended levels are consumed by children.

Thiamin intakes are satisfactory in all groups. Riboflavin consumption is about half the levels advised for both groups of children, two thirds of that recommended for pregnant and lactating women, and slightly low for other female and male adults. Niacin intakes are about half the recommended levels for children. The situation with retinol is even worse: intakes of children and adults are less than half of recommended levels. In pregnancy and lactation, intakes of retinol are only about one quarter of the recommendations.

The Management Entity, with the assistance of Dr. G. Beaton, applied a **probability assessment approach** (20.4) to the Mexico dietary data. The purpose of this approach as used here is to consider the likelihood that analyses using energy intake as the independent variable are in fact showing the effects of inadequacies of other nutrients in the diet. Protein, vitamins A and C, and iron are the nutrients tested here. There are several important caveats to the use and interpretation of this approach. First, errors in intake or food composition data will affect the estimate of prevalence, especially if such errors are biased. Random errors have a much smaller impact. Secondly, estimates of requirement are current judgements based on documented sources. Thirdly, the estimates of prevalence relate to the probable adequacy of diets, and not to the prevalence of suboptimal nutritional status of individuals. The assessments are based on the average intake of individuals during the study, and do not consider cyclic or temporary changes in intake. Finally,

analyses for adult women assume that they were not pregnant or lactating (when in fact many of them were). Estimates were not calculated for infants, and were only made for preschoolers who were weaned.

Since the analysis has only been performed so far using dietary data collected both pre-and post-January 1985, detailed prevalence estimates will not be presented here. However, the general pattern is as follows. A small percent (<8%) of children and adults have inadequate intakes of protein to maintain nitrogen balance and permit normal nitrogen accretion in children. In contrast, a high percentage of children (40-60%) and adults (about 40%) have vitamin A intakes below the level required to prevent clinical manifestations of deficiency. The probability of vitamin C deficiency is very high in children, and moderately high in adults. Assuming that dietary iron in Solis has a low availability overall, the percent of individuals who are likely to be consuming insufficient quantities to stabilize mild anemia is very low for preschoolers and adult males, but considerable in the case of schoolers and adult females (11-16%).

V. SOURCES OF DIETARY ENERGY AND PROTEIN

Tables 20.9 to 20.11 describe the types of foods that are consumed. On average, preschoolers derive 88% of their energy and 74% of their protein from plant sources. For schoolers and adults these percentages are 93 and 83% respectively. Well over half of the energy comes from tortillas in all groups. The observed median number of tortillas consumed by adult males and females during the diet validation study (Chapter 6) was 17 per day (1577 kcal), with a range of 6-39 for males, and 2-30 for females. Another 5-6% of total energy comes from beans, 3-5% from bread, 1-2% from pasta and 1% from rice. Most families produce their maize on their own or rented land but only a few of families grow beans. Vegetable oil is used sparingly in the preparation of beans, pasta, rice, eggs and meats, and only contributes about 5% to total dietary energy. Lard is not used. Not shown in these tables is the fact 12% of the non-breast milk intake of infants is from sugar, prepared in herb teas.

The intake of calories from vegetables (apart from the maize in tortillas) and fruits is negligible. The most common of these are onions, garlic and tomatoes that are added to pasta, rice, beans and meats; chiles in salsa and meat dishes; squashes, potatoes, and chard. Of these, only squash (calabaza, Cucurbita pepo), and beans are grown by some households. Fruits or juices are given to young children. These are largely purchased in season, and are oranges, bananas and mangos. "Agua de limon" (lemons, sugar and water) is commonly consumed with meals and can provide the main source of ascorbic acid for some children. "Cultivated" foods are seasonal, and include locally- or home-grown field crops (such as fresh maize, squash and squash flowers, and lima beans). Also in this category are the few wild foods, such as tunas, ("prickly pear", the fruit of the nopal cactus that is high in calcium, iron and ascorbic acid), nopales (cactus, Opuntia sp.), wild greens such as xoconostles and quelites (Brassica campestris), and huitlacoches or hongos de maiz (fungi on the ears of maize that are highly-prized and sold by the locals for cash to buyers from Mexico City). There are almost no "home gardens" in the valley in spite of the efforts of several past development projects.

Pulque, the alcoholic beverage brewed locally from the sap of the maguey cactus (Agave sp.), makes a significant contribution to energy intake of adults - 12% for men, 6% for women and slightly less (5%) for pregnant and lactating women. Higher intakes had been anticipated in lactation since many women reported that they drank pulque to "give milk". Pulque contains about 2% alcohol, in addition to a number of compounds that are reportedly hallucinogens. Other constituents include 430 kcal (of unknown digestibility), 120 mg calcium, 7 mg iron, 0.2 mg thiamin and riboflavin, 4 mg niacin, and 60 mg ascorbic acid per liter. Usual intakes per meal are between 500 ml and a liter, with some men consistently reporting the consumption of 3-5 liters per day. Men also drink beer, especially on weekends, although women do so rarely.

About three-quarters of the dietary energy of adults comes from tortillas and pulque. Although consumption of this beverage may reduce the intake of tortillas, it dramatically increases the intake of iron and ascorbic acid and explains part of the high intakes of these nutrients by men. In future analyses attention should be paid to the possible confounding role of high pulque intakes on the functions and hematological status of adults, breast-fed infants who may consume the alcohol and/or metabolites in milk, and the small number of preschoolers and schoolers who are given this

drink. For example, analyses presented in Chapter 24 suggest that pulque consumption is associated with macrocytic anemia in both adult males and non-pregnant, non-lactating adult females.

VI. FOODS OF ANIMAL ORIGIN

Compared to the situation for schoolers and adults, proportionately more of the foods given to infants are of animal origin. Preschoolers also receive slightly more milk and eggs.

Of the 7 to 8% of calories that are of animal origin in adult diets, over half are from meat, with slightly smaller proportions from dairy products and eggs. Stores within the valley do not sell dairy products or meat. Most families have chickens (85%) and turkeys (79%) which are consumed on special occasions. Beef and pork can be purchased from the market in Temascalcingo, but is not sold in the community stores. Meat is available in the community of Solis only early on Sunday morning, and members of some target households complain that they could afford to buy more meat, but do not have the opportunity to do so. In recent years, many families have changed to purchasing their food from a "food truck" that comes to the communities; this means that fewer go to markets where meat is sold. Although 51% of the families own a cow, the consumption of fresh milk is low. Milk production is low, there are few refrigerators, and some families sell their milk to a private individual who collects it with a truck. Milk (often diluted with water) is consumed by some families in coffee at breakfast, and sometimes in the evening. Dried, full-cream milk is often substituted. Cheese is expensive and almost never purchased, so that it is only consumed in quantity by the few families that make it from the milk of their own cow. Eggs are also acquired largely by home production, although they can be purchased in the community tiendas. In summary, the high cost of animal products, their low availability (especially of meat) and the lack of a refrigerator in most (85%) of the homes means that the intake of these foods by poorer families, and the population in general, is very low.

The low intake of animal foods is of concern because such foods are the main sources of available iron and zinc, and high quality protein. Maize is considered a poor quality protein because of its low lysine and tryptophan content, unless it is consumed with the complementary protein in beans. Pasta is now a substitute for beans in a large proportion of meals. The poor quality of maize protein could be part of the explanation for the poor growth of children in Solis. An additional concern is the poor digestibility of carbohydrate (energy) in maize. In the INN food tables, the energy value of maize is calculated from the formula:

$$\text{calories} = (\text{protein} \times 2.73) + (\text{fat} \times 8.37) + (\text{CHO} \times 4.13)$$

The heat of combustion of maize carbohydrate is 4.20, thus it is assumed that almost all of the carbohydrate is available. However, there are insufficient data on the digestibility of maize in Mexico. The grain is harvested when mature and dry, so the fiber content will be high. Field maize contains 2% fiber (USDA value, 20.5). The Atwater value for the factor to be applied to carbohydrate in corn is 4.03 (20.5), rather than the 4.13 used in the INN tables. If the Atwater value were used instead of the INN value, this would lower the estimated energy intake from tortillas by 2.5%. For adult males, this is a decrease of about 45 kcal/day. However, the digestibility of energy in rural Guatemalan diets containing maize, beans, rice and squash, but less fiber than those eaten in Solis, has been reported to be about 89% (20.6), compared to the Atwater estimate of 96% digestibility for the carbohydrate in corn. If 89% digestibility is assumed, then the "Atwater" value for energy in maize carbohydrate becomes 3.74, and energy intakes of adult males would be decreased by 168 kcal/d. Since even 89% digestibility is a high estimate for tortillas, the values for energy intake presented in the preceding tables probably overestimate available energy.

In many of the analyses below, the intake of calories and/or protein from animal sources is a predictor of more favorable functional outcomes. While care must be taken to control for those variables that might correlate with higher amounts of animal foods (e.g. socioeconomic status, a better environment etc.), such foods provide better quality protein and more absorbable energy, iron and zinc. They are also more energy-dense and less bulky or "filling" than tortillas. Any

or all of these advantages of animal foods could explain the better growth and development of those children who are fortunate enough to consume more animal foods.

VII. WEANING PATTERNS AND THE DIETS OF INFANTS AND PRESCHOOLERS

Since target infants were only followed up to 6-8 months after birth, and target preschoolers between 18 and 30 months of age, it is not possible to know with certainty the mean age at weaning in this sample. The weaning date of target infants and preschoolers was obtained from the mother during her monthly visit to the Solis clinic, and is the date when she first reported that she was no longer giving any breast milk to the child. The date can therefore be overestimated by up to 30 days. In addition to the data obtained in the clinic, a weaning date for all infants and preschoolers was obtained before the end of the study by asking the mother when weaning occurred. This recalled date was only used in the few cases where there were no available data from the clinic.

No target infants were completely weaned during the time they were studied. Most of the infants had a gradual introduction of foods, mostly after 3 months of age. The percentage of specific foods consumed out of a sample of 1,000 records of foods eaten by infants is as follows: ingredients in bean or pasta dishes (20%), sugar (11%), tortillas (7%), eggs (5%), milks (5%), rice (2%), fruit (mostly bananas, 2%), rice flour and soaked maize for the drink atole (1%), bread (1%), pulque (1%), colas (1%), meat (1%). The sugar is served in herb teas, and as mentioned above, constitutes about 12% of the non-breast milk calories consumed by infants. The sweetened teas are often the only supplemental food given to unweaned infants in the first few months of life. Dairy products, which provide about 18% of non-breast milk calories, are about one third dried whole cow's milk, 28% infant formula, 32% fresh or boiled cow's milk, and 5% evaporated milk.

Most preschoolers (72%) were weaned prior to 18 months of age (Table 20.12). Five preschoolers were not weaned until after 30 months of age. In analyses of relationships between intake and function, food intake data are only used from preschoolers after they are weaned.

TABLE 20.12
DISTRIBUTION OF WEANING DATES BY SEX FOR PRESCHOOLERS

	Number of Subjects		
	Sex		Total
	Male	Female	
No Weaning Date	4	3	7
Weaned Before 18 mo.	56	53	109
Weaned from 18-21 mo.	7	8	15
Weaned from 21-24 mo.	4	7	11
Weaned from 24-27 mo.	3	4	7
Weaned from 27-30 mo.	2	2	4
Weaned after 30 mo.	2	3	5
Total	78	80	158

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Chapter 21

ANTHROPOMETRY DATA

I. INTRODUCTION

Anthropometric data were collected repeatedly on all target individuals and once on non-target household members, as described in Chapter 7. Measurements were taken monthly on infants, preschoolers, and pregnant and lactating women, and every three months on schoolers, NPNL women, and adult males. Anthropometric data include length (up to 30 months of age), height, weight, abdominal and lower arm circumference, and subscapular, suprailiac, triceps, and biceps skinfold measures. In addition, percentiles and Z-scores for weight, height, and weight-for-height were computed based on NCHS growth standards.

This section describes the anthropometric data in two ways. First, anthropometric measures are averaged for each subject using all available data, and these averages are described for target groups. This description corresponds to a cross-sectional profile of the sampled population. Additional analyses comparing measures on a cross-sectional basis are reported. Second, anthropometric measures are summarized for infants, preschoolers, schoolers, and pregnant lead females on a monthly basis. This summary corresponds to a longitudinal profile of the sample population. Complete anthropometric data were not available on some target subjects. To insure that the summary represented a longitudinal cohort, subjects included had to have more than a minimum number of anthropometry measures to be included in the analysis. Finally, using the anthropometric data that were collected once on all non-target household members, a cross-sectional description of weight and height data is presented for the first 18 years of life.

II. INFANTS

A. Cross-sectional Analysis

The anthropometric measures reported are measures at birth. For cases in which data at the date of birth were unavailable, the nearest measure within 7 days after birth was selected. Approximately [illegible] measures reported here were taken on the actual date of birth. The other 10% are evenly spread across the remaining [illegible] days allowed in this subset. For these later measures, the time of measurement is accounted for in the calculation of percentiles and Z scores.

Tables 21.1 and 21.2 report cross-sectional statistics on weight and length by sex for target infants. Looking at the infants cross-sectionally, median birth weight is 3.2 kg with median length 50 cm. The infants are lighter (43rd percentile) and shorter (41st percentile) than expected from NCHS standards. Approximately 7% of the infants would be classified as low birth weight, with initial weights less than 2.5 kg. Weight-for-length at birth is very low, at the 17th percentile for females and the 25th percentile for males. However, this may be an artifact of the NCHS standards at birth, since weight-for-length is close to the 50th percentile for the 0 - 1 month age interval (Tables 21.3 and 21.4).

TABLE 21.1
SUMMARY BIRTH WEIGHT AND LENGTH DESCRIPTIONS
INFANT MALES

Variable	N	Median	Mean	(Min , Max)	SD
Mean Weight (kg)	41	3.2	3.2	(2.2 , 3.9)	0.38
Mean %ile wt	39	43	42	(0.5 , 97)	22.17
Mean Z wt	39	-0.17	-0.28	(-2.61 , 1.26)	0.75
Mean Length (cm)	34	50.0	49.9	(44.0 , 54.0)	2.22
Mean %ile ln	32	41	44	(0.2 , 94)	26.77
Mean Z ln	32	-0.21	-0.26	(-2.83 , 1.54)	1.01
Mean Wt/ln	33	0.063	0.063	(0.05 , 0.075)	0.005
Mean %ile wt/ln	25	21	29	(9 , 66)	17.96
Mean Z wt/ln	25	-0.8	-.62	(-1.33 , 0.4)	0.52

TABLE 21.2
SUMMARY BIRTH WEIGHT AND LENGTH DESCRIPTIONS
INFANT FEMALES

Variable	N	Median	Mean	(Min, Max)	SD
Mean Weight (kg)	29	3.0	2.9	(2.1 , 3.9)	0.41
Mean %ile wt	28	44	32	(1 , 97)	25.65
Mean Z wt	28	0.46	-0.55	(-2.29 , 1.83)	0.92
Mean Length (cm)	26	49.0	49.1	(44.0 , 55.2)	2.26
Mean %ile ln	25	35	40	(0.3 , 98)	25.93
Mean Z ln	25	-0.40	-0.32	(-2.70 , 2.09)	0.96
Mean Wt/ln	26	0.058	0.059	(0.048, 0.076)	0.006
Mean %ile wt/ln	17	9	17	(3 , 84)	19.57
Mean Z wt/ln	17	-1.34	-1.16	(-1.95 , 0.99)	0.73

In the reference population (NCHS), the 25th and 75th percentiles for weight correspond to 2.5 and 4.3 kg, while those for height correspond to 47 and 50 cm. In the sample population, these percentiles were 2.8 and 3.3 kg for weight, and 48 and 51 cm for height, respectively. The correlation between weight and height for the 60 subjects with both measures was 0.71.

B. Longitudinal Analysis

Anthropometric data were recorded on infants through 9 months of age, with 101 subjects meeting the minimum longitudinal criteria of 4 data measurements. These data are summarized for weight and height by month of age in Tables 21.3 and 21.4, for male and female infants, respectively. Figures 21.1 and 21.2 are plots of the weight and height percentiles of male and female infants combined, with the 3rd and 50th percentiles of NCHS standards shown for comparison.

TABLE 21.3
SUMMARY INFANT WEIGHT AND LENGTH MEANS BY MONTH
MALES

Variable	Month of Age 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Mean Weight (kg)	3.6	4.5	5.3	6.0	6.4	6.9	7.4	7.5
Mean %ile wt	41	44	46	45	38	34	34	25
Mean Z wt	-0.23	-0.11	-0.10	-0.18	-0.45	-0.60	-0.65	-1.05
(SD/mean)*100	15.80	17.02	14.64	14.99	15.36	15.15	15.44	15.00
Mean Length (cm)	50.2	54.0	56.6	59.7	61.8	63.4	64.8	66.2
Mean %ile ln	26	29	23	27	26	21	16	17
Mean Z ln	-0.92	-0.74	-0.96	-0.84	-0.92	-1.15	-1.36	-1.41
(SD/mean)*100	5.07	4.64	4.21	4.47	4.77	4.21	3.91	4.36
Wt/ln	0.076	0.083	0.094	0.100	0.103	0.108	0.113	0.112
Mean %ile wt/ln	51	68	76	66	60	55	57	49
Mean Z wt/ln	0.60	0.66	0.95	0.59	0.30	0.28	0.39	-0.04
Means (cm):								
Head circumf.	36.1	37.7	39.1	40.3	41.3	42.2	43.1	43.6
Abdominal cir.	35.2	37.1	39.0	40.8	41.7	42.3	43.3	43.2
Upper arm cir.	11.2	11.4	12.2	13.0	13.1	13.5	14.0	13.8
Lower arm cir.	10.5	10.8	11.6	12.3	12.4	12.9	13.2	13.0
Biceps skf.	3.4	3.7	4.0	4.3	4.0	4.3	4.5	4.2
Triceps skf.	5.5	6.4	6.9	7.5	7.6	7.7	8.0	7.7
Suprailiac skf.	4.5	5.3	6.5	7.3	7.5	7.6	7.6	7.2
Subscapular skf.	4.6	5.5	6.0	6.2	6.2	6.2	6.5	5.8
N (weight)	44*	42	39	47	43	48	39	44

* n=41 for length, 16-17 for circumferences and skinfolds

TABLE 21.4
SUMMARY INFANT WEIGHT AND LENGTH MEANS BY MONTH
FEMALES

Variable	Month of Age 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Mean Weight (kg)	3.3	4.1	4.9	5.5	6.0	6.2	6.7	6.9
Mean %ile wt	37	42	40	42	38	28	27	22
Mean Z wt	-0.41	-0.22	-0.20	-0.26	-0.39	-0.78	-0.76	-1.04
(SD/mean)*100	12.11	12.50	14.49	11.74	13.84	12.23	13.37	12.51
Mean Length (cm)	49.3	52.2	55.3	57.4	59.3	60.6	62.3	63.7
Mean %ile ln	21	18	19	17	13	11	10	11
Mean Z ln	-1.04	-1.14	-1.09	-1.21	-1.35	-1.52	-1.59	-1.58
(SD/mean)*100	4.47	3.72	3.64	4.02	3.21	3.45	3.22	3.37
Wt/ln	0.069	0.079	0.088	0.095	0.100	0.101	0.108	0.108
Mean %ile wt/ln	43	67	72	76	73	63	69	58
Mean Z wt/ln	-0.03	0.73	0.83	0.91	0.89	0.62	0.74	0.39
Means (cm):								
Head circumf.	35.4	36.5	38.2	39.1	40.0	40.7	41.4	42.1
Abdominal cir.	31.5	33.2	35.4	36.8	38.1	38.2	39.5	39.7
Upper arm cir.	10.3	11.1	11.9	12.6	13.1	13.2	13.6	13.7
Lower arm cir.	9.8	10.6	11.4	12.1	12.6	12.6	13.0	13.1
Biceps skf.	3.2	3.5	4.0	4.2	4.5	4.4	4.4	4.4
Triceps skf.	5.5	6.3	7.0	7.4	7.8	7.4	8.2	8.1
Suprailiac skf.	4.8	5.7	6.9	7.8	8.3	8.1	8.1	8.2
Subscapular skf.	4.2	5.1	6.0	6.3	6.7	6.8	6.7	6.6
N (weight)	38*	38	40	43	42	37	41	33

* n=33 for length, 13-14 for circumferences and skinfolds

Infant weights are slightly lower than the reference population weights at birth, then recover so that they approach or attain the 45th percentile for the first 3 months. This is followed by a steep decline so that male weights average 7.5 kg and female weights 6.9 kg at 8 months. These values represent the 25th and 22th percentiles. Length patterns are similar but more extreme. During the first month, average length is between 49.3 and 50.2 cm, which is close to the 25th percentile by NCHS standards. Male infants maintain this percentile until month 5, when they drop to the 16-17th percentiles by 8 months. Female infants show a steady decline in percentiles, dropping to the 11th percentile by 8 months. The weight-for-height ratio increases between birth and 3-4 months, then falls during the remaining 4 months. Overall, the data suggest there is much variability in growth among infants, and that growth failure starts to occur around 3 months of age on average. This apparent growth failure cannot be attributed solely to the use of the NCHS standards which were based primarily on data from formula-fed infants. Several investigators have shown that exclusively breast-fed infants actually grow faster than NCHS standards for the first three months of life (21.1 - 21.3); and at 6 months of age, they are still close to the NCHS 50th weight percentile (21.3).

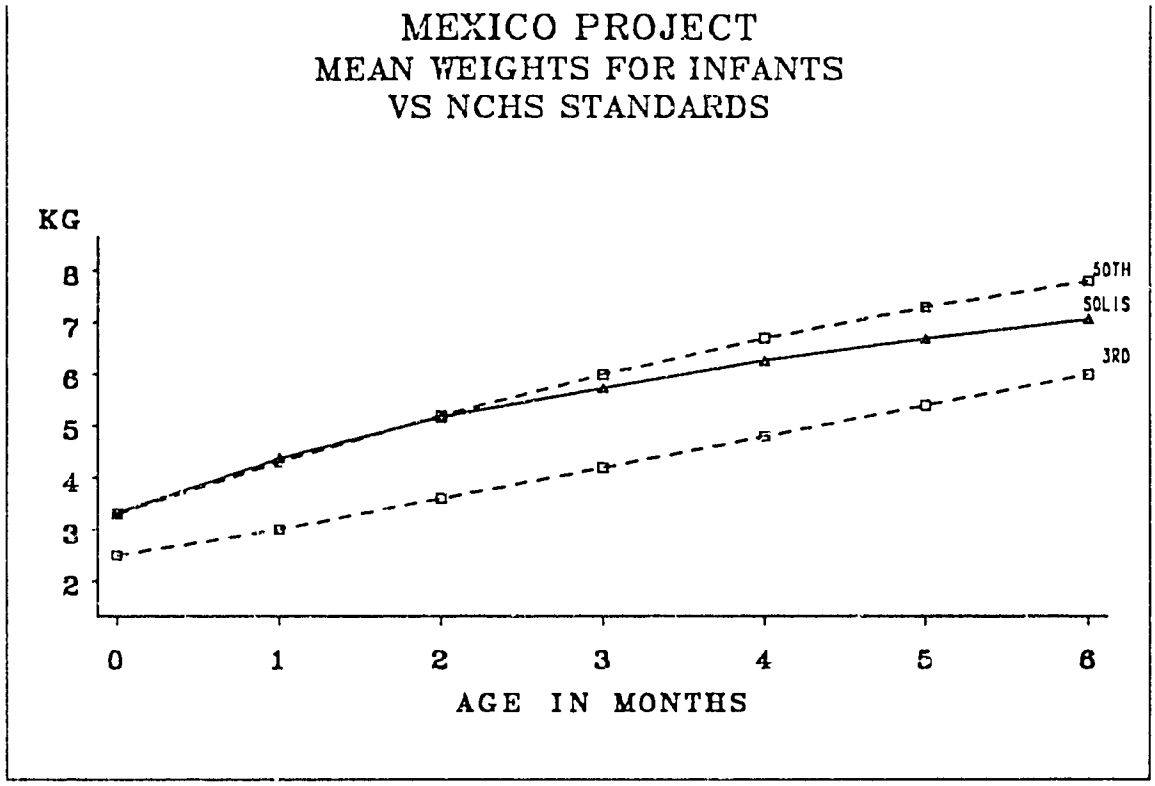

Figure 21.1

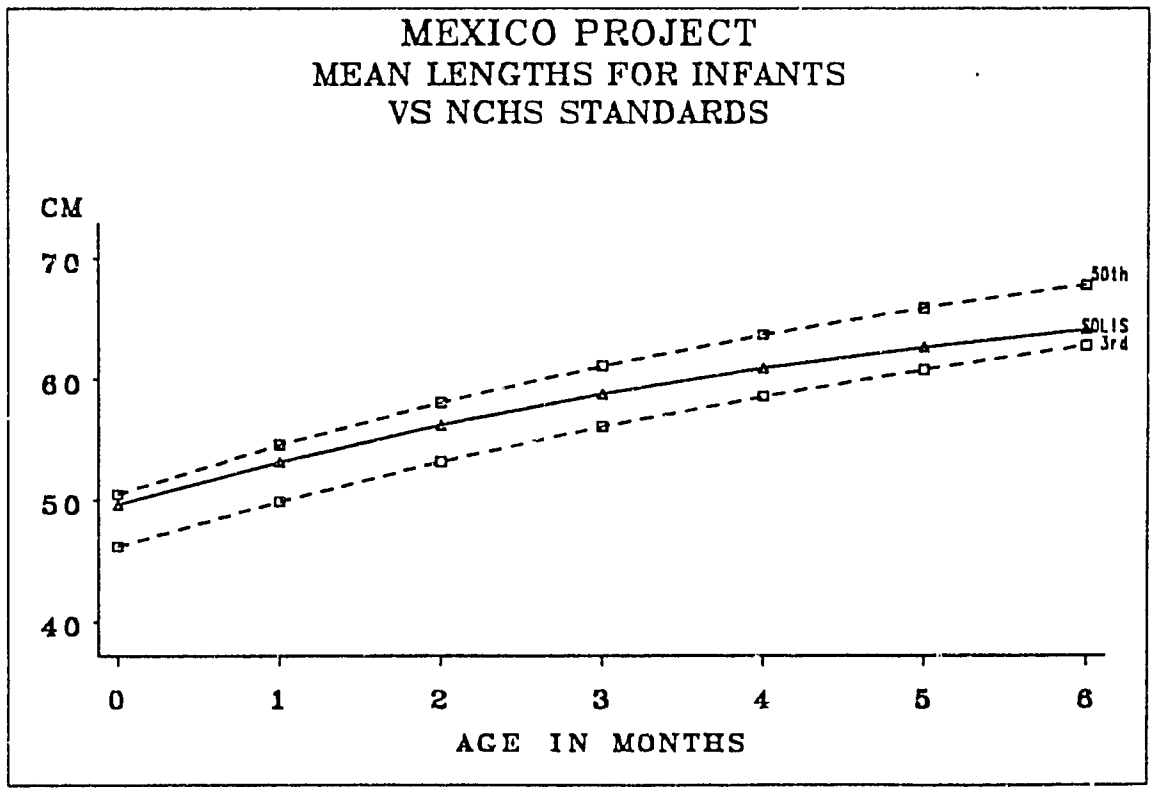

Figure 21.2

III. PRESCHOOLERS

A. Cross-sectional Analysis

Multiple anthropometric measures were gathered on preschoolers aged 18 to 30 months. Means per subject were calculated and used in determining the overall averages for weight and length presented in Tables 21.5 and 21.6 below. The median percentiles for weight are below the 15th percentile of the NCHS standards for both males and females. Length is even lower in comparison to the standards, as the medians are the 1st and 3rd percentile for male and female preschoolers, respectively. The mean age at measure for both weight and length is approximately 25 months. The correlation of weight and length for the 140 subjects with both measures was 0.81. Median weight-for-length has fallen markedly compared to the infant data, on average to the 32nd (males) and 39th (females) percentiles.

TABLE 21.5
SUMMARY WEIGHT AND LENGTH DESCRIPTIONS
PRESCHOOLER MALES

Variable	N	Median	Mean	(Min, Max)	SD
Mean Weight (kg)	72	10.8	10.7	(8.4 , 13.2)	0.99
Mean %ile wt	72	11	13	(.1 , 63)	13.14
Mean Z wt	72	-1.43	-1.51	(-3.34 , 0.38)	0.76
Mean Length (cm)	71	79.5	79.7	(72.2 , 89.4)	3.47
Mean %ile ln	71	1	7	(0 , 82)	13.56
Mean Z ln	71	-2.34	-2.17	(-4.41 , 0.9)	1.01
Mean Wt/ln	70	0.131	0.132	(0.104, 0.155)	.00
Mean %ile wt/ln	70	32	34	(0.3 , 83)	17.97
Mean Z wt/ln	70	-0.28	-0.48	(-2.78 , 1.18)	0.66

TABLE 21.6
SUMMARY WEIGHT AND LENGTH DESCRIPTIONS
PRESCHOOLER FEMALES

Variable	N	Median	Mean	(Min, Max)	SD
Mean Weight (kg)	75	10.4	10.6	(8.2 , 13.9)	1.21
Mean %ile wt	75	13	21	(.1 , 88)	22.36
Mean Z wt	75	-1.16	-1.12	(-3.15 , 1.41)	0.95
Mean Length (cm)	69	78.7	78.9	(71.6 , 88.8)	3.51
Mean %ile ln	69	3	9	(0 , 73)	13.41
Mean Z ln	69	-1.97	-1.96	(-4.15 , 0.63)	1.04
Mean Wt/ln	71	0.130	0.130	(0.105, 0.163)	.01
Mean %ile wt/ln	70	39	41	(1 , 94)	22.16
Mean Z wt/ln	70	-0.28	-0.26	(-2.21 , 1.71)	0.73

B. Longitudinal Analysis

Data were collected on preschoolers for the 12 month period between 18 and 30 months of age. There were 110 preschoolers who met the minimum criteria of having 4 anthropometry measures, as well as a minimum number of diet and morbidity measures. Half of the preschoolers had more than 9 months of anthropometry data. These data are summarized below for height and length by month of age for male and female preschoolers separately (Tables 21.7 and 21.8), and are shown graphically (for male and females combined) in Figures 21.3 and 21.4.

TABLE 21.7
SUMMARY WEIGHT AND LENGTH MEANS BY MONTH
PRESCHOOLER MALES

Variable	Month of Age											
	18	19	20	21	22	23	24	25	26	27	28	29
Mean Wt (kg)	9.5	10.1	10.0	10.0	10.3	10.3	10.7	10.7	11.0	11.3	11.3	11.5
Mean %ile Wt	8	17	11	12	11	8	13	13	13	6	14	14
Mean Z Wt	-1.75	-1.31	-1.57	-1.66	-1.56	-1.64	-1.42	-1.54	-1.50	-1.33	-1.41	-1.41
(SD/Mean)*100	10.01	12.14	9.84	11.98	10.59	7.90	8.11	10.83	10.03	9.90	11.23	10.16
(N)	(23)	(25)	(31)	(36)	(36)	(43)	(39)	(44)	(46)	(50)	(47)	(49)
Mean Ln (cm)	75.1	77.8	76.3	76.9	78.7	78.8	81.2	79.3	81.2	81.3	83.5	82.7
Mean %ile ln	7	8	3	3	4	3	15	7	6	5	12	7
Mean Z ln	-2.52	-1.89	-2.60	-2.61	-2.27	-2.50	-1.42	-2.30	-1.91	-2.06	-1.63	-2.07
(SD/Mean)*100	5.47	3.82	3.77	4.49	3.59	4.01	3.82	5.62	3.27	3.19	4.22	3.90
(N)	(23)	(25)	(31)	(36)	(36)	(43)	(39)	(44)	(46)	(50)	(47)	(49)
Wt/ln	0.126	0.132	0.126	0.126	0.131	0.130	0.133	0.133	0.133	0.135	0.140	0.135
Mn %ile wt/ln	37	35	30	28	38	28	35	32	33	38	44	36
Mean Z Wt/ln	-.40	-.22	-.59	-.66	-.37	-.50	-.50	-.38	-.48	-.35	-.20	-.43
Means (cm) :												
Abdominal cir.	46.6	46.7	46.7	47.6	46.7	47.0	48.8	48.6	48.4	49.0	49.3	50.0
Upper arm cir.	14.4	14.4	14.3	14.8	14.6	14.7	14.5	14.7	14.7	15.0	15.4	15.0
Lower arm cir.	13.6	13.5	13.3	13.4	13.5	13.6	13.7	13.7	13.7	14.0	14.2	13.9
Biceps skf.	4.4	4.0	4.3	4.5	4.3	4.1	4.4	4.2	4.6	4.4	4.2	4.6
Triceps skf.	8.1	6.7	7.5	7.5	7.3	7.4	8.2	7.6	7.4	8.1	7.8	7.7
Suprailiac skf.	6.5	5.8	5.8	6.3	6.6	6.0	6.9	6.5	7.5	7.8	5.9	6.4
Subscapular skf.	5.1	3.9	4.5	4.8	4.8	4.4	4.9	4.8	5.4	5.5	4.8	4.9
(N)	(15)	(12)	(15)	(21)	(16)	(21)	(14)	(19)	(16)	(23)	(13)	(25)
Means (cm) :												
Head circum.	46.2	46.8	46.7	46.2	47.3	47.0	47.4	47.7	47.8	7.4	48.5	48.1
(N)	(13)	(9)	(13)	(17)	(16)	(21)	(14)	(19)	(16)	(23)	(13)	(25)

TABLE 21.8
SUMMARY WEIGHT AND LENGTH MEANS BY MONTH
PRESCHOOLER FEMALES

Variable	Month of Age											
	18	19	20	21	22	23	24	25	26	27	28	29
Mean Wt (kg)	9.6	9.9	10.0	10.1	10.4	10.6	10.6	10.8	11.1	11.0	11.3	11.63
Mean %ile Wt	23	25	18	21	24	22	22	21	24	18	22	4-2
Mean Z Wt	-1.05	-.98	-1.07	-1.15	-1.01	-1.02	-1.10	-1.13	-1.03	-1.18	-1.10	-0.96
(SD/Mean)*100	13.76	13.20	12.42	13.62	12.00	11.38	12.85	11.48	11.51	10.04	12.53	11.03
(N)	(20)	(29)	(31)	(38)	(35)	(38)	(42)	(44)	(43)	(43)	(39)	(40)
Mean Ln (cm)	75.4	75.6	76.4	76.3	76.9	78.2	79.1	80.6	79.6	81.2	82.8	83.2
Mean %ile ln	9	4	4	8	5	3	13	16	6	15	16	12
Mean Z ln	-1.96	-2.22	-2.20	-2.46	-2.53	-2.37	-1.83	-1.53	-2.08	-1.82	-1.54	-1.65
(SD/Mean)*100	4.91	3.98	2.91	6.42	4.69	3.93	5.28	4.42	3.88	5.65	4.75	4.33
(N)	(20)	(29)	(31)	(38)	(35)	(38)	(42)	(44)	(43)	(43)	(39)	(40)
Wt/ln	0.127	0.126	0.124	0.128	0.128	0.130	0.129	0.136	0.130	0.131	0.137	0.137
Mn %ile wt/ln	45	46	34	48	45	48	40	48	37	38	49	46
Mean Z wt/ln	-.04	-.16	-.47	-.00	-.09	-.02	-.30	-.02	-.38	-.40	-.04	-.14
Means (cm) :												
Abdominal cir.	45.6	44.9	46.2	46.0	45.7	46.8	46.1	47.5	47.1	47.6	49.1	48.9
Upper arm cir.	14.6	14.6	14.0	14.4	14.6	14.7	14.5	15.2	14.8	14.8	15.4	15.3
Lower arm cir.	13.8	13.7	13.2	13.5	13.6	13.8	13.6	14.3	13.6	13.9	14.5	14.0
Biceps skf.	4.5	4.7	3.6	4.8	4.4	4.6	4.6	4.5	5.2	4.3	4.8	4.5
Triceps skf.	8.0	7.9	6.7	8.4	7.7	8.1	7.8	8.5	8.0	8.4	8.4	8.2
Suprailiac skf.	8.2	6.8	6.8	7.8	8.2	8.4	7.8	7.4	8.5	8.1	.8	8.3
Subscapular skf.	5.5	4.3	4.3	5.3	4.9	6.1	5.3	5.4	5.5	5.4	.4	5.4
(N)	(16)	(12)	(10)	(20)	(13)	(15)	(21)	(16)	(11)	(21)	(15)	(15)
Means (cm) :												
Head circum.	45.2	45.3	45.7	45.8	46.0	45.9	46.0	46.9	46.3	46.6	47.2	47.4
(N)	(15)	(10)	(9)	(19)	(13)	(15)	(21)	(16)	(11)	(21)	(15)	(15)

In contrast to infants, the preschooler males are generally lower than the females in terms of average percentiles by month, for both weight and length. In weight, there is variability with time, but no trends of gaining or losing ground in the percentiles. The male preschoolers begin at 9.5 kg. and increase to 11.5 kg by month 29, while percentiles vary between the 8th and 16th. Female preschoolers are roughly equal in initial weights and gains, starting at 9.6 kg. and gaining to 11.6 kg by month 29. The percentiles for females range between 18 and 25. In length measures, the percentile scores for both sexes are lower than those for weight. Males start and end on at the 7th percentile, varying between the 3rd and 15th percentiles in the interim months. Females show some improvement in length percentiles. For the first six months the percentiles remain below 10 while in later months they are generally in the low teens. Weight-for-length, while lower than in infancy, remains stable across this time period, with females in higher percentiles than males.

In summary, it appears that there is marked growth retardation by the time preschoolers reach 18 months of age; but, between 18 and 30 months, the rate of growth in both weight and length parallels the NCHS standards. Thus, the worst nutritional insult has probably occurred before 18 months, but there is no general trend of catching-up after this time. Nevertheless, as demonstrated by analyses in Chapter 29, there is great variation among the preschoolers in their rate of growth between 18 and 30 months.

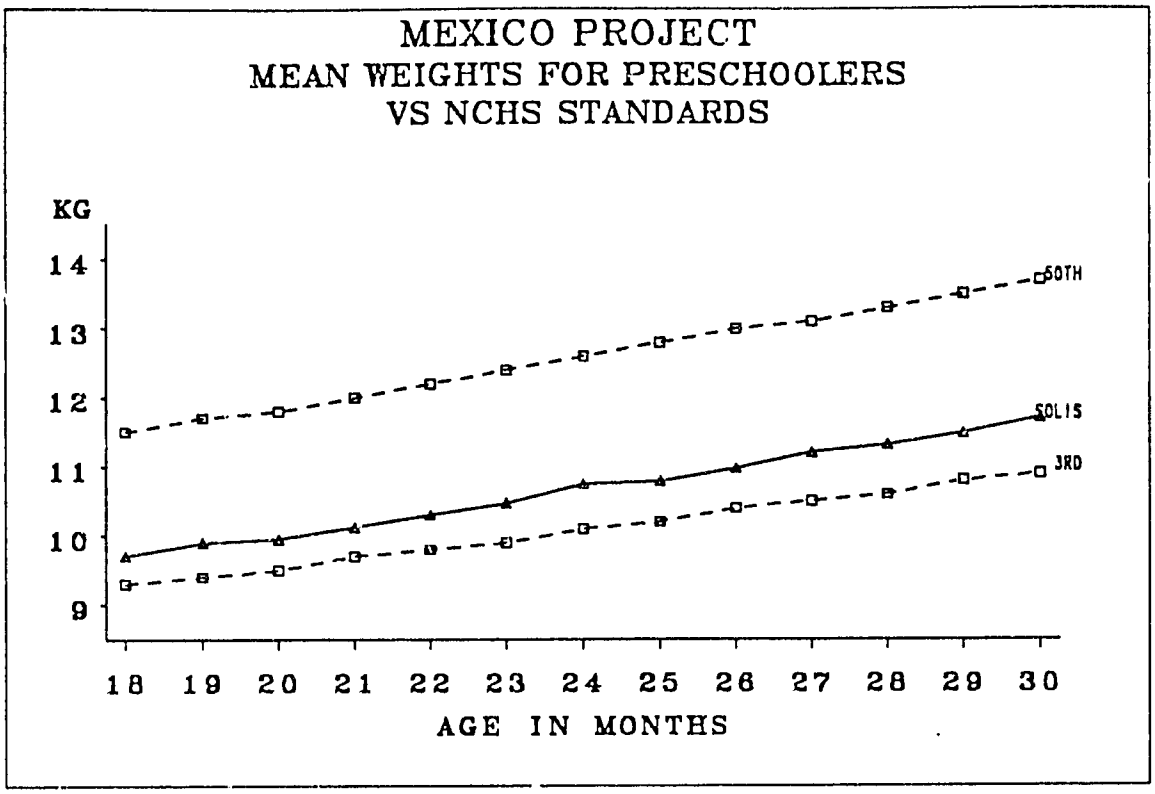

Figure 21.3

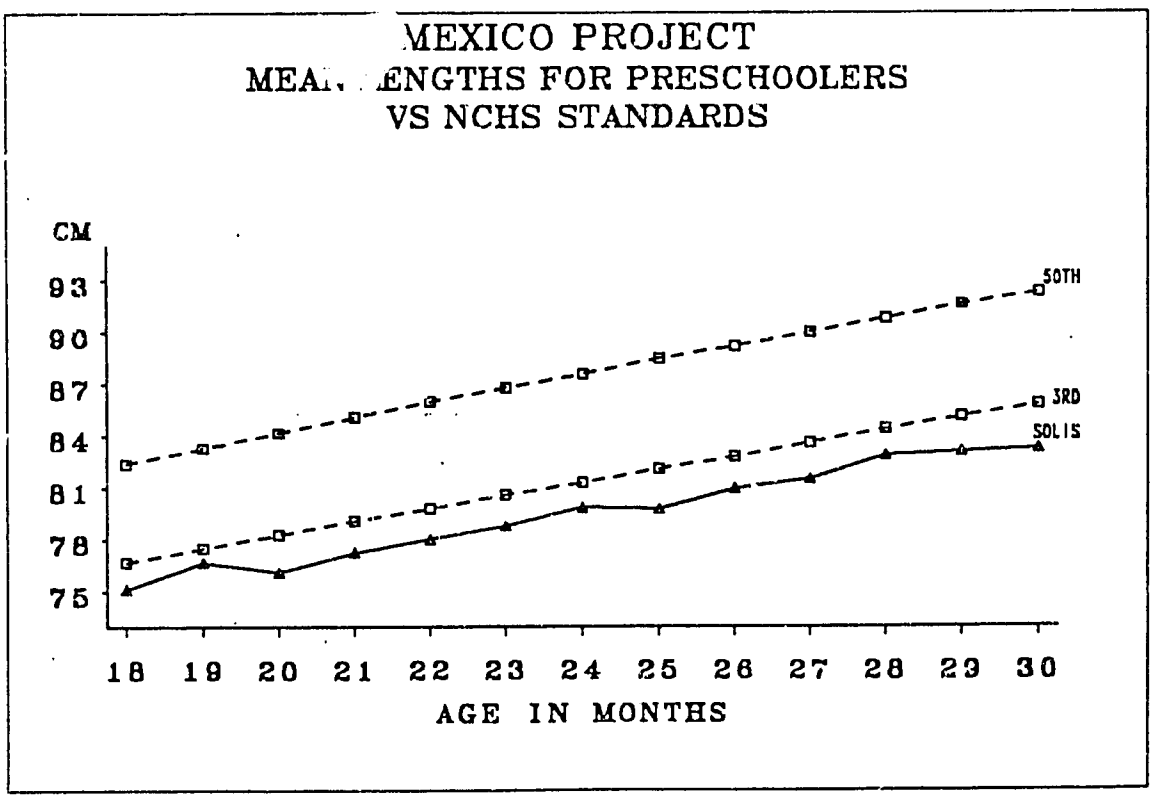

Figure 21.4

IV. SCHOOLERS

A. Cross-sectional Analysis

Measures reported here are for schoolers 7-9.5 years old, the average age being 8.2 years. The number of weight observations per subject in this group ranges from 1 to 9, with a mean of 5.3. Tables 21.9 and 21.10 below provide cross-sectional statistics for the average height and weight values of subjects. In these tables, the mean weight is 21.8 kg and the mean height is 118.2 cm. Based on NCHS standards, these values are all below the 15th percentile. Weight-for-height, however, is close to the 50th percentile for both males and females. The correlation between height and weight for all schoolers was 0.81 .

TABLE 21.9
SUMMARY WEIGHT AND HEIGHT DESCRIPTIONS
SCHOOLER MALES

Variable	N	Median	Mean	(Min, Max)	SD
Mean Weight (kg)	85	21.8	22.2	(16.8 , 30.0)	2.67
Mean %ile wt	85	15	22	(0.4 , 84)	19.41
Mean Z wt	85	-1.03	-0.96	(-2.64 , 1.01)	0.75
Mean Height (cm)	84	119.0	119.1	(107.1 , 129.0)	4.91
Mean %ile ht	84	9	16	(0 , 73)	16.55
Mean Z ht	84	-1.34	-1.34	(-3.55 , 0.6)	0.87
Mean Wt/Ht	84	0.182	0.184	(0.151, 0.246)	.02
Mean %ile wt/ht	84	43	45	(3 , 93)	20.84
Mean Z wt/ht	84	-0.14	-.09	(-1.90 , 3.06)	0.73

TABLE 21.10
SUMMARY WEIGHT AND HEIGHT DESCRIPTIONS
SCHOOLER FEMALES

Variable	N	Median	Mean	(Min, Max)	SD
Mean Weight (kg)	76	20.8	21.2	(16.6 , 28.3)	2.22
Mean %ile wt	76	12	16	(1 , 76)	4.09
Mean Z wt	76	-1.22	0.71	(-2.39 , .71)	0.61
Mean Height (cm)	76	116.3	116.9	(101.2 , 132.7)	5.36
Mean %ile ht	76	6	11	(0 , 85)	15.39
Mean Z ht	76	-1.60	-1.57	(-4.17 , 1.06)	0.85
Mean Wt/Ht	75	0.177	0.177	(0.150, 0.216)	.01
Mean %ile wt/ht	75	50	47	(4 , 97)	20.64
Mean Z wt/ht	75	0.01	-.10	(-1.73 , 1.88)	0.62

B. Longitudinal Analysis

Data were collected on target schoolers for a maximum of 12 months. Because of the wide age range covered, Tables 21.11 and 21.12 have been collapsed to several cohorts of subjects. At least 4 measures were available for each schooler. In the simple descriptive statistics provided, apparent trends over time may be confounded by the changing subject groups. Figures 21.5 and 21.6 are plots of the same data, for males and females combined, showing comparisons with the 3rd and 50th NCHS percentiles.

For all age ranges, the average percentiles for weight and height are generally below the 20th percentile. The percentiles are lower for the older schoolers. Whether a general decline with age is actually present or whether this is an artifact of sampling cannot be determined from this table. On average, the schoolers are growing at rates which cause them to continue to lose ground compared to the NCHS population. There is a slight tendency for weight-for-height to increase between 7 and 9 years of age.

TABLE 21.11
SUMMARY OF MALE SCHOOLER WEIGHT AND HEIGHT BY AGE IN YEARS

	Age in Years				
Variable	7 - <7.5	7.5 - <8	8 - <8.5	8.5 - <9	9 - <9.5
Mean Weight (kg)	20.8	21.3	22.2	23.3	23.8
Mean %ile wt	22	18	17	19	16
Mean Z wt	-1.02	-1.15	-1.17	-1.10	-1.24
(SD/mean)*100	12.50	11.97	11.80	11.55	14.62
(N)	(31)	(51)	(58)	(37)	(19)
Mean Height (cm)	115.4	118.0	120.0	122.5	123.8
Mean %ile ht	15	14	13	14	12
Mean Z ht	-1.53	-1.49	-1.50	-1.45	-1.59
(SD/mean)*100	4.61	4.24	4.10	3.89	4.10
(N)	(29)	(50)	(55)	(34)	(19)
Mean Wt/ht	0.176	0.181	0.183	0.187	0.194
Mean %ile wt/h	46	45	43	42	39
Mean Z wt/ht	-0.15	-0.13	-0.18	-0.21	-0.28
(N)	(28)	(49)	(55)	(37)	(8)
Mean Head circum. (cm)	50.3	50.5	50.8	51.1	51.3
(N)	(24)	(43)	(53)	(34)	(19)
Mean Biceps skinfold (cm)	2.9	2.7	2.7	2.7	2.8
(N)	(26)	(47)	(53)	(34)	(19)
Means (cm):					
Abdominal cir.	55.2	55.0	55.5	55.8	56.9
Upper arm cir.	16.6	16.9	17.0	17.2	17.3
Lower arm cir.	15.0	15.3	15.4	15.6	15.9
Triceps skinfold	5.7	6.0	6.1	6.2	6.7
Suprailiac skinfold	4.1	4.8	4.5	4.7	4.8
Subscapular skinfold	3.6	4.0	4.0	4.1	4.1
(N)	(29)	(50)	(55)	(34)	(19)

TABLE 21.12
SUMMARY OF FEMALE SCHOOLER WEIGHT AND HEIGHT BY AGE IN YEARS

Variable	Age in Years 7 - <7.5	7.5 - <8	8 - <8.5	8.5 - <9	9 - <9.5
Mean Weight (kg)	19.8	20.4	21.4	22.1	22.5
Mean %ile wt	21	17	16	13	9
Mean Z wt	-0.99	-1.15	-1.17	-1.30	-1.45
(SD/mean)*100	10.45	11.62	10.75	10.68	8.98
(N)	(22)	(50)	(61)	(39)	(22)
Mean Height (cm)	113.5	115.2	118.2	120.4	122.4
Mean %ile ht	13	11	12	11	9
Mean Z ht	-1.54	-1.68	-1.56	-1.60	-1.62
(SD/mean)*100	4.63	4.96	4.59	4.49	4.13
(N)	(21)	(51)	(59)	(38)	(22)
Mean Wt/ht	0.172	0.175	0.178	0.182	0.175
Mean %ile Wt/ht	50	49	45	46	32
Mean Z Wt/ht	0.01	-0.04	-0.15	-0.12	-0.48
(N)	(20)	(47)	(59)	(40)	(6)
Mean Head circum.(cm)	49.4	49.5	49.6	50.0	50.2
(N)	(15)	(38)	(55)	(38)	(22)
Mean Biceps skinfold (cm)	3.5	3.4	3.3	3.4	3.2
(N)	(17)	(41)	(56)	(38)	(22)
Means (cm):					
Abdominal cir.	55.6	55.7	56.5	57.3	58.2
Upper arm cir.	16.8	16.9	17.1	17.0	17.1
Lower arm cir.	15.0	15.1	15.3	15.3	15.3
Triceps skinfold	7.7	7.8	7.4	7.4	7.3
Suprailiac skinfold	5.3	5.9	5.8	5.6	6.3
Subscapular skinfold	4.6	4.9	4.8	4.4	4.8
(N)	(21)	(51)	(59)	(38)	(22)

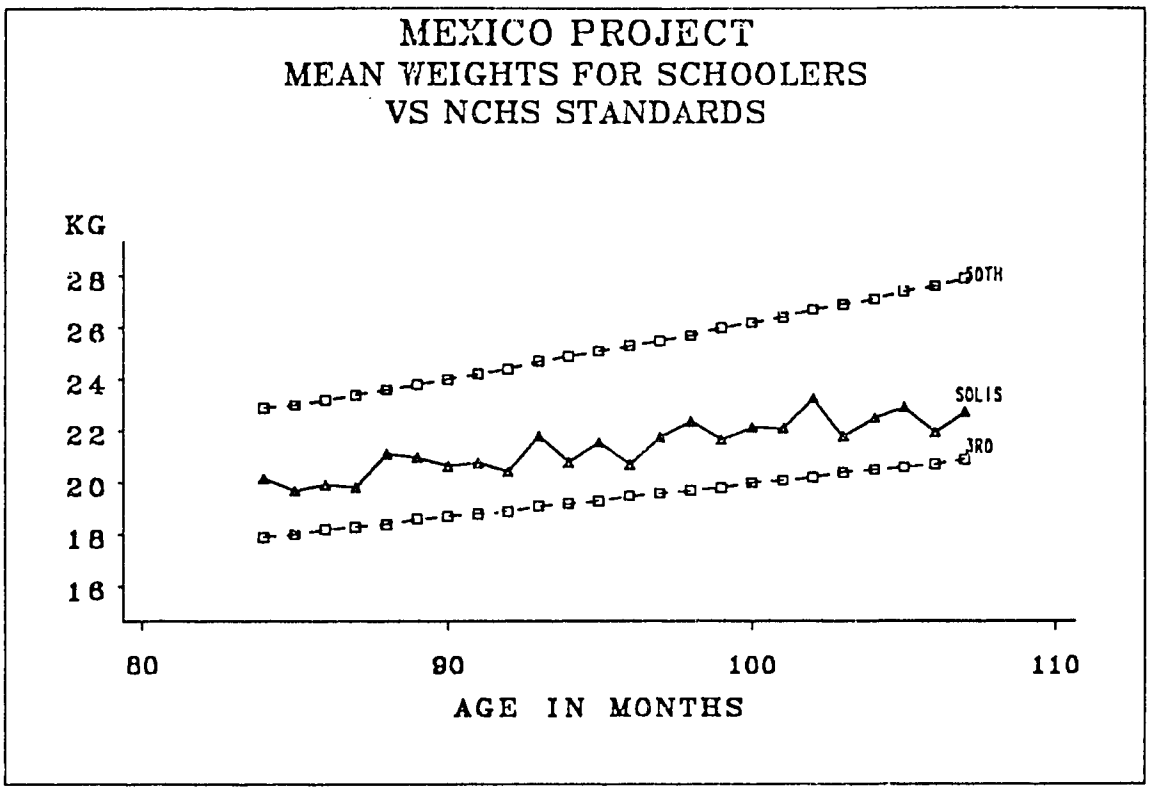

Figure 21.5

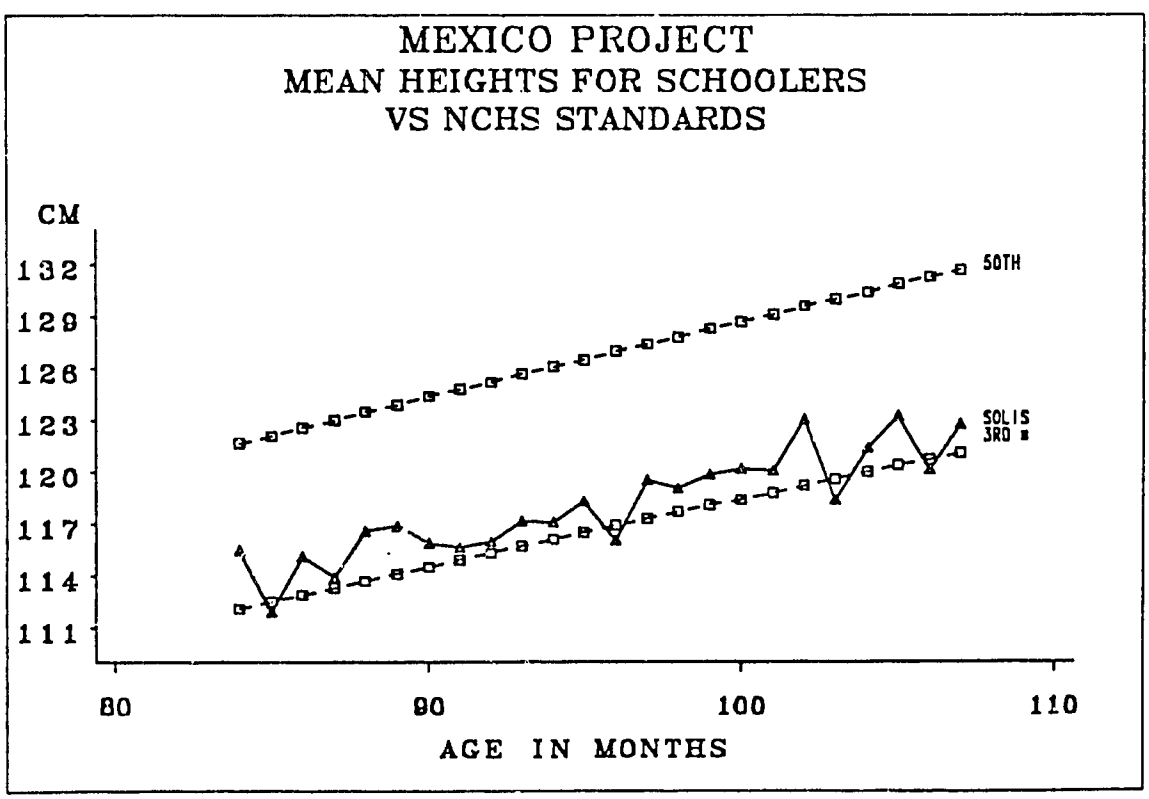

Figure 21.6

V. ADULTS

Adult anthropometric data are summarized in Table 21.13 - 21.16. These values will be used to estimate body composition. As will be described later in this report, maternal weight gain in pregnancy is low (7.7 kg). Skinfold thickness increases during the second trimester of pregnancy and drops quite markedly during the third. Upper arm circumference shows a similar pattern. The changes shown here must be interpreted with caution, since the same women were not included at each point in time. The NPNL group has higher body weights, skinfolds, and circumferences than the pregnant or lactating women because they are older on average. The Solis women become fatter with age. The proportion of lean body mass (calculated from Durnin and Womersley's formula using the sum of four skinfolds, 21.4), falls from 69% in teenage women, to 64% in women age 20-30 years, and 58% between 40 and 50 years. Male teenagers have 82% lean body mass which remains constant up to 50 years of age.

TABLE 21.13
WEIGHTS AND HEIGHTS OF LEAD MALES & FEMALES

Subject Type	# Obs.	Weight (kg)	# Obs.	Height (cm)	# Obs.	Wt/Ht^2
Adult Males	660	66.0 ± 9.6	509	166 ± 6	508	.0023 ± .0003
Adult Females						
Nonlactating						
NPNL	524	60.8 ± 10.4	319	154 ± 5	318	.0026 ± .0004
Tri I	77	53.5 ± 7.8	40	152 ± 6	40	.0024 ± .0003
Tri II	180	58.5 ± 7.5	23	153 ± 6	23	.0024 ± .0003
Tri III	317	61.2 ± 7.9	18	152 ± 5	18	.0027 ± .0003
Lactating						
0-3 mon*	276	57.3 ± 7.9	161	152 ± 5	161	.0025 ± .0003
3-6 mon*	321	57.5 ± 8.4	107	152 ± 5	107	.0025 ± .0003
6-8 mon*	228	56.8 ± 8.8	106	152 ± 5	106	.0024 ± .0003

* Lactating but not pregnant

TABLE 21.14
SKINFOLDS OF LEAD MALES & FEMALES

Subject Type	# Obs.	Biceps (cm)	# Obs.	Triceps (cm)	# Obs.	Suprailiac (cm)
Adult males	657	3.1 ± 2.1	660	7.5 ± 4.1	661	14.5 ± 7.5
Adult females						
Nonlactating						
NPNL	492	8.5 ± 4.24	95	18.4 ± 6	494	28.5 ± 10.9
Tri I	67	7.1 ± 3.8	67	15.7 ± 5	67	23.1 ± 10.0
Tri II	147	7.5 ± 3.9	148	16.1 ± 5	148	24.4 ± 8.9
Tri III	281	6.7 ± 3.4	281	15.5 ± 5	281	24.5 ± 8.5
Lactating						
0-3 mon*	173	7.0 ± 3.0	173	15.4 ± 4	172	27.0 ± 9.4
3-6 mon*	142	7.7 ± 3.9	143	17.4 ± 5	143	27.3 ± 9.4
6-8 mon*	144	7.3 ± 3.7	145	16.8 ± 5	145	27.7 ± 10.2

* Lactating but not pregnant

TABLE 21.15
SKINFOLDS & CIRCUMFERENCES OF LEAD MALES & FEMALES

Subject Type	# Obs.	Subscapular Skinfold (cm)	# Obs.	Upper Arm Circ. (cm)	# Obs.	Lower Arm Circ (cm)
Adult males	660	12.8 ± 6.5	658	28.2 ± 2.3	660	23.5 ± 1.8
Adult females						
Nonlactating						
NPNL	495	28.4 ± 10.9	493	29.0 ± 2.9	493	21.7 ± 1.8
Tri I	67	23.7 ± 9.3	67	27.1 ± 2.2	67	20.5 ± 1.3
Tri II	148	24.6 ± 8.3	148	27.1 ± 2.3	148	20.7 ± 1.5
Tri III	281	24.0 ± 7.8	281	26.8 ± 2.3	281	20.6 ± 1.5
Lactating						
0-3 mon*	172	27.1 ± 9.1	173	27.3 ± 2.5	173	20.6 ± 1.5
3-6 mon*	143	27.2 ± 9.1	143	27.9 ± 2.5	143	20.7 ± 1.5
6-8 mon*	145	27.5 ± 9.8	145	27.8 ± 2.8	145	20.8 ± 1.5

* Lactating but not pregnant

TABLE 21.16
CIRCUMFERENCES OF LEAD MALES & FEMALES

Subject Type	# Obs.	Abdomen Circ. (cm)	# Obs.	Head Circ. (cm)
Adult males	661	87.1 ± 8.0	430	55.8 ± 1.6
Adult females				
Nonlactating				
NPNL	494	97.8 ± 10.9	252	53.5 ± 1.3
Tri I	67	91.2 ± 8.6	39	52.7 ± 1.3
Tri II	148	96.0 ± 7.9	80	53.1 ± 1.4
Tri III	281	101.2 ± 7.7	102	52.8 ± 1.3
Lactating				
0-3 mon*	170	95.0 ± 8.3	72	53.2 ± 1.3
3-6 mon*	143	94.5 ± 8.9	56	52.9 ± 1.4
6-8 mon*	145	93.9 ± 9.5	95	53.3 ± 1.5

* Lactating but not pregnant

VI. FAMILY ANTHROPOMETRY

The anthropometry of all household members was measured once, at the end of the study. Figures 21.7 - 21.16 show weight, height, and weight and height percentiles for males and females separately, between the ages of 1 and 18 years. There is considerable variation among individuals, but both males and females have low weight and height percentiles at all ages. These household-level data indicate that the growth deficits that characterize the children in the longitudinal sample (infants, preschoolers, and schoolers) are also characteristic of their siblings at all ages between 1 and 18 years. Most individuals are below the 20th percentile for weight and the 10th percentile for height throughout the growth period. These deficits in weight and height cannot be attributed to "genetics", as there have been several studies that show growth of Mexican-American children to be close to the 50th percentile of the international standards used here (21.5). It is of interest that weight-for-height is relatively normal at all ages. Weight-for-height is obviously not a good indicator of chronic malnutrition.

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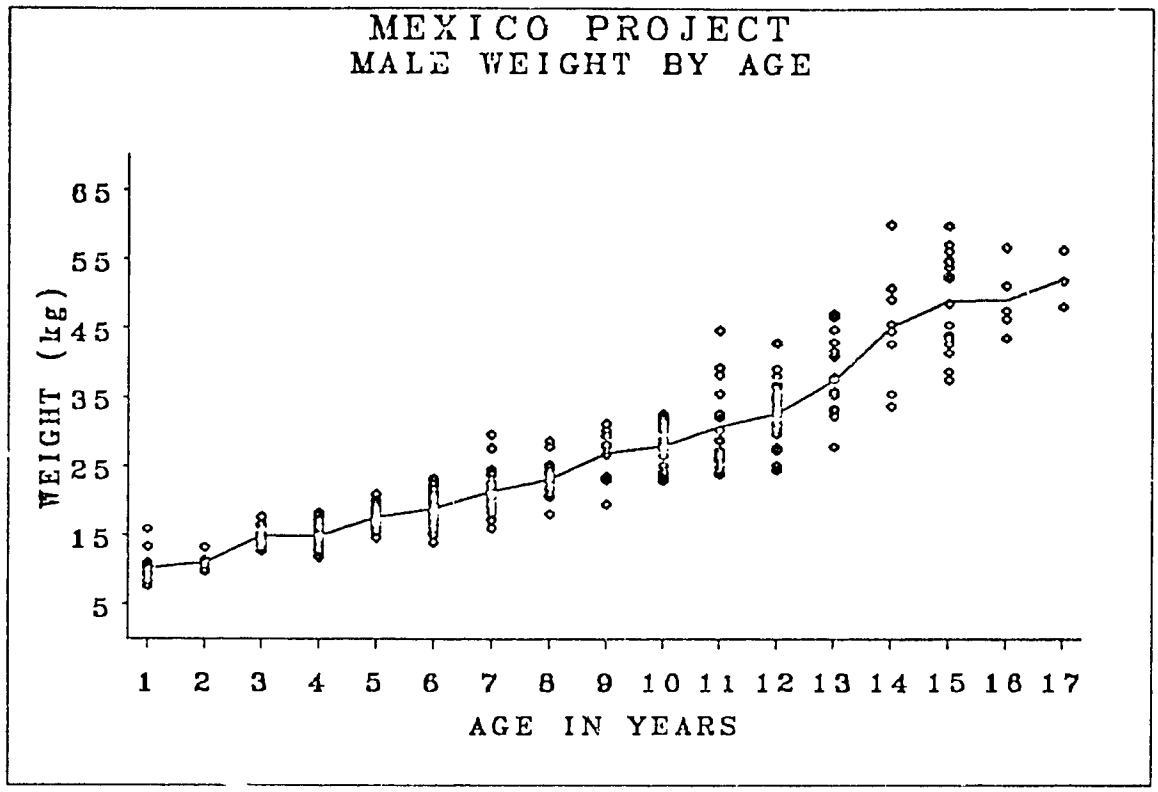

Figure 21.7 Scatterplot of weight by age for Solis males, age 1-17 years. Line indicates mean weight at each age.

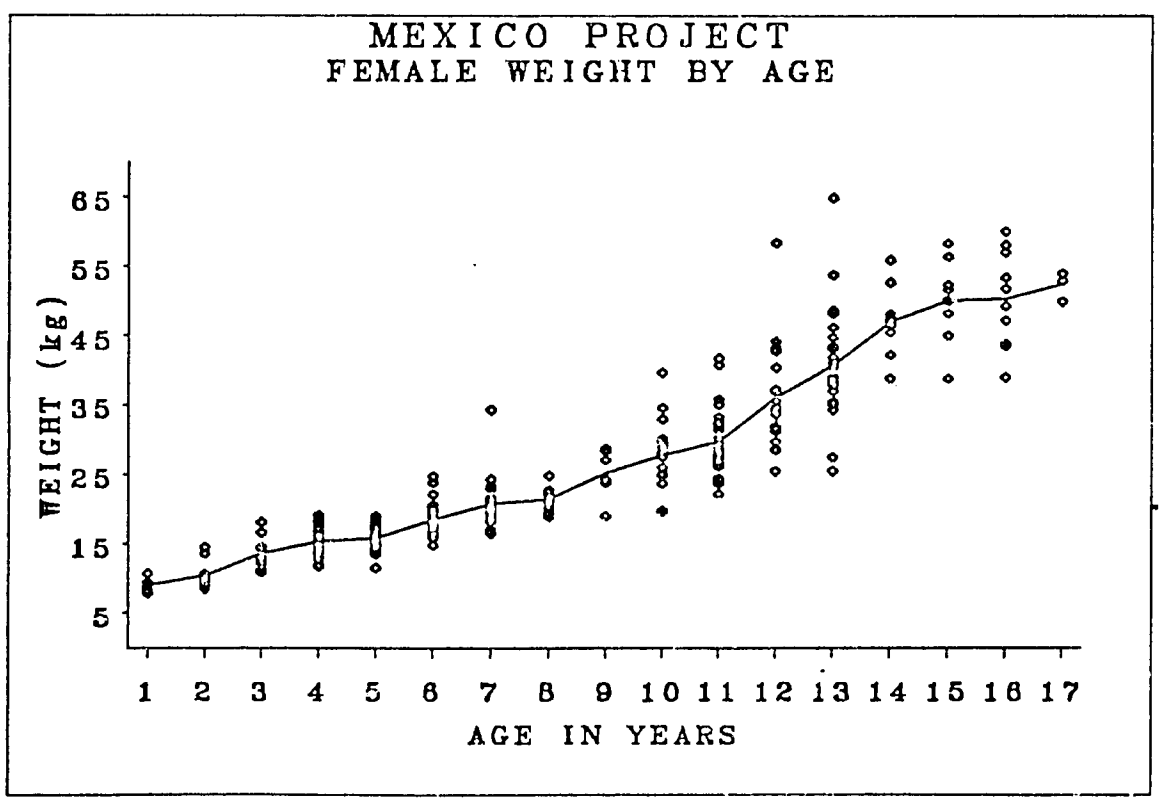

Figure 21.8 Scatterplot of weight by age for Solis females, age 1-17 years. Line indicates mean weight at each age.

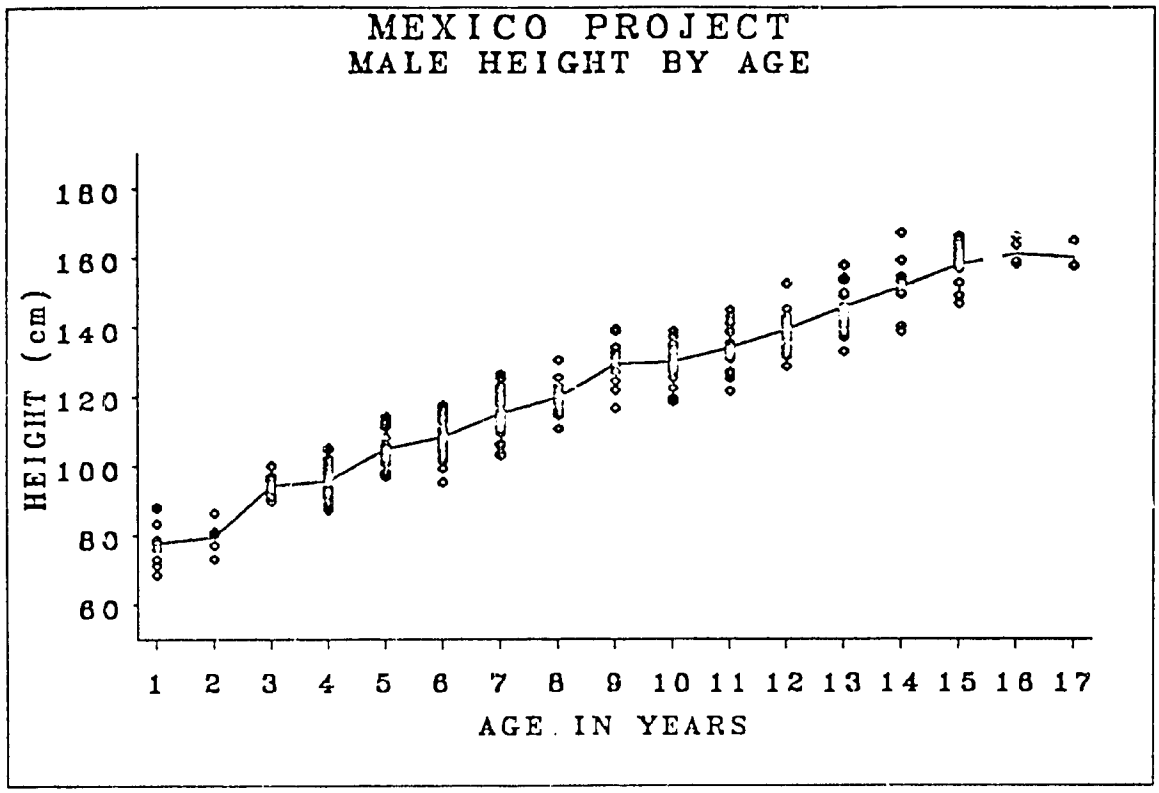

Figure 21.9 Scatterplot of height by age for Solis males, age 1-17 years. Line indicates mean height at each age.

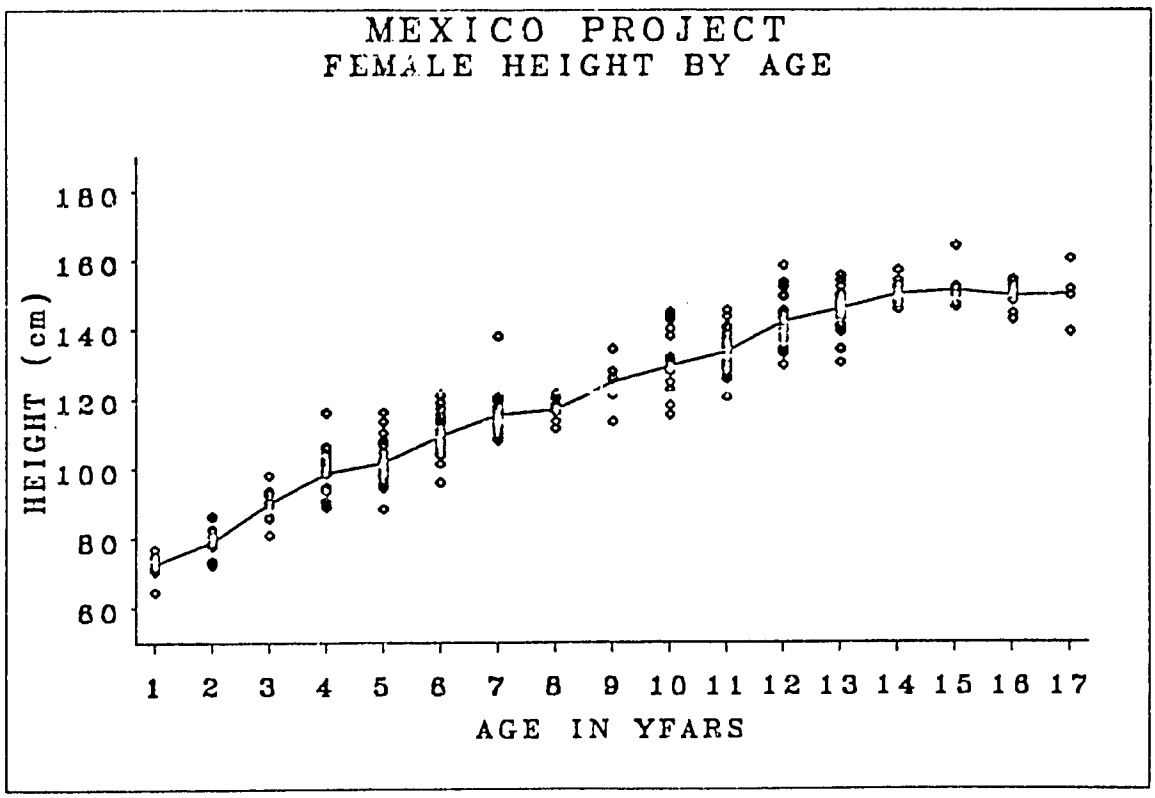

Figure 21.10 Scatterplot of height by age for Solis females, age 1-17 years. Line indicates mean height at each age.

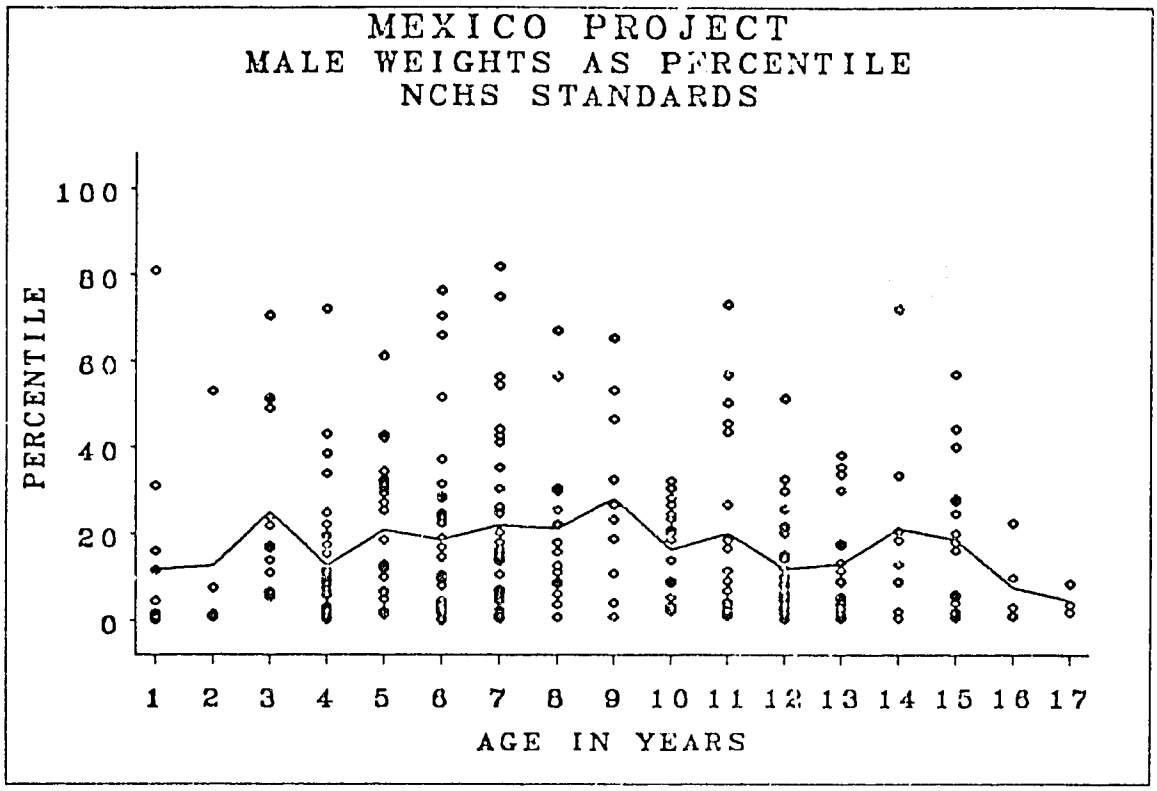

Figure 21.11 Scatterplot of weight-for-age percentiles for Solis males, age 1-17 years. Line indicates mean of percentiles at each age.

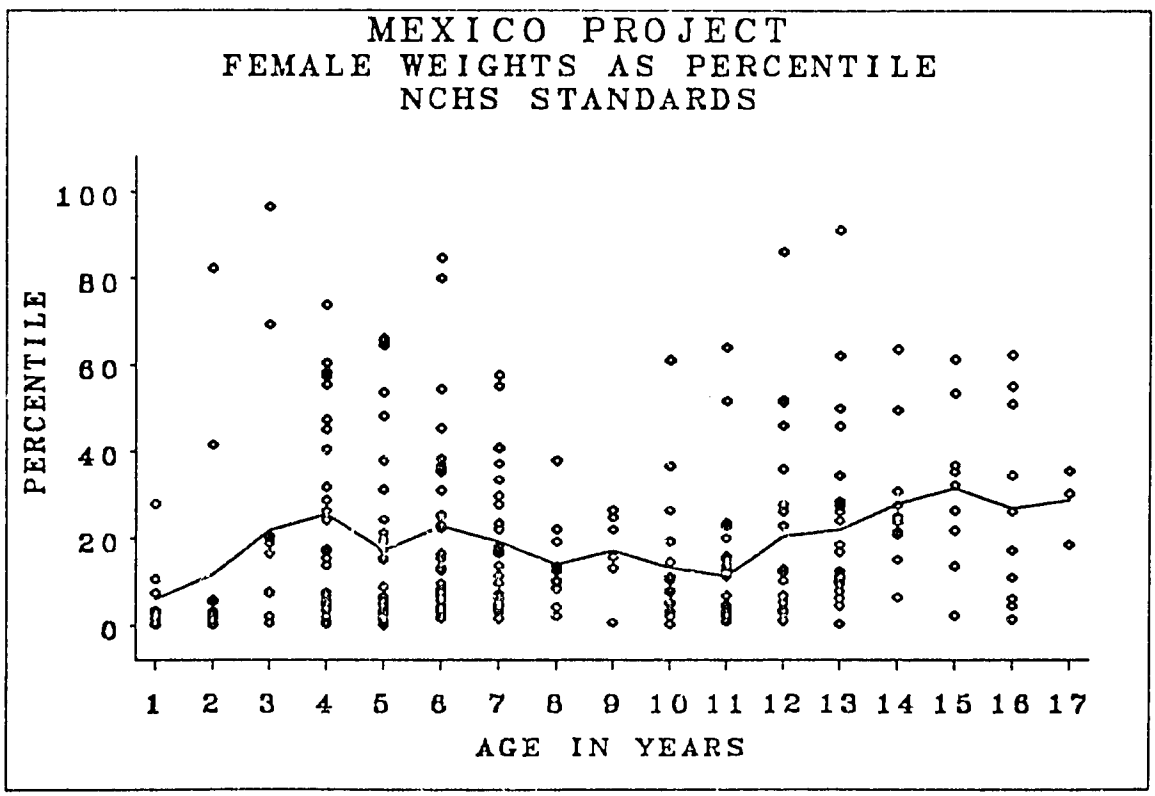

Figure 21.12 Scatterplot of weight-for-age percentiles for Solis females, age 1-17 years. Line indicates mean of percentiles at each age.

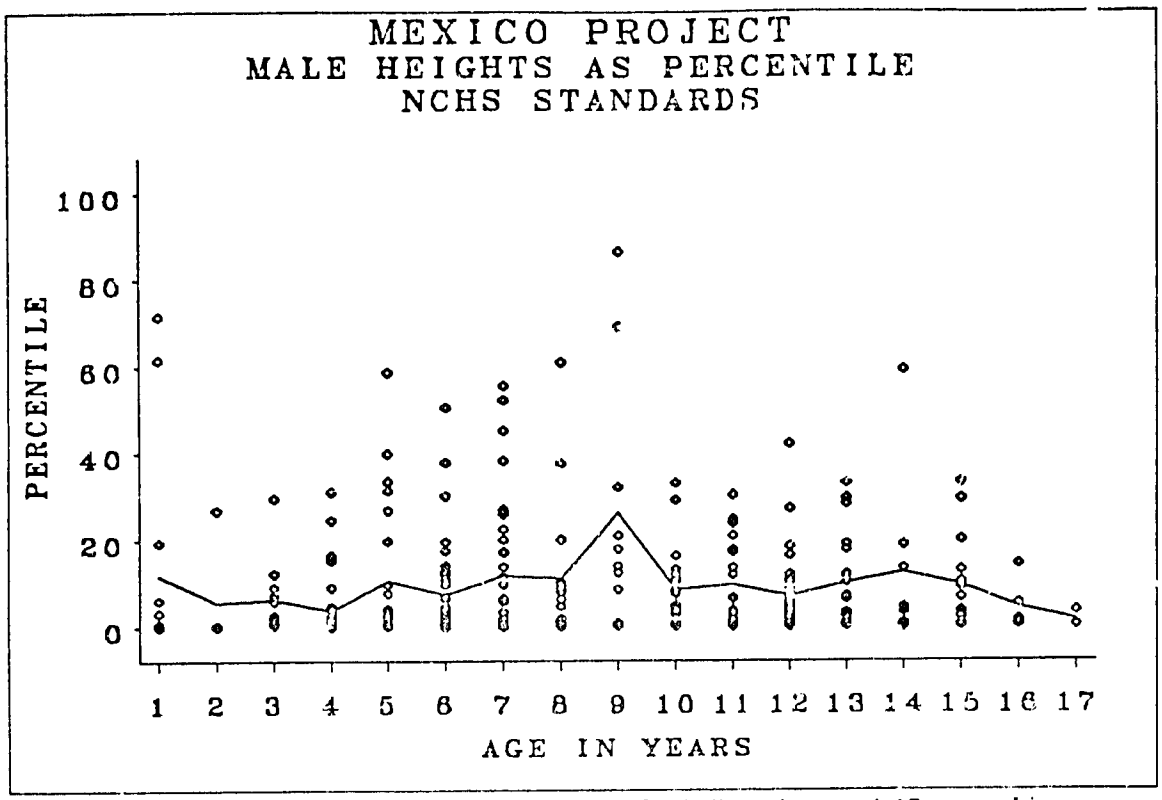

Figure 21.13 Scatterplot of height-for-age percentiles for Solis males, age 1-17 years. Line indicates mean of percentiles at each age.

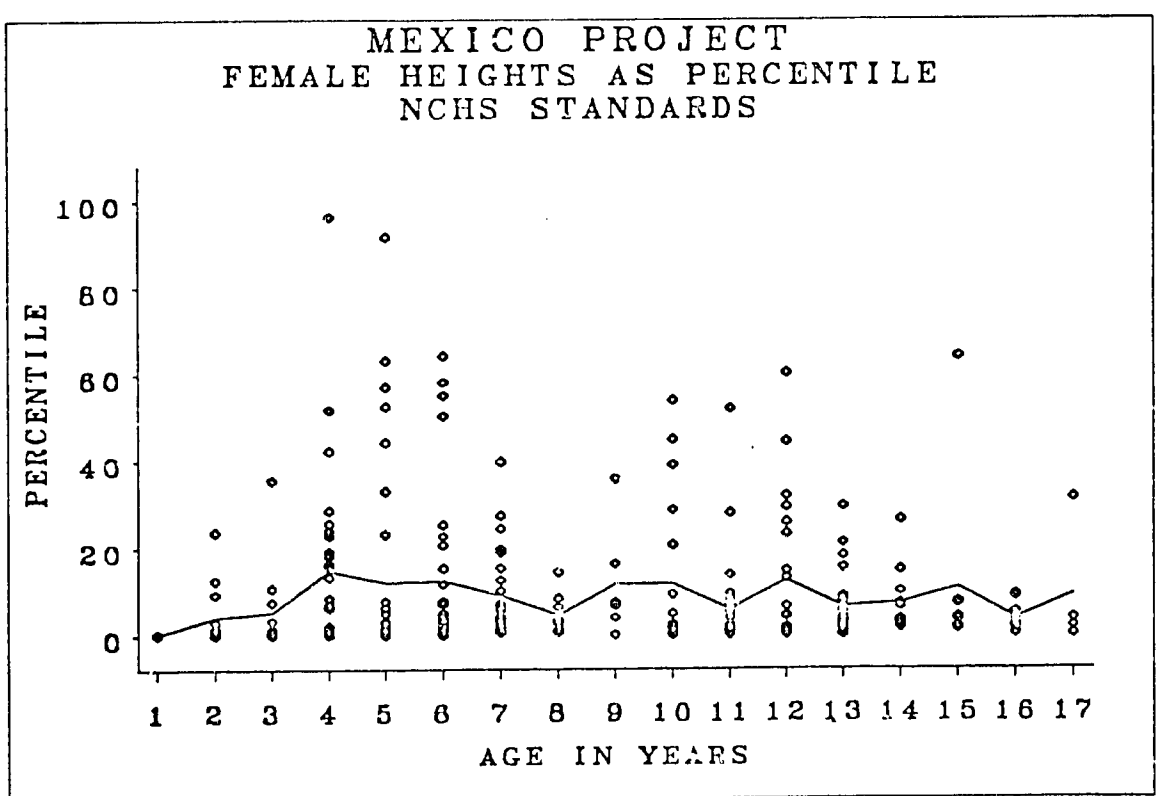

Figure 21.14 Scatterplot of height-for-age percentiles for Solis females, age 1-17 years. Line indicates mean of percentiles at each age.

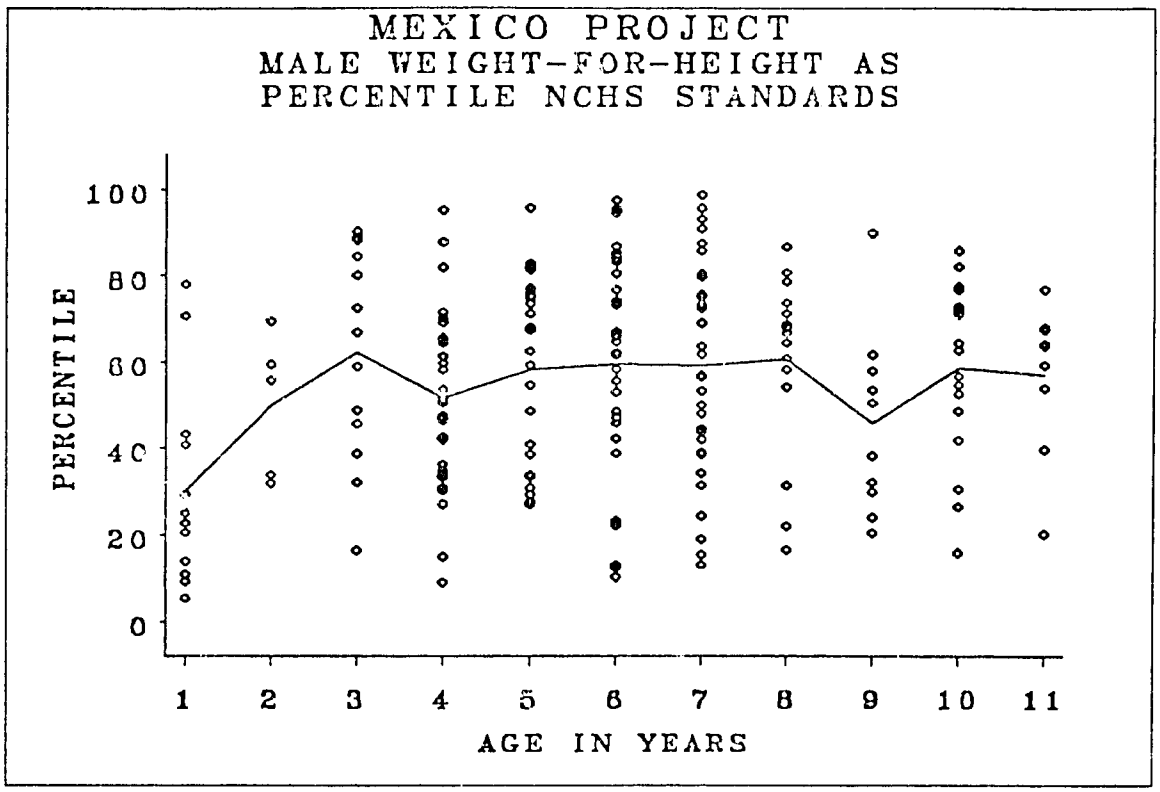

Figure 21.15 Scatterplot of weight-for-height percentiles for Solis males, age 1-11 years. Line indicates mean of percentiles at each age.

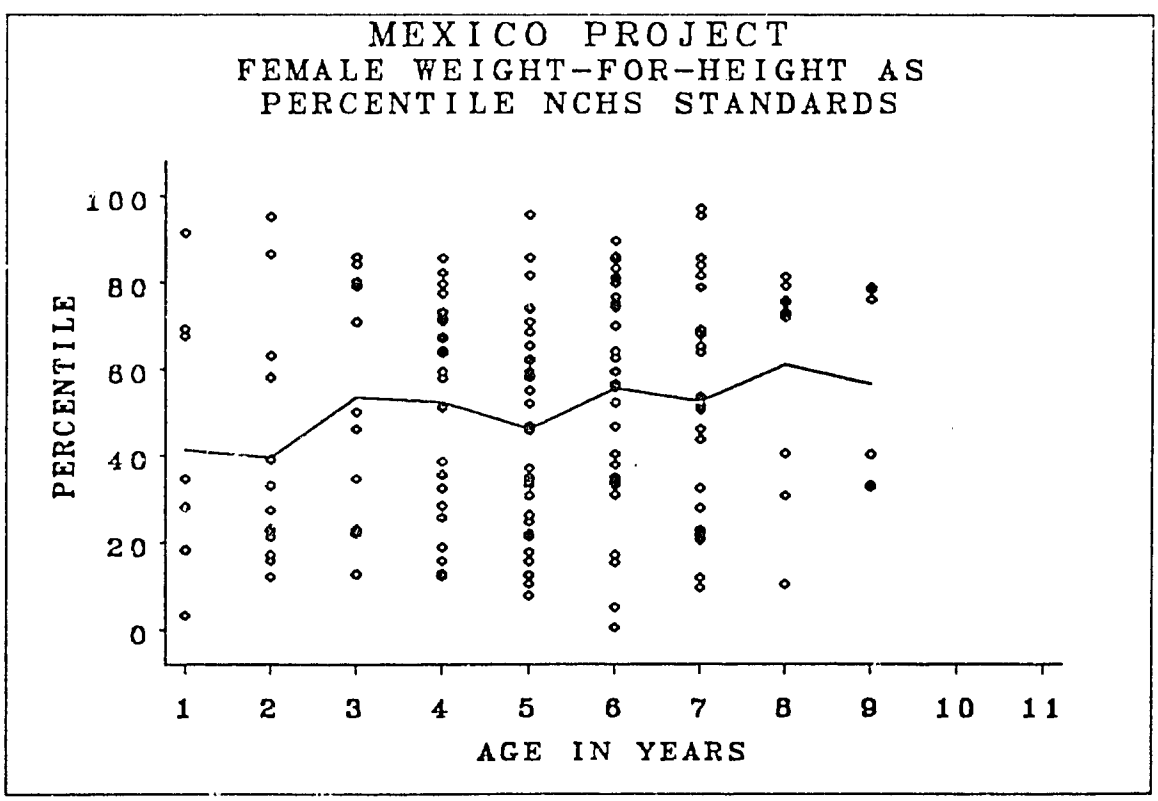

Figure 21.16 Scatterplot of weight-for-height percentiles for Solis females, age 1-11 years. Line indicates mean of percentiles at each age.

Chapter 22

INDIVIDUAL AND HOUSEHOLD MORBIDITY

I. INTRODUCTION

The first part of this chapter is devoted to a detailed discussion of the relationship between the methodology of data collection and the construction and interpretation of morbidity variables. This is followed by descriptive analyses of the variables that have been constructed from the data base. The tables include analyses by subject type for categories of illnesses and degree of severity. Illness is also examined by calendar month to assess seasonality in illness patterning. The chapter concludes with the presentation of descriptive data on mortality in the study households.

II. METHODOLOGICAL ISSUES

As described in Chapter 8, the morbidity protocol called for collection of data on all resident members of target households on a weekly basis. The mother in the family was the respondent for the household in an interview that always began by asking whether anyone in the house was ill on that day. In the original method, which was followed between January, 1984 and September, 1985, the interview was immediately terminated if the mother gave a negative response to the initial question. There was no further inquiry about whether anyone had been ill in the preceding week. If an individual family member was reported to be currently ill, the recent history of the symptoms was pursued. Also, in the case where an individual had been ill at the previous visit, the interviewer inquired about the course of the symptoms in the intervening week. For the discussion that follows, we will refer to this mode of questioning as the "Original Morbidity Method."

Beginning in September, 1985 and continuing to the end of the project, a supplementary recall routine was added to the basic protocol. This routine, hereafter referred to as the "Supplementary Morbidity Recall," required a second set of questions following the initial inquiry about the current state of household health. The additional questioning asked the mother to recall whether illness symptoms had occurred in household members during the previous week even though the symptoms had already terminated by the day of the interview.

Taken together, the two parts of the procedure followed from September, 1985 to the end of data collection, reflect the CRSP cross-project design, whereas the protocol from January, 1984 through August, 1985 restricted the information base. The original method also limits the types of epidemiological variables that can be constructed from that data base.

Field staff concern about the reliability and validity of recall data was the basis for restricting the original protocol. The supplementary protocol was added, albeit relatively late in the longitudinal study, in part to assess the effect of the more restricted method. Clearly, the original method would fail to record short-term illnesses that began and terminated between interviewer visits. Thus, with respect to occurrences of disease ("illness episodes"), the original protocol would lead to an underestimate of the number of illnesses experienced by individuals.

A second issue that affected the bias in the data base generated with the original method was the matter of signs and symptoms. When information was elicited about the nature of a condition identified by the mother as an "illness," she was asked to provide a list of the symptoms and signs the sick individual was experiencing. Her responses were recorded as specific signs and symptoms, rather than in nosological categories inferred by the interviewing physician. (The records were later coded into diagnostic categories.)

In the original method, although the illness episode must have overlapped a morbidity visit, all signs and symptoms did not have to be present on the day of the visit. For example, if a subject experienced an illness lasting 10 days, and had fever for 2 days neither of which was a visit day, 2 days of fever appear in the record for that individual and hence the individual also contributes 2 days of fever to the total data base.

The sequence of visits in each month served as a means of measuring morbidity in an individual. While considerable effort was made to maintain a weekly visiting schedule, inevitably some visits were missed. Therefore, in order to obtain a relative measure of the amount of morbidity data collected per month about an individual, an estimate was made of the number of days a record covered. We will refer to this estimate as "total days observed."

Because of missing weekly visits, the value for "total days observed" per month is not always 30 (or 31). Therefore, to construct a denominator for the ratio of "days ill" to "total days observed," the estimate of "total days observed" is based on the proportion of visits made to visits scheduled. The "visits scheduled" reflects the number of weekly visits per month that would have been made if an interviewer had gone to the house every seven days.

An additional problem in the morbidity data was introduced when the data were keypunched in Mexico. With the aim of reducing the amount of data to be processed, the date of each morbidity interview was not keypunched. Instead, morbidity data were entered with variables indicating the number of scheduled visits per month and the number of completed visits per month for each individual.

A. Extent of Underestimation of Illness Episodes

In order to assess the extent of underestimation of illness episodes engendered by the use of the original morbidity method, a comparative analysis was carried out on the data collected from September, 1986 to the end of the project. The results using just the original method were compared to the results using the original protocol with the supplementary recall.

Since the original method did not record illnesses that were confined to the period between visits (ie. short-term episodes), the probability of detecting an episode of specified length using the original method alone can be symbolized in Equation 1:

EQUATION 1: EXPECTED PROBABILITY OF DETECTING ILLNESS EPISODES OF SPECIFIED LENGTHS USING THE ORIGINAL MORBIDITY METHOD

$$\text{Minimum of} \quad \left[\left(\frac{\text{length of episode}}{\text{length of period between interviews}} \right), 1 \right]$$

Assuming an interval of seven days between morbidity interviews, Equation 1 can be interpreted as follows: the probability of detecting an illness of one day's duration is 1/7 (14%); the probability of detecting an illness of two day's duration is 2/7 (29%); and so on. The method will under-measure both the number of illness episodes and the number of days ill.

The supplementary morbidity recall should detect illness episodes missed by the original method. Assuming that all illnesses are recalled, it is expected that the percentage of illness episodes of specified length missed by the original method and detected by the supplementary recall can be expressed in Equation 2:

EQUATION 2: EXPECTED PERCENT OF ADDITIONAL ILLNESSES DETECTED BY USE OF THE SUPPLEMENTARY MORBIDITY RECALL

$$\text{Maximum of} \quad \left[1 - \left(\frac{\text{length of episode}}{\text{length of period between interviews}} \right), 0 \right] \times 100$$

The percentage of additional illnesses expected to be detected by the supplementary recall decreases as the length of the episodes increases: 6/7 (86%) of illnesses of one day's duration, 5/7 (71%) of illnesses of two day's duration, and 0% of illness episodes one week or longer - illnesses that would have been detected by the original method.

To assess the underestimation empirically, the following analyses were completed:

1) The number of total days ill reported with the original method is compared with the total days ill detected by the joint use of the original and supplementary protocols.

2) The percentage of additional illness episodes detected by the supplementary recall is examined, taking into account the length of the illness episodes.

In Table 22.1, the number of ill days recorded by the original method is expressed as a percentage of the ill days recorded by the combined protocol. As can be seen in the far right column of the table, the original method detects at least 80% of "illness episodes," but the detection of specific categories varies between 57% and 100%, with the exception of diarrhea in schoolers.

TABLE 22.1
PERCENT OF ILL DAYS DETECTED BY THE ORIGINAL MORBIDITY METHOD

			% Of Days Detected						
Type of Illness	# of Subjects	Mean # of Days Observed	Fever	Diarrhea	Upper Resp.	Lower Resp.	Runny Nose	Other	All
Infants	82	114	62	75	83	88	92	76	84
Preschoolers	76	129	57	81	92	82	87	66	82
Schoolers	80	100	86	0	100	79	77	85	80
Lead Females	137	130	63	93	79	95	87	92	88
Lead Males	136	99	100	91	90	100	97	91	94

Table 22.2 provides data on the number of additional illness episodes detected by the supplemental morbidity recall, taking into account the length of the episode. As suggested earlier, the expected percentage of additional illness episodes of a specified length detected by the supplementary recall is inversely proportional to the length of the episode. The number of illness episodes detected by each method is shown in the table. The frequencies are presented by length of the episode. Also included are those illness episodes detected by the supplementary recall and missed by the original method. The number of subjects participating in the study varied according to month, ranging from 474 in September, 1985 to 50 in May, 1986 when data collection on most subjects had been completed. However, since both methods were used for all subjects, this difference should not result in bias.

TABLE 22.2
NUMBER OF ILLNESS EPISODES DETECTED BY EACH COLLECTION METHOD (ALL ILLNESSES COMBINED)

	Length of episode in days						
Morbidity Recall	1	2	3	4	5	6	7+
Original	11	16	18	36	36	40	214
Original+Supple.	29	37	40	54	46	54	228
Additional episodes detected by Supplementary Recall	18	21	22	18	10	14	14

Table 22.3 shows the percent of additional morbidity episodes **expected** to be detected by the Supplementary Morbidity Recall estimated by Equation 2. The table also displays the percent of additional illness episodes **actually** detected.

TABLE 22.3
PREDICTED AND ACTUAL ADDITIONAL PERCENT OF MORBIDITY DETECTED BY THE SUPPLEMENTAL MORBIDITY RECALL

	Length of episode in days						
	1	2	3	4	5	6	7+
Additional Expected %	86	71	57	43	29	14	0
Additional Actual %	62	57	55	33	22	26	6
Difference between Actual and Predicted %	-24	-14	-02	-10	-07	+12	+6

The actual percentages for the episodes of 1 to 5 days duration, shown in Table 22.3, are somewhat lower than predicted by Equation 2. That is, fewer illnesses are being recalled than would be expected given the distribution of episodes of varying duration. The supplemental morbidity recall requires the respondent to remember symptoms that are no longer present. It is not surprising that short-term illnesses should be under-reported since they are likely to be regarded as less serious, and therefore likely to be forgotten or otherwise not reported. Also, the number of days between the remission of an illness and the morbidity recall visit will be longer, on average, as the duration of the illness becomes shorter. There is simply more time to forget a short duration illness than a longer duration illness.

The two far-right columns in Table 22.3 show that the longer illnesses (of duration 6 and 7+ days) have a **higher** percentage of additional illness episodes reported by the recall method than expected. This could result if the period of time between the interviews was not always one week. In fact, the time between morbidity visits varied, with a distribution around a mean that is probably somewhat greater than seven days.

B. Computer Simulation of Adjusted Original Morbidity Recall Data

Based on the empirical analyses above, we conclude that the original morbidity method records about 80% of the illness days detected by the combined methods. In addition to days of illness, another concern is the extent to which the original method fails to identify illness episodes. A computer simulation was used to investigate the effect of adjusting data collected with the original method by a factor derived from an estimate of missed illnesses. The goal was to assess whether the explanatory power of the morbidity data set might be improved by the adjustment.

The computer simulation generated illness episodes for a period of one year on 1000 subjects. Assuming that an interview took place every 7 days, estimates of illness incidence were made using: (a) the original protocol, (b) the combined protocols, and (c) the original method data adjusted for the under-detection of short-duration illnesses. The "adjusted" estimates were created by inflating the estimated number of illnesses of a specified length (based on the original method) by the quantity shown in Equation 3.

EQUATION 3: OBTAINING A VALUE FOR INFLATING NUMBER OF ILLNESS EPISODES OF A SPECIFIED LENGTH DETECTED BY THE ORIGINAL MORBIDITY RECALL

$$\text{Maximum of} \quad \left[\frac{\text{number of days between interview}}{\text{length of illness episode}} \; , \; 1 \right]$$

The mean square error was calculated for an estimator. The MSE of the estimator provides a measure of how close the estimator is to the true value, on average. Mean square error measures the accuracy of the estimate, which is derived from the reliability and the validity of an estimate. Reliability refers to how reproducible the estimate is over repeated samples in the population, and is estimated by the sampling variance. The validity of an estimator refers to how the mean of the estimate differs from the true value of the parameter, over repeated samples, and is expressed in terms of the bias of an estimate. The equation for the mean square error is:

EQUATION 4: EQUATION FOR MEAN SQUARE ERROR (MSE)

$$MSE = VAR + BIAS^2$$

A good estimator will have both small variance and minimal bias, i.e. small MSE. From the simulation, it was found that when the incidence rate of illness episodes was 0.01 or less (as is the case in this data base), the original method and the combined methods had much smaller mean square errors than the "inflation method." Although the "inflation method" provided an unbiased estimate of the total number of illnesses, the variance was very large. The original method was biased, but the smaller variance resulted in a smaller MSE than with the inflation method.

Since the bulk of the morbidity data were collected using the original method alone, two analysis options are available:

(1) The original morbidity method data could be used, resulting in an underestimate of the number of short duration illness episodes, or

(2) The original method data could be inflated, which would provide an unbiased estimate, but, due to its large variance, the result might not be very reliable.

Because the mean square error for the original method model was much smaller than the mean square error of the adjusted model, the unadjusted number of illness episodes appears to be a more accurate estimate. Therefore, it was decided to use the original method data in unmodified form in the construction of statistical models.

III. VARIABLES DERIVED FROM ORIGINAL MORBIDITY METHOD DATA

The data set obtained by the original method includes the following variables for each individual: dates of onset and remission for signs and symptoms of illness, and the "severity" indicators -- degree of change in activity due to illness, alteration in appetite, and change in diet (see Chapter 8, Morbidity).

A number of variables have been derived to summarize individual morbidity experience. These include: "Estimated Days Observed," "Illness Episodes by Illness Category" (type of illness), "Illness Days by Illness Category," "Total Illness Episodes," "Total Illness Days," and "Severity." The time frame for the variables differs, depending on the analysis. The time periods include: calendar month summaries, age-month summaries (30 day periods based on the subject's age), and summaries of longer periods of time (e.g. one year).

The derivation of these variables is as follows:

1) Estimated Days Observed (per calendar month basis):

a) In cases where either 4 or 5 visits were scheduled in a month, estimated days observed are calculated as:

$$\frac{\text{(number of interviews completed in the month)}}{\text{(number of interviews scheduled in the month)}} \times \text{(number of days in the month)}$$

b) In cases where 3 or fewer visits were scheduled, the number of days observed are estimated to be:

$$\text{(number of visits completed in the month)} \times 7$$

It should be noted that this estimate is compromised in that the only days truly observed were days on which the morbidity visit was conducted, and days on which an individual suffered from an illness that overlapped at least one morbidity visit. Therefore, the number of **Estimated Days Observed** may be inflated with respect to the actual number of days an individual was observed. **Estimated Days Observed** was created for use as the denominator in computing an illness rate variable that could be used in cross project CRSP comparisons. A more reliable, but less comparable rate would be **Days Ill per Morbidity Visit**, rather than **Days Ill per Estimated Days Observed**. However, **Days Ill per Morbidity Visit** has no comparable variable in the Egypt and Kenya projects.

2) **Six Illness Categories** (Fever, Diarrhea, Acute Upper Respiratory Illness, Acute Lower Respiratory Illness, Runny Nose, and Other Illnesses) are defined from the "symptoms" recorded in the interviews. (The Mexico interview protocol included 99 symptoms, such as nausea, chills, flu, and respiratory distress (See Chapter 8, Morbidity).

3) Illness Episodes **for a Specific Illness Category** is defined as the total number of occurrences of a specific illness category. In accordance with the cross-project CRSP protocol, a person must be free of illness for two days before a "new" morbidity episode is said to begin. As a result, when the remission date of a symptom is separated by one day from the onset date of a symptom of the same illness category, the illness is considered to be one episode. The one symptom free day, therefore, is considered to be an "ill day."

4) **Days Ill with a Specific Illness Category** is defined as the total number of days with symptoms that are regarded as characteristic of the specific illness category. In cases where symptoms of the same illness category overlap in time, the earliest symptom onset date is defined as the beginning of the

illness and the latest symptom remission date is defined as the end of the illness. (Again, a single symptom-free day surrounded by days with symptoms of the same illness category is considered an ill day.)

5) **Total Illness Episodes** is calculated from the sum of continuous periods of illness, regardless of illness category; e.g. 5 days of fever, followed immediately by 5 days of unrelated diarrhea, followed immediately by 5 days of unrelated runny nose, would be counted as one total illness episode of 15 days duration.

6) **Total Illness Days** is defined as the total number of days ill during one episode. In cases where symptoms or illness categories overlap in time, the total illness days are calculated as beginning at the onset of the earliest symptom and ending with the remission of the last symptom, regardless of the specific illness categories to which the symptoms belong.

7) Three types of **Severity Measures** were recorded for each reported symptom (see Chapter 8, Morbidity). These variables were: a) "activity change," measured by a three point ordinal scale; b) "dietary change," measured by a 5 point ordinal scale; and c) presence or absence of "appetite change." In cases where symptoms overlap, the most extreme value for the severity variable is taken as the value for illness episode. In the descriptive analysis presented below, the severity variables are reduced to presence or absence of activity change, dietary change, and appetite change.

IV. MORBIDITY EPISODES

Illness episode data using only the data base generated by the original method are presented below by types of subjects in the study. The subjects in these analyses are all members of the longitudinal sample. The time periods observed and the estimated days observed, which vary by type of individual, are indicated in the tables. The data presented include: a) the number of subjects experiencing at least one episode of a particular category of illness during the specified time period, and b) an illness episode rate that is calculated as the sum of all illness episodes (of a given type) for a subject divided by the sum of all "estimated days observed" for that subject. It should be noted that, due to episodes in which an individual experienced more than one type of illness, the value for **Total Days Ill** is not the sum of the individual illness categories. **Total Days Ill** is the number of days a person was recorded as ill, using the CRSP protocol requiring two symptom free days before new symptoms are regarded as a new illness.

A. Infants

The majority of infants suffered at least one illness episode during the period they were in the study. Table 22.4 indicates that the common ailments for male infants are diarrhea, lower respiratory illness, and runny nose. Episodes of runny nose appear to be of the longest duration. Upper respiratory illness showed the fewest number of episodes. Overall, the female infant morbidity pattern appears to be very similar to that of the males (Table 22.5). While none of the specific illness categories exhibited a statistically significant sex-related difference, male infants were found to be more likely to suffer at least one episode of illness than female infants (Fisher's Exact Test, two-tailed, p=.053).

TABLE 22.4
ILLNESS EPISODES FOR MALE INFANTS

Type of Episode	# of Subjects with Illness N=53 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes per Day 50%	75%	90%
Fever	9	(17.0)	1.27	0.00	0.00	6.88
Diarrhea	7	(32.1)	2.86	0.00	6.54	9.99
Upper Resp	5	(9.4)	0.62	0.00	0.00	3.49
Lower Resp	21	(39.6)	3.61	0.00	6.67	10.76
Runny Nose	21	(39.6)	3.96	0.00	6.87	13.36
Other Ill	9	(17.0)	1.51	0.00	0.00	6.47
Total Ills	42	(79.2)	11.17	9.35	15.27	23.26

* x 1000

Period covered = birth - 180 days of age. Median number estimated days for all infants = 146, first quartile = 122.5, third quartile = 163

TABLE 22.5
ILLNESS EPISODES FOR FEMALE INFANTS

Type of Episode	# of Subjects with Illness N=49 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes per Day 50%	75%	90%
Fever	6	(12.2)	1.27	0.00	0.00	5.92
Diarrhea	16	(32.7)	3.40	0.00	6.85	13.16
Upper Resp	3	(6.1)	0.48	0.00	0.00	0.00
Lower Resp	14	(28.6)	2.75	0.00	6.25	11.63
Runny Nose	20	(40.8)	4.39	0.00	7.09	12.50
Other Ill	8	(16.3)	1.27	0.00	0.00	6.25
Total Ills	30	(61.2)	10.72	7.14	19.67	27.21

* x 1000

Period covered = birth - 180 days of age. Median number estimated days for all infants = 143, first quartile = 129.5, third quartile = 156

B. Preschoolers

As Tables 22.6 and 22.7 show, approximately three quarters of the male and female preschoolers suffer at least one illness episode. The least common illness category for preschoolers is upper respiratory illness.

TABLE 22.6
ILLNESS EPISODES FOR MALE PRESCHOOLERS

Type of Episode	# of Subjects with Illness N=57 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes Per Day 50%	75%	90%
Fever	23	(40.4)	1.68	0.00	2.99	5.15
Diarrhea	23	(40.4)	1.85	0.00	3.00	6.15
Upper Resp	10	(17.5)	0.75	0.00	0.00	3.61
Lower Resp	32	(56.1)	2.78	2.81	5.15	6.56
Runny Nose	33	(57.9)	3.61	2.89	5.86	11.46
Other Ill	16	(28.1)	1.11	0.00	2.88	5.14
Total Ills	43	(75.4)	8.14	8.38	12.08	15.50

* x 1000

Period covered = 18 - 30 months of age (390 days). Median number estimated days for all preschoolers = 330, first quartile = 290.5, third quartile = 347.

TABLE 22.7
ILLNESS EPISODES FOR FEMALE PRESCHOOLERS

Type of Episode	# of Subjects with Illness N=53 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes Per Day 50%	75%	90%
Fever	17	(32.1)	1.18	0.00	2.92	3.20
Diarrhea	23	(43.4)	2.16	0.00	3.43	6.24
Upper Resp	4	(7.5)	0.39	0.00	0.00	1.67
Lower Resp	20	(37.7)	1.62	0.00	3.02	5.71
Runny Nose	26	(49.1)	2.87	0.00	4.71	8.84
Other Ill	12	(22.6)	0.91	0.00	0.00	3.51
Total Ills	42	(79.2)	6.87	6.35	9.49	15.27

* x 1000

Period covered = 18 - 30 months of age (390 days). Median number estimated days for all preschoolers = 321, first quartile=300.5, third quartile = 342.5

There is little difference between the male and female preschoolers in the patterning of illness episodes. The only difference of possible interest is the greater percent of male preschoolers with at least one reported lower respiratory illness episode (Fisher's Exact Test, two-tailed, p=.059).

C. Schoolers

Approximately half of the male and female schoolers are reported as having at least one illness during the study period (Tables 22.8 and 22.9). The most common illness category for schoolers is runny nose and the least common is diarrhea.

TABLE 22.8
ILLNESS EPISODES FOR MALE SCHOOLERS

Type of Episode	# of Subjects with Illness N=44 (percent)		Mean N of Illness Episodes per Days of Observation*	Percentiles of Illness Episodes Per Day 50%	75%	90%
Fever	5	(11.4)	0.24	0.00	0.00	1.83
Diarrhea	0	(0.0)	0.03	0.00	0.00	0.00
Upper Resp	3	(6.8)	0.15	0.00	0.00	0.00
Lower Resp	7	(15.9)	0.45	0.00	0.00	2.44
Runny Nose	13	(29.5)	0.94	0.00	1.87	3.76
Other Ill	8	(18.2)	0.84	0.00	0.00	2.03
Total Ills	20	(45.5)	1.48	0.00	2.55	4.45

* x 1000

Period covered = 7 - 9.5 years of age. Median number estimated days for all schoolers = 384, first quartile=329.25, third quartile = 467.5

TABLE 22.9
ILLNESS EPISODES FOR FEMALE SCHOOLERS

Type of Episode	# of Subjects with Illness N=38 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes per Day 50%	75%	90%
Fever	8	(21.1)	0.59	0.00	0.00	2.13
Diarrhea	5	(13.2)	0.29	0.00	0.00	1.87
Upper Resp	6	(15.8)	0.42	0.00	0.00	2.11
Lower Resp	11	(28.9)	0.73	0.00	1.76	2.45
Runny Nose	11	(28.9)	0.79	0.00	1.91	2.90
Other Ill	11	(28.9)	0.77	0.00	1.86	2.89
Total Ills	21	(55.3)	2.26	1.97	4.15	6.78

* x 1000

Period covered = 7 - 9.5 years of age. Median number estimated days for all schoolers = 394.5, first quartile=352.75, third quartile = 477.5

There is little difference between male and female schoolers in the rate of illness. The only sex difference of statistical interest is the absence of diarrhea among male schoolers compared to 5 cases for female schoolers (Fisher's Exact Test, two-tailed, p= .018).

D. Lead Females and Males

Comparing recorded illnesses for lead males and lead females, adult women are much more likely to have been ill at least once than are men (Fisher's Exact Test two-tailed, p<0.001) (Tables 22.10 and 22.11). Adult women also show significantly higher rates of illness for all illness categories. It should be noted that females had a higher number of Estimated Days Observed than males: a median of 434.5 days vs 390 days for lead males. A comparison of Tables 22.16

and 22.17 shows that males have lower mean illness rates for total illnesses and for the six illness categories. However, the ranking of illness rates for types of illness category is the same for both males and females.

The clear sex difference in rate of reported illness in these data parallels findings cross-culturally. In most surveys, women are more likely than men to report illness symptoms, as they are also more likely to seek medical care (22.1). In this study, where women are the informants about their husband's state of health, the matter of male reluctance to report illness to an interviewer is not a factor. However, this does not rule out the possibility that men frequently fail to discuss their health with their wives. These comments are not intended to suggest that the illness experiences of men are actually equal to those of women, but rather that the interpretation of the data must be made in light of the general cross-cultural tendency for women to report (or experience) greater illness symptomology.

TABLE 22.10
ILLNESS EPISODES FOR LEAD FEMALES

Type of Episode	# of Subjects with Illness N=226 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes Per Day 50%	75%	90%
Fever	43	(19.0)	0.51	0.00	0.00	2.12
Diarrhea	20	(8.8)	0.22	0.00	0.00	0.00
Upper Resp	64	(28.3)	0.76	0.00	1.45	2.83
Lower Resp	74	(32.7)	1.03	0.00	1.94	3.24
Runny Nose	103	(45.6)	1.77	0.00	2.98	5.57
Other Ill	112	(49.6)	2.10	0.00	3.04	5.92
Total Ills	167	(73.9)	4.48	3.75	6.36	11.38

* x 1000

Period covered dependent on physiological status and/or presence of a target child in the household. Median number estimated days for all lead females = 434.5, first quartile=338.0, third quartile = 533.25

TABLE 22.11
ILLNESS EPISODES FOR LEAD MALES

Type of Episode	#N of Subjects with Illness N=142 (percent)		Mean N of Illness Episodes per Day of Observation*	Percentiles of Illness Episodes Per Day 50%	75%	90%
Fever	11	(7.7)	0.25	0.00	0.00	0.00
Diarrhea	4	(2.8)	0.16	0.00	0.00	0.00
Upper Resp	17	(12.0)	0.39	0.00	0.00	1.86
Lower Resp	21	(14.8)	0.49	0.00	0.00	2.29
Runny Nose	39	(27.5)	0.86	0.00	1.78	3.27
Other Ill	39	(27.5)	0.91	0.00	1.67	3.52
Total Ills	72	(50.7)	2.03	1.53	3.47	5.40

* x 1000

Period covered dependent on presence of a target child in the household. Median number estimated days for all lead males = 390.5, first quartile = 289.5, third quartile = 503.5

V. SEVERITY

Using data on subjects followed longitudinally, information on the severity of illness episodes is provided for the various subject types in Tables 22.12 - 22.19. These tables show the number of illness episodes observed for each type of symptom and, for the given symptom, the associated incapacity, change in diet, and change in appetite. Illness episodes are the unit of analysis, and individuals may contribute a variable number of illness episodes. Also, when interpreting Tables 22.12 - 22.19, the small numbers should be considered and, therefore, the effect of random variation.

Across all individual types, approximately one-third to one-half of all episodes were associated with some change in activity, diet, or appetite. For infants, males and females appear to suffer the observed effects of illness equally, with diarrhea being associated with the highest severity as measured by changes in activity, diet, and appetite (Tables 22.12 and 22.13).

TABLE 22.12
SEVERITY OF ILLNESS EPISODES FOR MALE INFANTS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	10	2	(20)	2	(20)	2	(20)
Diarrhea	21	6	(29)	5	(24)	7	(33)
Upper Resp	5	1	(20)	1	(20)	2	(40)
Lower Resp	26	9	(35)	8	(31)	6	(23)
Runny Nose	32	6	(19)	11	(34)	9	(28)
Other Ill	9	0	(0)	1	(11)	1	(11)
Total Illnesses	83	21	(25)	24	(29)*	28	(34)

* Note: no illnesses result in bedridden infants

TABLE 22.13
SEVERITY OF ILLNESS EPISODES FOR FEMALE INFANTS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	9	1	(11)	4	(44)	3	(33)
Diarrhea	23	6	(26)	2	(9)	4	(17)
Upper Resp	3	0	(0)	2	(67)	1	(33)
Lower Resp	9	3	(16)	7	(37)	4	(21)
Runny Nose	31	9	(29)	9	(29)	4	(13)
Other Ill	9	1	(11)	0	(0)	0	(0)
Total Illnesses	75	24	(32)	25	(33)*	12	(16)

* Note: no illnesses result in bedridden infants

Fever and diarrhea both produce moderate levels of change in diet, activity and appetite for male and female preschoolers (see Tables 22.14 and 22.15). Upper respiratory illness shows high levels of incapacity, but the number of episodes is small. The overall pattern of diet, activity and appetite changes appears to be similar for male and female preschoolers.

TABLE 22.14
SEVERITY OF ILLNESS EPISODES FOR MALE PRESCHOOLERS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	35	15	(43)	17	(49)	24	(69)
Diarrhea	43	16	(37)	14	(33)	24	(56)
Upper Resp	14	6	(43)	8	(57)	8	(57)
Lower Resp	56	9	(16)	10	(18)	15	(27)
Runny Nose	73	12	(16)	14	(19)	18	(25)
Other Ill	23	8	(35)	10	(43)	12	(52)
Total Illnesses	168	51	(30)	74	(44)*	80	(48)

* Note: six episodes report bedridden male preschoolers

TABLE 22.15
SEVERITY OF ILLNESS EPISODES FOR FEMALE PRESCHOOLERS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	22	8	(36)	12	(55)	15	(68)
Diarrhea	40	14	(35)	15	(38)	15	(38)
Upper Resp	8	3	(38)	7	(88)	3	(38)
Lower Resp	32	4	(13)	16	(50)	10	(31)
Runny Nose	55	12	(22)	18	(33)	19	(35)
Other Ill	16	7	(44)	8	(50)	8	(50)
Total Illnesses	126	47	(37)	68	(54)*	71	(56)

* Note nine episodes report bedridden female preschoolers

For schoolers, the pattern of dietary, activity, and appetite changes due to illness is similar for females and males. While the number of illness episodes is relatively small for the illness categories of fever and diarrhea, these cases are usually associated with change in activity and appetite (Tables 22.16 - 22.17).

TABLE 22.16
SEVERITY OF ILLNESS EPISODES FOR MALE SCHOOLERS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	7	3	(43)	7	(100)	6	(46)
Diarrhea	2	1	(50)	1	(50)	2	(100)
Upper Resp	8	2	(25)	6	(75)	6	(75)
Lower Resp	12	2	(17)	7	(58)	6	(50)
Runny Nose	25	4	(16)	12	(48)	13	(52)
Other Ill	14	4	(29)	7	(50)	10	(71)
Total Illnesses	46	14	(30)	23	(50)*	28	(61)

* Note: seven episodes report bedridden male schoolers

TABLE 22.17
SEVERITY OF ILLNESS EPISODES FOR FEMALE SCHOOLERS

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	16	9	(56)	11	(69)	12	(75)
Diarrhea	5	4	(80)	4	(80)	4	(80)
Upper Resp	10	1	(10)	3	(30)	3	(30)
Lower Resp	22	13	(59)	10	(45)	12	(55)
Runny Nose	21	7	(33)	9	(43)	9	(43)
Other Ill	22	3	(14)	11	(50)	12	(55)
Total Illnesses	64	24	(38)	33	(52)*	37	(58)

* Note: seven episodes report bedridden female schoolers

The "severity" data are presented for lead males and females in Tables 22.18 and 22.19. Earlier, we presented data showing a higher rate of illness in women compared to men. In the tables below, we see that women are are also more likely to be bedridden with an illness.

TABLE 22.18
SEVERITY OF ILLNESS EPISODES FOR LEAD FEMALES

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	52	13	(25)	35	(67)	28	(54)
Diarrhea	21	11	(52)	7	(33)	13	(62)
Upper Resp	80	15	(19)	34	(42)	24	(30)
Lower Resp	106	16	(15)	54	(51)	36	(34)
Runny Nose	178	31	(17)	55	(31)	61	(34)
Other Ill	210	48	(23)	92	(44)	89	(42)
Total Illnesses	446	124	(28)	207	(46)*	205	(46)

* Note: twenty-eight episodes report bedridden lead females

TABLE 22.19
SEVERITY OF ILLNESS EPISODES FOR LEAD MALES

Type of Episode	# of Illnesses Observed	Dietary Change (%)		Activity Change (%)		Appetite Change (%)	
Fever	13	4	(31)	10	(77)	8	(62)
Diarrhea	9	3	(33)	3	(33)	5	(56)
Upper Resp	20	7	(35)	11	(55)	7	(35)
Lower Resp	26	5	(19)	15	(58)	7	(27)
Runny Nose	50	16	(32)	23	(46)	19	(38)
Other Ill	51	16	(31)	24	(47)	28	(55)
Total Illnesses	112	36	(32)	54	(48)*	55	(49)

* Note: five episodes report bedridden lead males

VI. SEASONALITY

Since there is little difference in morbidity between male and female children (infants, preschoolers, and schoolers), analyses of seasonal effects were carried out on combined samples. Tables 22.20 - 22.24 present these data. In these tables, N represents the total number of subjects observed in the given month. Since the study spanned more than one year, the N in each month represents the sum for that month in the years 1984-1986.

Seasonal variation in morbidity patterns is most apparent in the infant and preschooler data (Tables 22.20 and 22.21). Among these, cases of diarrhea appear to be more common in May and June. The months of March and October evidenced higher rates of lower respiratory illness among infants and runny nose in both groups. Infants and preschoolers experienced relatively low levels of illness episodes in April. High levels of illness are reported for infants for March. The reason for this is unknown.

There was a slight indication of a seasonal morbidity pattern for lead females (Table 22.23). Episodes of runny nose were more common in October and November and, as with infants and preschoolers, the fewest illness episodes were reported in April.

Schoolers and lead males had minimal seasonal variation in morbidity patterns. It may be noted that the mean number of visits completed during the months of January and December are consistently low relative to the other months. This is because no visits to monitor morbidity were scheduled during the Christmas holidays.

TABLE 22.20
PERCENT OF INFANTS WITH ILLNESS, BY MONTH

Month	N	Mean # of Visits	Fever	Diarrhea	Upper Resp.	Lower Resp.	Runny Nose	Other	Total Illness
Jan	73	2.90	2.7	4.1	2.7	8.2	15.1	5.5	28.8
Feb	75	3.63	2.7	6.7	2.7	6.7	13.3	0.0	25.3
Mar	72	3.46	5.6	9.7	0.0	12.5	16.7	11.1	41.7
Apr	75	3.36	4.0	6.7	1.3	1.3	8.0	0.0	14.7
May	72	3.70	2.8	19.4	0.0	6.9	9.7	1.4	27.8
Jun	70	3.41	1.4	12.9	0.0	7.1	10.0	5.7	30.0
Jul	72	4.11	1.4	6.9	0.0	1.4	8.3	6.9	22.2
Aug	75	3.67	6.7	2.7	5.3	6.7	14.7	2.7	25.3
Sep	66	3.61	1.5	6.1	0.0	3.0	10.6	1.5	18.2
Oct	65	4.22	3.1	3.1	1.5	12.3	24.6	1.5	36.9
Nov	65	3.52	9.2	9.2	4.6	15.4	20.0	1.5	36.9
Dec	66	2.48	1.5	7.6	1.5	9.1	9.1	0.0	22.7

TABLE 22.21
PERCENT OF PRESCHOOLERS WITH ILLNESS, BY MONTH

Month	N	Mean # of Visits	Fever	Diarrhea	Upper Resp.	Lower Resp.	Runny Nose	Other	Total Illness
Jan	124	2.90	6.5	1.6	1.6	9.7	8.9	3.2	21.0
Feb	134	3.70	3.7	3.0	3.0	8.2	8.2	1.5	20.1
Mar	138	3.70	8.0	5.1	2.9	8.0	15.9	3.6	26.1
Apr	131	3.30	4.6	6.1	1.5	3.8	4.6	0.0	12.2
May	123	4.23	4.9	14.6	0.8	4.1	9.8	3.3	28.5
Jun	118	3.66	4.2	11.0	0.8	4.2	6.8	5.1	18.6
Jul	121	4.31	2.5	8.3	1.7	2.5	5.8	4.1	20.7
Aug	116	4.18	3.4	6.0	0.9	6.9	12.1	3.4	23.3
Sep	119	3.69	2.5	4.2	0.8	5.9	10.1	4.2	19.3
Oct	128	4.27	5.5	6.3	2.3	7.8	14.1	2.3	22.7
Nov	128	3.76	2.3	3.9	0.8	10.9	7.8	2.3	21.9
Dec	127	2.67	2.4	2.4	1.6	6.3	7.9	1.1	15.0

TABLE 22.22
PERCENT OF SCHOOLERS WITH ILLNESS, BY MONTH

Month	N	Mean # of Visits	Fever	Diarrhea	Upper Resp.	Lower Resp	Runny Nose	Other	Total Illness
Jan	181	2.74	1.7	0.6	1.7	5.0	3.9	0.0	7.2
Feb	177	3.82	2.3	0.6	1.1	3.4	2.8	0.0	5.1
Mar	171	4.00	4.1	0.0	0.6	1.8	1.8	1.2	5.8
Apr	172	3.58	1.7	0.0	1.2	1.7	1.2	1.7	3.5
May	168	4.29	0.6	0.0	0.6	0.0	2.4	1.2	3.6
Jun	161	3.80	0.0	0.6	0.6	0.0	0.6	3.1	4.3
Jul	182	4.35	0.0	1.1	1.1	0.5	2.2	2.2	6.0
Aug	178	4.16	0.0	0.0	0.0	0.0	0.0	3.4	3.4
Sep	167	3.75	0.0	0.0	1.8	1.8	2.4	1.8	6.6
Oct	166	4.33	1.2	0.0	0.0	1.8	1.2	2.4	4.8
Nov	158	3.87	1.9	1.3	1.9	2.5	5.7	1.9	9.5
Dec	153	2.78	0.7	0.7	0.7	2.6	3.3	2.6	6.5

TABLE 22.23
PERCENT OF LEAD FEMALES WITH ILLNESS, BY MONTH

Month	N	Mean # of Visits	Fever	Diarrhea	Resp.	Upper Resp.	Lower Nose	Runny Other	Total Illness
Jan	343	2.81	1.7	0.3	2.9	3.8	4.1	5.5	12.8
Feb	338	3.75	0.9	0.3	3.0	4.7	5.3	5.3	12.4
Mar	336	3.84	1.8	0.3	2.7	3.9	6.5	6.5	13.1
Apr	336	3.46	0.6	0.0	1.2	1.8	2.7	2.7	6.0
May	322	4.21	1.2	0.9	2.2	0.9	4.3	3.4	10.2
Jun	301	3.69	1.3	0.3	1.0	1.7	4.0	6.6	11.3
Jul	318	4.32	2.2	0.6	2.2	2.2	5.0	7.2	13.5
Aug	311	4.11	0.6	1.6	1.0	2.3	1.9	7.1	11.3
Sep	300	3.73	2.3	1.7	2.3	2.3	5.7	7.7	16.0
Oct	303	4.27	1.0	0.7	2.3	3.6	7.6	9.6	15.2
Nov	297	3.78	0.7	0.0	4.4	5.1	8.4	5.4	16.5
Dec	291	2.72	2.7	0.3	2.1	3.8	5.2	3.4	10.3

TABLE 22.24
PERCENT OF LEAD MALES WITH ILLNESS, BY MONTH

Month	N	Mean # of Visits	Fever	Diarrhea	Upper Resp.	Lower Resp	Runny Nose	Other	Total Illness
Jan	229	2.41	0.0	0.4	0.0	0.9	3.1	0.9	3.9
Feb	227	3.29	0.9	0.4	0.9	1.3	3.5	3.1	6.6
Mar	226	3.35	0.9	0.0	0.9	0.9	3.1	3.1	5.3
Apr	221	2.91	0.0	0.0	0.9	0.5	0.0	1.8	2.7
May	217	3.43	0.0	0.5	0.0	0.0	1.4	0.9	2.8
Jun	204	2.84	0.0	0.0	1.0	1.5	1.0	1.0	2.9
Jul	213	3.42	0.0	0.5	0.9	1.4	1.9	1.4	4.2
Aug	213	3.34	0.5	0.9	0.9	1.4	1.9	2.8	5.2
Sep	203	2.98	0.5	0.5	0.0	1.0	1.5	2.0	3.9
Oct	205	3.63	1.0	1.5	1.0	0.5	2.4	4.4	6.3
Nov	199	3.46	1.5	0.0	3.0	2.5	3.5	2.5	9.0
Dec	193	2.50	0.5	0.0	0.5	1.0	2.6	2.1	4.7

Table 22.25 summarizes target household mortality between 1982 and 1986.

TABLE 22.25
DEATHS IN TARGET HOUSEHOLDS

Age	Males	Females	Totals
0-1	6	4	10
1-3	2	1	3
4-17	1	2	3
18-59	2	0	2
60+	4	2	6

The highest mortality (10 deaths) occurs in infants less than a year old. Three deaths were due to premature births where the infants survived 1,2, or 4 days. Bronchial pneumonia was the cause of death for an infant 2 months old and an infant 10 months old. Other causes of mortality in infants were congenital malformation, dehydration, hemorrhages, and gastroenteritis.

The next highest mortality (6 deaths) occurred in adults over 60 years old. Causes of mortality were heart failure, arterial hypertension, cancer of the prostate, stroke, and a perforated peptic ulcer.

In the 4-17 year-old age group, two teenagers died of head trauma and one 7 year-old drowned.

All the deaths reported were members of target households. However, none of these were subjects in the longitudinal study.

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Chapter 23

HEALTH STATUS, HEALTH HISTORY AND HEALTH PRACTICES

The examination of relationships between intake and health outcomes requires an assessment of the general health conditions within which the short-term effects find expression. Chronic illness, endemic parasitism and alcoholism are among the factors that affect and confound intake-morbidity interactions. Hence it is important to identify previous health history, current health status, and general physical condition of subjects and their families. The initial health interview and physical examination, and subsequent follow-up visits, which were carried out by project physicians, provide this information.

The clinical interviews also provided an opportunity to collect data on health practices, particularly related to pregnancy and lactation. These are very useful for understanding intake behavior and activity patterns during pregnancy because they document the cultural context and cultural expectations. For example, it is important to know that some of the women (but not all) apparently deliberately change their food intake during pregnancy and lactation because of their beliefs about the value or harm associated with ingesting particular foods. Similarly, the resumption of physical activity following parturition is culturally programmed, although many women are not able to conform to these norms because they lack the supportive resources necessary to refrain from many domestic tasks.

This chapter presents the descriptive results from the clinical interviews conducted with lead males and females, and with mothers on behalf of their children.

Table 23.1 shows personal health history data for adult men and women. Virtually all of the reported pathologies were diagnosed by a physician. Therefore, while there may well be serious under-reporting, primarily because of undiagnosed pathology, one may be reasonably sure that the reported health problems represent diagnosed pathology.

Concerning the health history of adults, we find very low levels of diagnosed chronic illness. However, the finding that 46% of the men have experienced a trauma reflects the fact that in both work and non-work activities, men in the Solis valley face a high risk of injury. Injuries occur in a number of different ways, including automobile accidents, agricultural accidents, and wounds incurred from guns or knives. The injury risk for women is much lower than for their spouses, although their experience with surgery is not very much lower. For women, a proportion of prior surgery is probably accounted for by reproductive problems, whereas for men, much of the reported surgery was most likely associated with trauma.

TABLE 23.1
PERSONAL HEALTH HISTORY: PERCENT OF ADULT RESPONDENTS

Health problem	Lead Females (N = 252)	Lead Males (N = 195)
Surgery	15.5	20.5
Trauma	7.5	45.6
Allergies	3.2	3.1
Hypertension	2.0	4.1
Convulsions	1.2	1.0
Cardiopathology	0.4	0.5
Diabetes	0.0	0.5

Table 23.2 includes data about the familial health history of the parents and siblings of lead males and females. Again, the vast majority of the reported pathologies were diagnosed by a physician, according to the respondents. There were only two cases of pathology diagnosed by a traditional healer (curandera) and one by a nurse. For both men and women, the respondent's mother is the person most frequently identified as the afflicted individual. More rarely is the father the person with a pathology. This feature is undoubtedly influenced by differential utilization of health services by women and men.

As seen in Table 23.2, hypertension and diabetes are reported with the highest frequencies. The rate of reported convulsions appears to be rather high, and occurs in families of men and women equally. Some of the psychiatric problems reported by respondents may be related to alcohol abuse.

TABLE 23.2
FAMILIAL HEALTH HISTORY: PERCENT OF RESPONDENTS REPORTING PRESENCE OF DISEASE

Disease	Adult Women (N = 246)	Adult Men (N = 194)
Hypertension	15.0	14.9
Diabetes	8.5	10.8
Convulsions	7.3	7.2
Neoplasms	6.5	4.6
Allergies	4.1	6.7
Congenital abnormalities	3.7	2.6
Psychiatric problems	2.4	4.6

The data in Table 23.3 are from the interviews with the mothers of all children in the study, including those who were not studied over the course of a full year. As in the previous tables, the conditions were uniformly diagnosed by a physician. However, the same caution must be applied to these data as to the previous tables -- a great deal of illness goes undiagnosed. A further source of under-reporting, perhaps less significant in magnitude than the undiagnosed illnesses, is mothers' failure to remember specific illness events of the past. From whatever source, it is likely that the common childhood pathologies about which the mothers were questioned have a higher incidence rate than would appear from these data.

TABLE 23.3
CHILDHOOD ILLNESSES: PERCENT OF CHILDREN IN THE STUDY

Illness	Infants (N = 108)	Preschool (N = 134)	School-age (N = 142)
Measles	0.9	8.2	19.0
Rubella	--	0.8	---
Chickenpox	--	0.8	8.5
Scarlet fever	--	1.5	0.7
Lower respiratory tract infection*	--	12.7	14.8
Dehydration*	--	21.6	14.4
Otitis media*	--	3.0	7.8

*At least one occurrence

Note: There were no reported cases of polio.

Concerning chronic pathologies in children, there is 1 school-age child with a cardiac problem; two preschoolers are described as suffering from allergies and 2 school children have a history of convulsions. One preschooler, 2 schoolers and 1 infant had experienced surgery, while 7 cases of trauma were reported, all of which were found in school-age children.

As part of the clinical interview, respondents were asked about the frequency with which they consumed alcohol and used tobacco. Table 23.4 shows the responses of women, and Table 23.5 presents the results for men. The results in Table 23.4 confirm the impressions of fieldworkers that alcohol consumption of women is confined mainly to pulque. Not shown in the table are the responses from 1 woman who reported she occasionally drinks brandy and other liquors, or the responses of 6 women who drink beer, one of them on a daily basis. None of the women drink tequila or other distilled liquors. Only 5 women smoke cigarettes, and of these, only 1 smokes on a daily basis.

TABLE 23.4
FREQUENCY OF PULQUE CONSUMPTION BY WOMEN, AS REPORTED TO A PHYSICIAN: PERCENT OF RESPONDENTS (N = 252)

	Daily	3-5/ Week	1-2/ Week	<1/ Week	Never
Frequency of consumption	40.5	6.7	8.4	8.7	35.7
Frequency of inebriation	1.2	---	0.8	9.9	88.1

The high frequency with which men consume pulque as a primary beverage is seen in Table 23.5. Eighty-seven percent of men report drinking this locally produced beverage, which is followed in popularity by beer. Thirty-five percent of men drink beer, although only 15% do so on a daily basis. Brandy is reported to be consumed by 6% of men, with a usual consumption frequency of less than once a week. With respect to inebriation from beverages other than pulque or beer, 4% of the men claim they consume a sufficient quantity to produce inebriation. None of the men drink liqueurs or tequila, although one man reported drinking "other" alcoholic beverages on a daily basis, with sporadic inebriation. Nearly 40% of the men smoke cigarettes, with "daily" smoking the most common response among the smokers.

Pulque consumption also occurs among school-age children. According to their mothers' report, 19% of the children consume pulque, although only 6% do so on a daily basis.

TABLE 23.5
FREQUENCY OF ALCOHOL CONSUMPTION AND INEBRIATION OF LEAD MALES, AS REPORTED BY THEM TO A PHYSICIAN: PERCENT OF RESPONDENTS (N = 195)

	Daily	3-5/ Week	1-2/ Week	<1/ Week	Never
PULQUE					
Frequency of consumption	63.6	10.8	7.7	5.1	12.8
Frequency of inebriation	2.6	5.1	21.6	50.8	20.0
BEER					
Frequency of consumption	15.4	3.1	8.8	9.3	63.6
Frequency of inebriation	0.5	2.6	7.7	23.0	66.2

TABLE 23.6
FREQUENCY AND QUANTITY OF CIGARETTE SMOKING BY LEAD MALES AS REPORTED TO A PHYSICIAN: PERCENT OF RESPONDENTS (N = 195)

	Daily	3-5/ Week	1-2/ Week	<1/ Week	Never
Frequency of smoking	28.2	4.6	3.6	2.1	61.5
	>6/d	4-6/d	1-3/d	Don't know	None
Quantity smoked	8.7	8.7	20.5	0.5	61.5

WOMEN'S HEALTH: REPRODUCTIVE HISTORY

All of the women in the study were interviewed extensively about their reproductive history, whether or not they were in the study for a pregnancy. Information about reproductive history and sexually-related variables is often difficult to elicit, and is typically subject to some distortion. In the Solis Valley, and in Mexican culture generally, there is considerable reticence about discussing such matters. However, the fact that these data were collected by young, female physicians probably helped to assure cooperation in the responses. The rate of missing data is very low in all of the tables that follow, and results probably represent "reality," as the women perceive and recall it.

Table 23.7 shows the responses to questions on age of menarche, first sexual activity and first pregnancy. The 13 month difference between mean age of first sexual activity and first pregnancy reflects the absence of wide spread use of contraceptives, both currently and in the past. The table also shows that early teen-age pregnancy (below age 16) is rare, and the modal category for first pregnancy is 19 years or older.

On a population level, mean age of menarche partially reflects nutrition and health status. In the U.S. today, the mean age of menarche is 12.8 years, as compared to about 17 in the 19th century (23.1). Comparatively, the mean age of 13.6 in the Solis sample is younger than that of Mayan Indians (15.1 years), but higher than that reported for samples in Argentina (12.5), Venezuela (12.6) or Cuba (12.9). Very delayed sexual maturation, as reflected in age at menarche, is rare in Solis, with only 5% of the sample reporting a first menses after age 15.

TABLE 23.7
SEXUAL MATURATION OF ADULT WOMEN: PERCENT OF RESPONDENTS (N = 246)

AGE	Menarche	First Sexual Activity	First Pregnancy
10-12	19.2	----	----
13-15	71.6	13.4	2.8
16-18	4.8	45.5	40.0
19+	0.8	40.4	57.2
Mean	13.6	18.4	19.5
Range	10-19	13-31	15-31

The data on family size and structure reflect a population that has not, in the past, engaged in extensive family planning. However, the data in Table 23.8 show that more than 20% of the couples in the sample are currently using some form of contraception, and the rate of use appears to be growing. Oral contraceptives are the most popular method, followed by injectable hormones. IUDs are not commonly used, and have the same rate of frequency of use as the rhythm method. It is interesting to note that 5% of the couples use male rather than female methods, and 4.3% of the men have undergone vasectomy.

TABLE 23.8
USE OF CONTRACEPTIVES: PERCENT OF WOMEN RESPONDENTS (N=255)

Duration	% Respondents	Type	% Respondents
Never	78.5	Oral	10.4
< 1 year	10.0	Injection	4.8
1-4 years	9.2	Vasectomy	4.3
5+ years	2.4	IUD	1.0
		Rhythm	1.2
		Condom	0.4

Table 23.9 presents the responses to inquiries about menstruation characteristics. Forty four percent of women have experienced pelvic pain with menstruation at some point, while 15% report having experienced irregularity.

TABLE 23.9
MENSTRUAL CYCLE PATTERNS REPORTED TO A PHYSICIAN: PERCENT OF ADULT WOMEN (N=246)

Problem	Ever Experienced
None	38.6
Irregular cycle	15.9
Behavior changes	13.4
Migraines	3.3
Other	1.2
Duration:	
< 3 days	4.9
3 days	39.0
4-8 days	52.0
> 8 days	3.7
Unsure	0.4

Reproductive problems with pregnancies prior to the start of the study are shown in Table 23.10. The data on premature birth and low birth weight must be viewed with caution since most women would have little way of making a judgment about these matters, except in extreme cases.

TABLE 23.10
PREVIOUS REPRODUCTIVE PROBLEMS REPORTED TO A PHYSICIAN: PERCENT OF ADULT WOMEN (N = 246)

During Previous Birth:

Problem	Never Experienced	One Occurrence	Two or more Occurrences
C-section	95.5	4.1	0.4
Forceps delivery	91.9	6.9	1.2
Premature birth	88.2	11.0	0.8
Still birth	87.8	10.2	2.0
Low birth weight	77.2	15.9	6.9
Miscarriage	70.4	18.4	11.2

Time Period	Problem	Percent Women Ever Experienced
Previous Gestation:	Varicose veins	9.3
	Threat of premature birth	7.7
	Threat of miscarriage	5.7
	Toxemia	5.7
	Vaginal hemorrhage	2.4
Previous Birth:	Prolonged delivery	4.9
	Breech position	1.6
Previous post-partum:	Excessive bleeding	17.1
	Fever	8.5
Previous lactation:	Cracked nipples	20.7
	Breast infection	9.3
	Milk insufficiency	6.9
	No milk	2.4

THE CULTURE OF PREGNANCY AND LACTATION

The data in Table 23.10 are not only biological in nature, but they also reflect social and cultural conditions. For example, the very low incidence of C-Section and forceps-assisted deliveries is a function of the nature of medical services in the Solis Valley and surrounding area. The clinics in the area do not have the facilities to carry out surgery, and midwives do not use forceps. Lactation is also an aspect of health behavior that is heavily influenced by cultural factors. With respect to lactation, it is interesting to find that only 9% percent report problems with milk volume, of which 6.8% is described as "milk insufficiency." These figures are very low in comparison with many, particularly urban, populations in developing and developed countries where early weaning from the breast is commonly associated with perceived "milk insufficiency" (23.2).

While the data above are based on the previous experiences of the women, summarized in terms of whether they had ever had any of the problems listed, Table 23.11 examines reproductive history in a somewhat different way. This table

presents data from the clinical interviews on children. Here the women are asked to report on the delivery characteristics of the child -- infant, preschooler or school-age.

In Table 23.11 we see that more than a third of the births from pregnancies followed during the study period (the column labelled "infant") took place at home. Close to 50% of the preschool children were born at home, and the figure rises to 64% for the school-age children.

Since clinic facilities were available to project participants at a token fee, financial constraints are not a factor in explaining the sizeable percent of infants who were born at home. An important part of the explanation for this phenomenon is the lack of convenient transportation in the valley. Although third class bus service provides villagers with access to most areas of the valley, including Solis and the municipal center, the buses go to the communities only once or twice a day and there is no service in the evening. With the relatively dispersed settlement pattern, and in the absence of telephones, women in labor often cannot find transportation to the clinic. Thus, many babies were born at home, even when the mother intended to use the clinic facilities for delivery.

There is a close correspondence between clinic and hospital delivery and delivery assisted by a physician. The figures on midwife-attended births reflect the common pattern in which the midwife goes to the home of the woman in labor rather than the reverse. Rarely does delivery take place in the home of the midwife. A rapid decline in the use of midwives is apparent in the comparison of delivery attendant by subject type, which shows a four-fold decline in the past 7-8 years. On the other hand, the stability in the figure for "relative/neighbor-attended" births (remaining at 1 in 4) reflects the lack of transportation facilities as an important factor influencing birth practices.

TABLE 23.11
DELIVERY CHARACTERISTICS: PERCENT OF CHILDREN IN THE STUDY

Delivery Characteristics	Infant (N = 109)	Preschool (N = 134)	School-age (N = 142)
Place of Delivery			
Hospital	4.6	6.0	3.5
Clinic	58.7	44.8	23.9
Own home	36.7	47.8	64.1
Midwife's home	-	1.5	8.5
Delivery Attendant			
Doctor	61.5	52.2	28.2
Nurse	1.8	0.8	2.8
Midwife	11.0	23.9	41.6
Relative/neighbor	25.7	23.1	26.1
Type of Delivery			
Normal	92.7	97.0	93.7
Abnormal	3.7	3.0	5.6
C- Section	3.7	-	0.7

Most cultures, including Euro-American ones, have fairly elaborate ideas concerning appropriate food intake during pregnancy. Usually the cultural wisdom includes both food prescriptions and proscriptions. The latter, often referred to as "food taboos," have been the subject of considerable criticism by biomedically trained professionals, who point to the negative nutritional consequences of many of these restrictions. On the other hand, some anthropologists have urged caution in condemning such beliefs, pointing out that they may have subtle but important positive functions. Pregnancy food "rules" in traditional Mexican culture are derived primarily from the humoral system, which is pervasive throughout Latin America. Thus while only 1% of the women attributed the source of their pregnancy food avoidances to "tradition," it is probable that the other 19% who avoided some foods in order to "prevent problems" were also reflecting cultural beliefs related to the "hot/cold" system.

Concerning the responses in Table 23.12, it is interesting to note that the great majority of women practice **no** food avoidances during pregnancy, a finding that suggests rapid cultural change has occurred in the valley communities. The paucity of items listed under the column of foods "specially consumed," contrasts markedly with what one would expect to find in populations in industrialized countries. The fact that 50% perceive no change in appetite, together with the low response rate on foods specially consumed or avoided, suggests that the women do not view pregnancy as a period requiring dietary change or special dietary attention.

One notes that pulque appears in both the "foods avoided" and the "special foods" columns, but in both instances the number of women mentioning pulque in response to open-ended questions is very small. Eighty-one women who were followed through a pregnancy reported to the physician that they consumed some pulque during their pregnancy. Two-thirds of the mothers of school-age children and preschoolers in the study reported that they had consumed pulque during the pregnancy of that child. A very small number (6 women) also consumed beer during pregnancy.

TABLE 23.12
DIETARY PRACTICES DURING LAST, PREVIOUS PREGNANCY: PERCENT OF WOMEN RESPONDENTS (N = 256)

CHANGE IN APPETITE	(%)	REASON FOODS AVOIDED	(%)
No change	50.6	No avoidances	77.7
Increase	25.5	Prevent problems	19.5
Decrease	22.3	"Tradition"	1.2
		Medical advice	0.4
		Don't know	1.2

FOODS AVOIDED	(%)	FOODS SPECIALLY CONSUMED	(%)
Pork	6.0	"Cravings"	6.3
Spicy foods	4.4	Chicken	4.0
Chile	3.6	Pasta	2.4
Pulque	2.4	Pulque	2.4
		Atole	0.4
		Chicken consomme	0.4
		Tea	0.4

A key feature of the culture of reproduction in Latin America is the practice of the cuarentena, the forty day postpartum period during which the mother and infant are given special treatment and care. In central, highland Mexico, traditional postpartum activities involved a combination of aboriginal (Nahuatl/Aztec) practices (including ritual baths) and practices derived from Spain. Among the chief components of the cuarentena were the consumption of special foods, refraining from many domestic activities, and avoidance of stress and exposure to dangers of various sorts.

The data in Tables 23.13 and 23.14 suggest that the cuarentena is still very much alive in the Solis valley, and the responses of the women in the sample are in accord with the ethnographic data. In contrast to pregnancy, a much higher percent of women follow some food prescriptions and proscriptions. In their last (previous) pregnancy, only 22% of the women avoided some foods, whereas 43% reported food avoidances during the postpartum period. Similarly 17% of the women sought to eat special foods during pregnancy, but the majority (81%) consumed special foods during the cuarentena. It is striking to see that chicken and atole, both traditional postpartum foods, are mentioned by a significant number of the women. We see also that "tradition" is frequently mentioned as the reason for avoiding "dangerous" foods.

The list of activities in Table 23.14 was derived from key informant interviewing during Phase I of the project. With the exception of bathing, these are the activities that women said should be foregone during the cuarentena. Traditionally, bathing during this period was done only in the temascal, the small separate structure for the sweat bath. However, today this practice has virtually disappeared, but there is still some concern on the part of many women about exposing the body to "cold" in bathing. This is reflected in the report, by about a third of the sample, that they do not resume bathing until the second postpartum week.

TABLE 23.13
DIETARY PRACTICES IN THE LAST, PREVIOUS POSTPARTUM PERIOD:
PERCENT OF RESPONDENTS (N = 251)

CHANGE IN APPETITE	(%)
No change	57.6
Increase	30.4
Decrease	10.8

REASON FOODS AVOIDED	(%)
No avoidances	56.2
Prevent problems	2.8
"Tradition"	38.0
Medical advice	1.2
Don't know	0.8

FOODS AVOIDED	(%)
Pork	21.0
Spicy foods	4.4
Chile	29.7
Pulque	3.2

FOODS SPECIALLY CONSUMED	(%)
"Cravings"	0.8
Chicken	74.5
Pasta	36.3
Pulque	8.8
Atole	41.4
Chicken consomme	16.3
Tea	1.2

TABLE 23.14
DAYS POSTPARTUM TO RESUMPTION OF ACTIVITIES: PERCENT OF RESPONDENTS (N = 251)

Activity	1-7 days	8-14 days	15-21 days	22-39 days	> 40 days
Sweeping	7.2	23.6	40.4	17.2	11.6
Washing dishes	10.8	31.6	42.0	10.8	4.8
Cooking	10.8	29.6	42.0	12.4	5.2
Lifting objects	0.4	3.6	16.8	36.0	43.2
Going to market	1.2	6.0	19.2	38.0	35.6
Carrying baby outside	4.0	8.0	19.2	35.2	33.6
Visiting doctor	8.0	5.6	5.2	5.6	75.6
Bathing	65.2	31.6	1.6	0.0	1.6

Note: For each activity, between 2 and 4 women could not remember; hence row totals do not reach 100%. These data reflect previous, not current, postpartum periods.

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Chapter 24

LABORATORY DATA

This chapter presents the results of descriptive analyses of laboratory data. Thus far these values have not been tested for their associations with dietary intake or any functional outcomes. However, they serve to alert us to several nutritional and health problems in the Solis population that might confound the interpretation of relationships between dietary energy intake and function.

I. URINE ANALYSES

Table 24.1 summarizes the results of the urine analyses. The bacteriological examination of urine evaluated total bacteria and gram-negative bacteria in a semi-quantitative manner. For total bacteria a finding of 100 or more colonies per plate or 10^5 bacteria or colonies/ml was regarded as abnormal. For gram-negative bacteria findings of 20 to 99 colonies per plate (10^4 bacteria or colonies/ml) and 100 or more colonies per plate (10^5 bacteria or colonies/ml) were regarded as abnormal. Counts of gram-negative rods greater than 10^5 may indicate infection of the urinary tract. The highest incidence of bacteriuria occurred in pregnant women. Women are predisposed to urinary tract infections during pregnancy due to the dilation of the ureters caused by hormones and by pressure from the enlarged uterus. Such infections can lead to serious renal debility.

Levels of protein greater than or equal to 30 mg/dl were regarded as abnormal. Proteinuria is an indication of renal disease and toxemia of pregnancy. Healthy persons may exceed normal levels of protein in the urine during exercise or with dehydration. Functional proteinuria is also found with congestive heart failure, cold exposure and fever. In the Solis sample, no children exhibited proteinuria. Adult males had a high frequency of abnormal levels, for reasons that are not understood. There was no increase in the incidence of proteinuria during pregnancy.

Levels of glucose greater than or equal to 100 mg/dl were considered abnormal. Glucosuria with hyperglycemia is indicative of diabetes mellitus, some endocrine and central nervous system disorders, and metabolic disturbances. In pregnancy an increase in glucose in the urine may appear at relatively low blood glucose levels, but pregnancy did not appear to increase glucosuria. The low percentage of abnormally high urine glucose values indicates that diabetes is not endemic in the Solis population.

Ketone levels greater than or equal to 5 mg/dl were considered excessive. No levels greater than 40 mg/dl were observed. In children ketonuria may occur in vomiting, diarrhea and fever; only one toddler, and no schoolers, had ketonuria. Vomiting or low blood glucose during pregnancy may also produce ketonuria. In these cases, limited food intake resulting in fat catabolism may be the cause.

The smell of urine was reported to be "abnormal" in 13-18% of adult women, and in 26% of those who were both pregnant and lactating. A possible explanation for this is that the higher numbers of bacteria these samples caused more degradation to occur prior to analysis. Average urine density ranged between 1.018 and 1.020 among groups except that it fell slightly below this (1.017) in the last two trimesters of pregnancy.

II. FECAL ANALYSES

The macroscopic examination of feces evaluated consistency and the presence of mucus and/or blood. Consistency of feces was described as watery, soft, pasty, hard or combinations of two consistencies. Feces that were watery, soft or in any combination with watery or soft were judged abnormal. The presence or absence of blood and/or mucus was noted. Approximately 20% of fecal samples from infants, children and women were classified as having some "soft" or "watery" characteristics (Table 24.2). About 40% of adult males, and women in their first trimester of pregnancy had feces of this type.

Judged from the number of parasite cysts and eggs in fecal samples that were collected from individuals at 3-month intervals (Tables 24.3 and 24.4) several parasites are endemic to the valley. These are Entamoeba histolytica, Giardia lamblia, and Ascaris lumbricoides. Cysts were reported in a semi-quantitative manner. "Low" indicates the detection of 1 - 10 cysts per slide. "High" refers to the detection of 10 or more cysts per slide, and is considered abnormal. When counting the presence of eggs, "low" refers to the detection of less than 5 eggs per slide. "High" refers to the detection of 5 or more eggs per slide. Both "low" and "high" values for eggs are considered abnormal.

About 20% of infant's samples have entamoeba cysts, but there are almost no cases of giardia or ascaris at this age (Tables 3 and 4). Toddlers have lower levels of entamoeba and ascaris cysts than adults, but giardia is particularly prevalent in this group. The feces of schoolers show a common prevalence of amoebas (43% of samples, 23% of which have high counts), giardia (13%), and ascaris (21%). E. vermicularis, Hymenolepsis nana, and helminths were not common.

TABLE 24.1.
URINE ANALYSIS BY TYPE OF INDIVIDUAL (PERCENT OF OBSERVATIONS)

Subject	# of Tests	Total Bacteria $\leq 10^5$	Gram Negatives $\leq 10^4$	Gram Negatives $\leq 10^5$	Protein ≥ 30 mg/dl	Glucose ≥ 100 mg/dl	Ketones ≥ 5 mg/dl
Toddlers	7	14	0	0	0	0	14
Schoolers	15	0	0	0	0	0	0
Adult males	346	7	3	3	14	1	6
Adult females							
NPNL	424	14	6	7	8	1	4
Tri I	73	11	7	5	4	1	1
Tri II	145	14	6	10	3	0	3
Tri III	206	24	10	12	8	1	4
Lactating							
0-3 mo	173	18	6	11	4	1	3
3-6 mo	162	22	8	12	4	0	1
6-8 mo	114	12	3	10	7	1	1
> 8 mo	175	18	3	11	6	0	1
Preg & Lact	23	26	4	17	4	0	0

TABLE 24.2
INDIVIDUALS WITH ABNORMAL FECES (PERCENT OF OBSERVATIONS)

Subject type	# of Tests	Soft or Watery Feces	Mucus in Feces	Blood in Feces	Entamoeba Trophoz.	Giardia	Taenia Trophoz
Infants	69	18.8	7.8	1.5	2.9	1.5	0.0
Toddlers	333	20.1	10.2	0.0	0.0	2.1	0.0
Schoolers	567	19.3	9.9	0.2	0.0	1.8	0.5
Adult males	336	39.0	7.4	0.0	0.0	1.8	0.0
Adult females							
NPNL	343	26.8	8.2	0.3	0.0	1.2	0.3
Pregnant							
Tri I	46	41.3	6.5	0.0	0.0	0.0	0.0
Tri II	109	22.9	10.1	0.0	0.0	3.7	0.0
Tri III	172	21.5	7.6	0.0	0.0	0.0	0.0
Lactating							
0-3 mo	144	14.0	9.0	0.0	0.0	3.5	0.7
3-6 mo	145	18.6	9.0	0.0	0.0	2.8	0.0
6-8 mo	106	17.9	6.6	0.0	0.0	3.8	0.0
>8 mo	154	18.3	9.7	0.0	0.0	1.3	0.0
Preg & Lact	18	16.7	22.2	0.0	0.0	11.1	0.0

TABLE 24.3
PERCENT OF INDIVIDUALS WITH CYSTS IN FECES

Subjects	# of Tests	E. histolytica Low	E. histolytica High	Giardia Low	Giardia High	Other cysts Low	Other cysts High
Infants	69	10.1	8.7	0.0	1.5	0.0	0.0
Toddlers	333	9.6	8.1	5.7	12.0	0.6	0.6
Schoolers	567	19.9	23.5	3.5	9.4	3.5	1.8
Adult males	336	15.8	11.0	4.5	5.1	1.8	0.9
Adult females							
Nonlactating							
NPNL	343	17.2	21.9	1.7	1.2	1.2	0.6
Tri I	46	21.7	41.3	4.3	4.3	0.0	1.2
Tri II	109	16.5	34.9	4.6	1.8	2.8	0.0
Tri III	172	24.4	15.7	1.7	2.3	0.0	1.2
Lactating							
0-3 mo	144	19.4	27.1	1.4	3.5	0.7	2.1
3-6 mo	145	22.8	25.5	2.1	0.0	3.5	0.0
6-8 mo	106	19.8	21.7	2.8	0.9	0.0	1.3
>8 mo	154	24.7	16.2	1.3	3.2	0.0	0.0
Pregnant & Lact.	18	22.3	33.3	0.0	0.0	5.6	0.0

TABLE 24.4
PERCENT OF INDIVIDUALS WITH EGGS IN FECES

Subjects	# of Tests	Ascaris Low	Ascaris High	E. vermic. Low	E. vermic. High	Hymenolepsis Low	Hymenolepsis High	Helminths Low	Helminths High
Infants	69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toddlers	333	3.3	2.7	1.2	0.9	0.6	0.9	1.8	1.5
Schoolers	567	9.9	11.5	1.6	1.6	0.9	1.4	3.5	5.1
Adult males	336	6.3	5.7	0.0	0.6	0.0	0.0	0.3	0.6
Adult females:									
Nonlactating:									
NPNL	343	5.2	7.9	0.9	0.0	0.0	0.6	0.6	0.6
Tri I	46	13.4	8.1	0.0	0.0	0.0	0.0	0.0	0.0
Tri II	109	5.5	9.2	0.0	0.0	0.0	0.9	0.0	0.0
Tri III	172	13.4	8.1	0.0	0.0	0.0	0.0	0.6	0.6
Lactating:									
0-3 mo	144	9.7	9.7	0.7	0.0	0.7	0.0	0.0	0.0
3-6 mo	144	4.3	12.5	0.7	0.7	0.7	0.0	0.0	0.0
6-8 mo	106	5.7	6.6	0.0	0.0	0.0	0.0	0.9	0.0
>8 mo	154	8.4	4.6	0.7	0.0	0.0	0.0	0.0	0.0
Pregnant & Lact.	18	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0

III. DIFFERENTIAL COUNTS

The results of the white blood cell differential counts are shown in Table 24.5. The average values for all parameters are within the normal range. The high number of white blood cells in samples from toddlers deserves further analysis.

TABLE 24.5
WHITE BLOOD CELL DIFFERENTIAL COUNTS

Subjects	# of Tests	# WBC (/μL)	% Neu-tros	% Lym-phos	% Eosin	% Basos	% Monos	% Ban-ded
Toddlers	50	8001 ± 2095*	51.0 ± 8.4	44.9 ± 9.2	2.3 ± 2.6	0.20 ± 0.45	1.51 ± 1.69	0
Schoolers	90	5794 ± 1727	54.4 ± 8.9	41.4 ± 9.1	2.4 ± 2.6	0.50 ± 0.27	1.89 ± 2.00	0
Adult males	74	5180 ± 1744	58.5 ± 8.4	38.6 ± 7.5	1.4 ± 1.8	0.08 ± 0.28	1.41 ± 1.53	0
Adult females								
NPNL	73	5725 ± 1556	61.1 ± 6.7	35.8 ± 6.7	1.5 ± 2.0	0.11 ± 0.43	1.34 ± 1.22	0
Tri II†	34	6669 ± 1530	62.0 ± 8.3	33.6 ± 8.4	1.7 ± 1.7	0.09 ± 0.28	2.28 ± 1.20	0
Tri III†	67	6724 ± 1789	61.0 ± 7.1	34.5 ± 7.0	1.7 ± 1.5	0.08 ± 0.23	2.68 ± 1.49	0
Lactating‡								
3-6 mo	16	6251 ± 2453	57.4 ±10.5	38.8 ± 5.3	1.3 ± 1.4	0.18 ±0.39	1.12 ± 0.99	0
6-8 mo	47	6039 ± 1519	57.1 ± 6.9	39.9 ± 6.4	1.5 ± 1.7	0.25 ±0.91	1.52 ± 1.44	0
>8 mo	32	5724 ± 1606	62.7 ± 6.7	34.0 ± 6.2	1.8 ± 1.8	0.03 ±0.18	1.44 ± 1.54	0

* Standard deviation

† Pregnant but not lactating.

‡ Lactating but not pregnant.

TABLE 24.6
HEMATOLOGY, MEAN VALUES

Subjects	# of Tests	Hb (g/dl)	Hct (%)	# RBC ($10^6/\mu L$)	MCV (m3)	MCHC (%)
Toddlers	50	11.5 ± 1.3	36.4 ± 4.6	4.2 ± 0.6	85.3 ± 6.5	31.6 ± 2.4
Schoolers	90	12.6 ± 1.0	38.5 ± 4.2	4.2 ± 0.5	89.8 ± 4.9	32.5 ± 1.7
Adult males	74	15.4 ± 1.1	47.4 ± 4.2	4.9 ± 0.5	97.5 ± 6.5	32.5 ± 1.7
Adult females						
NPNL	73	13.0 ± 1.2	40.4 ± 4.3	4.3 ± 0.5	93.7 ± 5.1	32.4 ± 1.8
Tri II*	34	12.3 ± 1.2	36.7 ± 3.7	4.0 ± 0.4	90.7 ±11.5	33.6 ± 1.0
Tri III*	67	12.6 ± 1.8	38.1 ± 5.2	4.1 ± 0.6	92.3 ± 8.1	33.2 ± 1.4
Lactating†						
3-6 mo	16	13.8 ± 0.7	43.4 ± 4.8	4.6 ± 0.6	94.3 ± 4.4	31.7 ± 2.1
6-8 mo	48	13.3 ± 1.2	41.6 ± 4.5	4.5 ± 0.5	93.3 ± 5.5	31.9 ± 2.5
>8 mo	32	13.0 ± 1.3	40.2 ± 4.9	4.2 ± 0.5	94.8 ± 4.9	32.2 ± 2.0

* Pregnant but not lactating.

† Lactating but not pregnant.

TABLE 24.7
PERCENT OF INDIVIDUALS WITH HEMATOLOGICAL VALUES INDICATIVE OF ANEMIA*

Subjects	N	Hb cut-off	Hb %low	Hct cut-off	Hct %low	RBC Count cut-off	RBC Count %low	MCV cut-off (low&high)	MCV %low	MCV %high	MCHC cut-off	MCHC %low
Toddlers	49	11.5	45	35.0	37	3.95	22	73, 100	2	4	31	30
Schoolers	90	12.5	40	37.5	43	3.95	31	76, 100	0	2	31	12
Adult M.	74	13.5	4	34.5	1	4.68	41	80, 100	0	27	31	15
Adult Females												
NPNL	71	12.5	28	34.5	8	4.16	37	80, 100	0	4	31	18
Tri II	38	11.5	21	31.5	8	3.95	42	80, 100	9	5	31	0
Tri III	67	11.5	18	31.5	4	3.95	33	80, 100	6	7	31	4
Lactating												
3-6 mo	16	12.5	0	34.5	0	4.16	25	80, 100	0	6	31	19
6-8 mo	47	12.5	17	34.5	6	4.16	29	80, 100	0	9	31	21
>8 mo	31	12.5	29	34.5	19	4.16	39	80, 100	0	6	31	9

* See text for derivation of cut-off values

The hematological data in Tables 24.6 and 24.7 can be used to describe the prevalence of anemia in the Solis communities. The values for hemoglobin, hematocrit and number of red blood cells are affected by the high altitude of Solis, 2,300 m. After consultation with Dr. Yip of the Center for Disease Control (CDC) in Atlanta, GA, we obtained the CDC's corrections for high altitude and used these to correct the values below which deficiency is assumed to be present. These corrections were:

Hemoglobin:	+ 0.5 g/dl
Hematocrit:	+ 1.5 %
RBC :	+ 4.0 % of value

To define high altitude (Solis) cut-off levels, these corrections were applied to deficient or abnormal cut-off values obtained from the following sources:

Hemoglobin:	World Health Organization, corrected for altitude (24.1)
Hematocrit:	(Toddlers and schoolers) Amer. Academy of Pediatrics, corrected for altitude (24.2)
	(Adult males, NPNL females) INACG, corrected for altitude (24.3)
	(Pregnant women) Natl. Nutrition Survey, altitude corrected (24.4)
RBC:	Refs. 24.5 and 24.6, corrected for altitude
MCV:	Ref. 24.7, no altitude correction
MCHC:	World Health Organization, no altitude correction (24.1)

The prevalence of low hemoglobin levels is very high in all groups except adult males. Almost half of the children - including toddlers - have values suggestive of anemia, as do up to one-third of women, depending on their physiologi-

cal status. Additionally, the low red blood cell (RBC) counts suggest a population-wide prevalence of anemia, although surprisingly this also occurs in adult males who had few low hemoglobin and hematocrit values.

The percentage of high values for MCV suggesting folate and/or vitamin B_{12} deficiency in adult men is striking (Table 24.7). The highest prevalence of the folate and/or B_{12} anemias occurs in adults, rather than children, and especially in adult males. The presence of macrocytic anemia in the adult males may explain why this group has such a high percentage of low RBC counts in the apparent absence of deficient hemoglobin and hematocrit levels. The major sources of folate are green leafy vegetables, organ meats, lean beef, wheat, eggs, orange juice, fish and dry beans. Of these, only dry beans are eaten in substantial amounts by adults in Solis, and cooking destroys 72% of the folate in beans. Although vitamin B_{12} deficiency is generally encountered much less frequently than folate deficiency, it is possible that those adults who consume almost no animal products may be depleted in this vitamin.

The relationship between the consumption of pulque, energy, meat and tortillas was examined by correlation analysis for adult males and non-pregnant, non-lactating females (Table 24.8). Averaging daily pulque consumption of each individual during their time in the study, the 72 adult males with hematological data reported here consumed on average almost one liter per day, with a range of 0 to 4.4 liters per day. The average intake by women was 0.3 (range 0 to 1.8) liters per day. Pulque consumption was positively correlated with MCV and negatively correlated with the RBC count, in both adult males and females. The only other significant associations were between meat intake and hemoglobin in women, and tortilla intake and red blood cell count in women (negative). These relationships are consistent with the suggestion that pulque is associated with macrocytic anemia, while (in women only) low hemoglobin values are associated with smaller intakes of meat and higher intakes of tortillas. Our current interpretation of these data is that a constituent of pulque - perhaps alcohol, since this is known to decrease folate absorption, lower hepatic affinity for folate, and impair folate utilization - causes folate deficiency anemia. Iron deficiency anemia in women is less prevalent when the highly available iron in meat is consumed, and more prevalent if more total iron comes from tortillas in which availability is only about 1%.

TABLE 24.8
RELATIONSHIP BETWEEN HEMATOLOGICAL VALUES AND HABITUAL CONSUMPTION OF PULQUE AND OTHER FOODS.

	HEMOGLOBIN		MCV		# RBC	
	r	p≤	r	p≤	r	p≤
Adult males (N=72)						
Kcal from pulque	- .17	(.16)	.20	(.09)	- .32	(.006)
Total kcal	.01	(.93)	.11	(.36)	.01	(.95)
Kcal from meats	.04	(.70)	.05	(.67)	- .04	(.76)
Kcal from tortillas	.02	(.86)	.03	(.82)	.11	(.37)
Adult females (N=71)						
Kcal from pulque	- .05	(.65)	.33	(.005)	- .22	(.06)
Total kcal	- .02	(.84)	- .02	(.79)	- .14	(.25)
Kcal from meats	.24	(.04)	- .07	(.54)	.15	(.20)
Kcal from tortillas	- .17	(.15)	.01	(.94)	- .25	(.04)

Interpretation of the data, however, must be done with caution because of the paucity of reliable cut-off values for populations at this altitude. There are also inconsistencies in the data, e.g. the percent of individuals with low MCV values is negligible. The existence of iron deficiency and folate and/or B_{12} deficiency concurrently will confound the interpretation of MCV. Serum ferritin data (Table 24.9 below) support the interpretation of a high prevalence of iron deficiency; it will also be important in future analyses to examine the relationship between available iron consumption and iron status of individuals. Finally, confirmation of a high prevalence of folate and/or vitamin B_{12} deficiency in adult males will only be possible by the collection and analysis of additional blood samples.

Serum ferritin values <10 (or 12) ng/dl are indicative of iron deficiency anemia at all ages (24.3). The pattern of low values indicated in Table 24.9 parallels that of low values of hemoglobin and hematocrit, i.e. a high incidence in toddlers, schoolers, and women. In pregnancy the situation is particularly severe, with half the women appearing to be anemic. Some, but not all, of the decrease in late pregnancy might be ascribed to hemodilution; postpartum, there are fewer low ferritin values but the incidence is still about 20%.

The normal range of transferrin values is 200-400 mg/dl. In iron deficiency, serum transferrin may be elevated to twice the normal values. As shown in Table 24.9, the prevalence of high transferrin levels is greatest in toddlers (12%), and adult females (10 - 19% except for pregnant women). Low transferrin values may indicate impaired protein status (in conjunction with other serum proteins), and transferrin values <100 or <150 are suggested as an indicator of possible nutritional risk. From 1 to 10% of persons in all groups have values below 150 mg/dl. Elevation of transferrin is expected during pregnancy and probably explains the zero incidence of low values, and the high incidence of high values, in Solis pregnant women. Total iron binding capacity (and transferrin) reaches adult levels after 6 months of age. Further analysis is required before the conflicting effects of marginal malnutrition (lowering) and iron deficiency (stimulating) on transferrin levels can be interpreted in the Solis data.

Normal prealbumin levels are in the range 10-40 mg/dl (Table 24.9). Values mg/dl have been suggested as indicating nutritional risk. About one quarter of Solis children had low prealbumin levels, which supports a diagnosis of marginal malnutrition.

Complement C3 and immunoglobulin levels have been investigated with particular reference to nutritional risk in children. Depression of serum complement C3 may occur due to i) decreased synthesis, and/or ii) activation of C3 (it binds immune complexes in tissue and is removed from serum). Chandra found the mean level of C3 to be decreased in PEM, with mean values of 61 ± 9 mg/dl compared to values of 143 ± 15 mg/dl in healthy individuals (24.8). The Solis schoolers and toddlers (Table 24.9) had low levels of complement C3 (normal range taken as 55 - 120 mg/dl), with a mean value close to that found by Chandra in malnourished children. The following values of IgA have been reported in children: malnourished 203 ± 98 mg/dl, recovered 130 ± 87 mg/dl, controls 83 ± 40 mg/dl (24.9). Levels of adult IgA are obtained by age 16. By age 3.5 years only 50% of eventual adult levels are obtained, so that the 30% low values in Solis schoolers might be partly an age effect.

TABLE 24.9.
PLASMA PROTEINS BY TYPE OF INDIVIDUAL

Subject type	N	Ferritin* ng/dl Mean	% low	N	Transferrin† mg/dl Mean	% low	% high	N	Prealbumin‡ mg/dl Mean	% low
Toddlers	45	26 ± 52	33	43	262 ± 88	7	12	44	15 ± 7	23
Schoolers	77	24 ± 15	13	74	262 ± 62	1	1	77	17 ± 5	6
Adult males	52	131 ± 111	2	57	289 ± 90	7	9	57	31 ± 10	4
Adult females:										
NPNL	64	31 ± 34	20	64	316 ± 90	0	17	66	26 ± 11	2
Tri II§	23	20 ± 21	35	16	99 ± 31	0	(48)	29	27 ± 9	0
Tri III§	46	13 ± 12	52	24	107 ± 22	0	(63)	57	29 ± 11	2
Lactating:**										
0-3 mo	4	12 ± 12		4	242 ± 78			4	19 ± 5	
3-6 mo	16	27 ± 23	19	16	298 ± 84	6	19	16	23 ± 10	6
6-8 mo	35	22 ± 15	20	41	275 ± 96	10	10	42	23 ± 8	2
>8 mo	27	25 ± 22	22	27	25 ± 10	4	16	27	25 ± 10	7

* Low ferritin = <10 ng/dl

† Low transferrin = <150 mg/dl, High = >400 mg/dl

‡ Low prealbumin = <10 mg/dl

§ Pregnant and not lactating

** Lactating and not pregnant

(continued on next page).

TABLE 24.9 (continued)

Subject type	Complement C3†† N	mg/dl Mean	% abnormal	IGA‡‡ N	mg/dl Mean	% abnormal	Rosette Formation§§ N	% Mean	% abnormal
Toddlers	8	56 ± 13	50 (low)	14	108 ± 81	0	31 ± 14	34	94
Schoolers	40	65 ± 12	20 (low)	54	139 ± 65	30 (low)	72 ± 15	27	94
Adult males	16	82 ± 17	0	22	297 ±140	23 (high)			
Adult females									
NPNL	20	79 ± 17	5 (low)	29	214 ± 95	3 (high)	22	36 ± 16	82
Tri II§	16	99 ± 31	19 (high)	15	196 ± 64	0	2	33 ± 20	100
Tri III§	24	107 ± 22	21 (high)	21	192 ± 64	0	3	59 ± 20	33
Lactating**									
3-6 mo	2	118 ± 40	0	5	216 ± 72	0	11	33 ± 14	100
6-8 mo	5	67 ± 19	0	15	203 ± 93	0	36	34 ± 11	92
>8 mo							14	35 ± 14	93

†† Low complement c3 = <55 mg/dl, High = >120 mg/dl

‡‡ Low IGA = < 90 mg/dl, High = > 450 mg/dl

§§ Abnormal rosette formation = < 50%

In healthy individuals rosette-forming cells (RFC) are greater than 50% of peripheral lymphocytes. The number of toddlers and schoolers with a low percentage of these cells is striking (Table 24.9). The mean % RFC among toddlers was 34% and among schoolers, 27%. This compares to values of 16.6 + 2.7 S.E. (24.10) or a range between 11 and 40% (24.11) in children with protein energy malnutrition as defined by low serum albumin and low weight-for-age. In normal children the mean %RFC has been reported as 59.7% + 1.4 S.E. (24.10), and as within the range of 58 to 79% (24.11). The fall in RFC parallels weight deficit (24.11). Depression of T-lymphocyte levels in the Solis women is also suggested. Although alcohol consumption may depress the level of T-lymphocytes this is not expected to be an explanatory factor for the Solis women and children. It has been shown by other investigators that children born small for gestational age exhibit long-term depression of T-lymphocyte levels even after nutritional rehabilitation. It has been hypothesized that relative malnutrition at a critical period in the development of the thymus-dependent immune system may result in prolonged or permanent impairment of cell-mediated immunity (24.10).

For all of the above tests, control samples were collected and analyzed from healthy individuals in Mexico City. We have not yet had the opportunity to compare these values with those from Solis, and this step will be essential for the interpretation of Solis data. Future analyses will include examination of the association of all laboratory values with other nutritional and health-related outcomes.

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Chapter 25

RESTING METABOLIC RATE DATA

Resting metabolic rate data for adults, collected as described in Chapter 12, are summarized in Tables 25.1 and 25.2. In Table 25.1, values have been calculated per minute and per day, per kg body weight (using the weight measure taken at the same time that RMR was measured), and per cm height (using the mean height measure of the individual during the entire study). The data are reported for the number of observations, rather than the number of subjects. There were 1,860 measurements of RMR on adults, an average of approximately 4 measures per individual. In order to judge the reasonableness of the values, the weight and height data from each individual, by decade of age, were used in the WHO/FAO equations that predict BMR from body size (25.1). The Solis values are very close to predictions for non-pregnant, non-lactating women; FAO/WHO values are 22.5 and 22.9 kcal/kg for women aged 20 - 30 and 30 - 40 years, respectively. For adult males, the Solis values are slightly lower than those predicted; FAO/WHO values are 25.5, 25.6, and 26.0 kcal/kg for men in their 20s, 30s, and 40s, respectively. The difference between predicted and actual values increases with the age of the men, being almost identical in the 20 - 30 year olds, and approximately 3.5 kcal/kg lower in the 50 - 60 year old Mexicans, compared to predictions for that age group. As discussed in Chapter 12, Solis measurements were taken on subjects who fasted overnight, so that their metabolic rate should be closer to "basal" rather than "resting".

For those women on whom data were available prior to conception and throughout pregnancy and lactation, a separate analysis was performed in order to follow the longitudinal changes in RMR that may occur with changes in physiological status (Table 25.2). Of 39 women who had measures prior to conception, in each trimester of pregnancy and throughout lactation, 35 remained after data cleaning. The other 4 cases were rejected because they had an out-of-range value (20% different from the mean value from that individual) at some time point. The slightly higher daily RMRs of the non-pregnant, non-lactating cross-sectional group in Table 25.1 are higher than values for the NPNL group in Table 25.2. This can probably be explained by the higher body weights of the older women in this sample, since values were similar when expressed on a body weight basis.

In the longitudinal group, there were no significant changes in RMR per minute or per kg during pregnancy, although values per minute were slightly higher (but not significantly) in the third trimester. Figure 25.1 provides a scatterplot of the data. Values plotted at 0 days of pregnancy represent measures made on non-pregnant women. On a kcal/cm basis, RMR in trimester 3 was significantly higher than in the non-pregnant, non-lactating group (MANOVA, Scheffe's comparisons).

Currently, there exists much controversy over the extent to which maternal RMR increases during pregnancy, and the cumulative energy cost attributable to this increase. The US RDAs are based on a theoretical increment in RMR that amounts to a total of 36,000 kcal over the course of pregnancy (25.2). More recently, data have been published from studies in which RMR was actually measured during pregnancy. The general pattern that emerges is that the cumulative energy cost of maintenance is higher in well-nourished women than in those who are malnourished. For example, estimates of the cumulative RMR increase during pregnancy are 46,500 kcal in Swedish women (25.3), 20,000 kcal in Scottish women, (25.4), 13,000 kcal in nutritionally-supplemented women in The Gambia, and only 1,000 kcal in malnourished Gambian women (25.5).

The average cumulative energy cost of RMR was calculated for the Solis pregnant sample by subtracting the mean NPNL value from the mean value in each trimester. The estimated cumulative increase was 20,030 kcal. In future analyses of these data, we plan to use an integration approach to calculate the cumulative extra cost of resting metabolism at various stages of pregnancy. It is likely that this will result in a lower estimate of the increment in RMR than our current method of comparing trimester averages to NPNL values.

On a kcal/minute basis, our data agree closely with values reported by Lawrence et al. on malnourished women from The Gambia (25.5); in Solis, the increase was 0.09 kcal/min between conception and 37 weeks of gestation, compared to 0.08 kcal/min in The Gambia (although only six malnourished women in the Gambian study had values at both conception and 37 weeks). This increase is much lower than that predicted by Hytten (25.4), who suggested that the rise in pregnancy should reach 0.18 kcal/min by the end of pregnancy in well-nourished women.

In the Solis study, there were no significant differences (MANOVA, Scheffe's comparisons) between any stage of pregnancy, any stage of lactation, or between pregnancy and lactation.

TABLE 25.1
RESTING METABOLIC RATE OF ADULTS

Subject	# Obs	Kcal/min S.D.	Kcal/d S.D.	Kcal/kg S.D.	Kcal/cm S.D.
Adult males	565	1.11 ± 0.22	1601 ± 310	24.59 ± 5.06	9.64 ± 1.82
Adult females:					
NPNL	399	0.92 ± 0.16	1324 ± 231	22.34 ± 4.12	8.59 ± 1.45
Tri I	63	0.88 ± 0.17	1266 ± 239	23.08 ± 4.39	8.27 ± 1.54
Tri II	115	0.90 + 0.18	1296 ± 258	22.35 ± 4.39	8.44 ± 1.61
Tri III	140	0.93 ± 0.18	1344 ± 254	22.36 ± 4.08	8.86 ± 1.56
Lact. 0-3 mo	146	0.89 ± 0.16	1275 ± 231	22.47 ± 3.92	8.37 ± 1.47
Lact. 3-6 mo	127	0.89 ± 0.15	1281 ± 212	22.86 ± 4.21	8.40 ± 1.35
Lact 6-8 mo	128	0.90 ± 0.14	1294 ± 208	23.06 ± 3.81	8.48 ± 1.29

TABLE 25.2
RESTING METABOLIC RATE OF WOMEN FOLLOWED LONGITUDINALLY DURING PREGNANCY AND LACTATION (N=35)

Subject	# Obs	Kcal/min S.D.	Kcal/d S.D.	Kcal/kg S.D.	Kcal/cm S.D.
NPNL	33	0.85 ± 0.16	1229 ± 234	22.45 ± 4.12	8.05 ± 1.44
Tri I	39	0.87 ± 0.14	1258 ± 198	24.07 ± 3.85	8.26 ± 1.27
Tri II	43	0.89 ± 0.11	1281 ± 153	23.39 + 3.78	8.39 ± 0.94
Tri III	36	0.94 ± 0.12	1356 ± 172	23.29 ± 3.73	8.90 ± 1.08
Lact. 0-3 mo	38	0.89 ± 0.14	1280 ± 206	22.94 ± 3.22	8.35 ± 1.24
Lact. 3-6 mo	32	0.87 ± 0.16	1257 ± 228	24.13 ± 4.73	8.32 ± 1.49
Lact 6-8 mo	25	0.87 ± 0.14	1248 ± 198	22.49 ± 3.45	8.15 ± 1.21

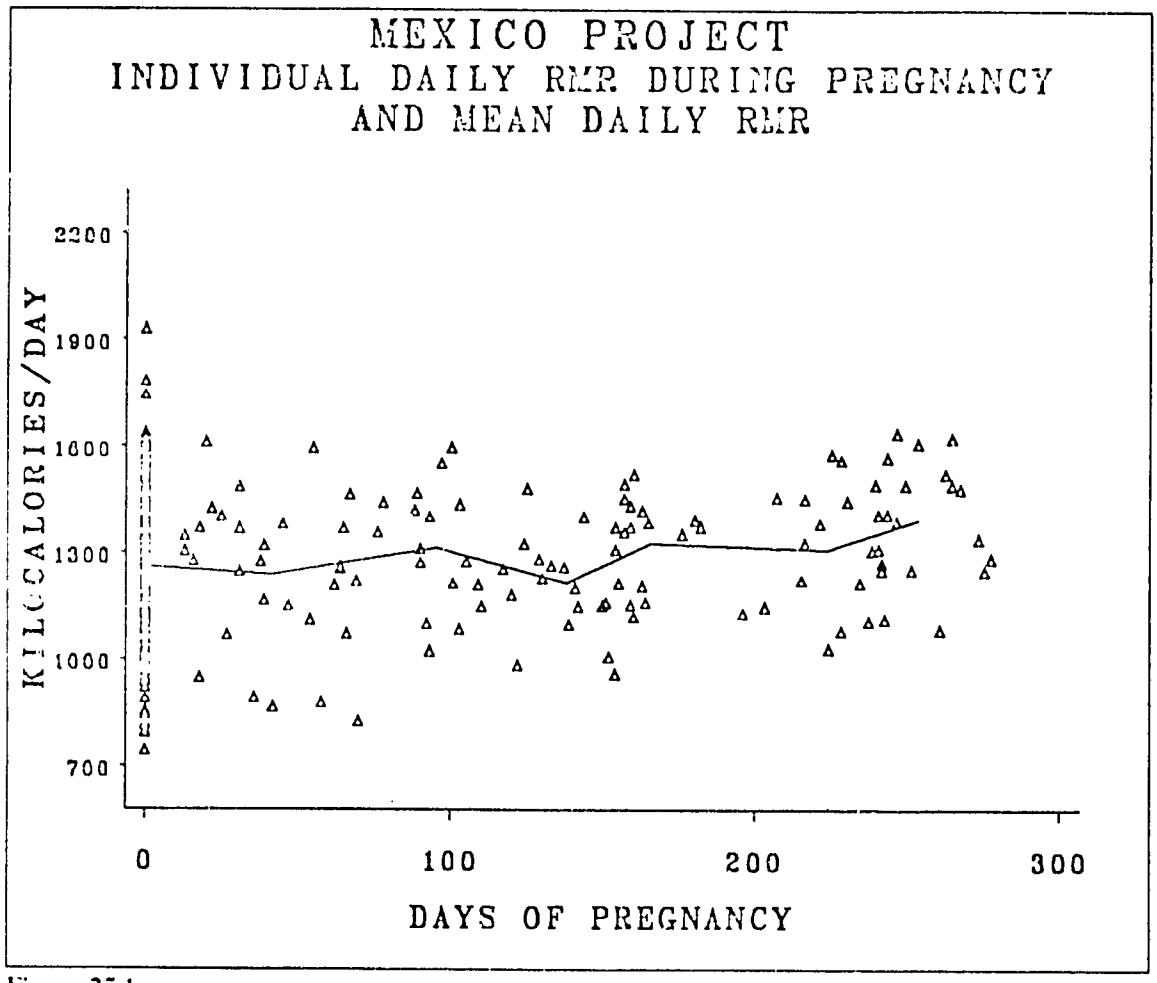
MEXICO PROJECT
INDIVIDUAL DAILY RMR DURING PREGNANCY
AND MEAN DAILY RMR
KILOCALORIES/DAY
2200
1900
1600
1300
1000
700
0
100
200
300
DAYS OF PREGNANCY

Figure 25.1

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Chapter 26

HOUSEHOLD SANITATION AND PERSONAL APPEARANCE

I. INTRODUCTION

The purpose of the household sanitation and personal appearance measures is to capture, in a quantified fashion, household and individual differences in physical appearance and general cleanliness. The concepts of personal cleanliness and appearance of one's physical surroundings may not be "human universals," but they are found widely in human cultures. On the other hand, there are large cultural differences in what is regarded as "clean," "neat," or "fastidious," and there are also striking differences in the value that is placed on achieving or ignoring cultural expectations. The extent to which cultural norms of cleanliness are actually associated with pathogenic exposure is undoubtedly highly variable, particularly since "cleanliness" can be defined in ideological terms of "spiritual or social purity" that have little to do with hygiene in the western sense.

In assessing "cleanliness" and "sanitation" the challenge is to design a method that uses cultural norms and, at the same time, provides some indication of "probable level of hygiene," however crude. The sensitivity to cultural norms is imperative, not least because the observers are being asked to make judgments that inevitably have an element of subjectivity no matter how much effort the investigator makes to train the observers using specific criteria. When the fieldworkers are members of the same, general culture they will use those norms as a matter of course.

Some indicators of hygiene and sanitation can be readily observed or can be ascertained through interviewing. These include items such as source of water, waste disposal, toilet facilities, and so on. Other characteristics, such as whether an individual washes his or her hands after defecating or before preparing meals, are difficult or impossible to observe, and considerable caution is advisable in the interpretation of verbal responses.

Table 26.1 shows the answers men and women in the sample gave to physicians when queried about personal and household hygiene practices. Here we see, for example, that nearly one in five adults claim to brush their teeth daily. However, the dental examinations revealed a very poor state of dental and periodontal health, suggesting that some of the postive responses reflect the respondents' knowledge of what they should do, not what they actually do.

TABLE 26.1
PERSONAL HYGIENE OF ADULTS, AS REPORTED TO PHYSICIANS; PERCENT OF RESPONDENTS

	Adult Women (N = 235)			Adult Men (N = 194)		
Practice	Daily	2-4/ week	1/ week	Daily	2-4/ week	1/ week
Bathing	1.7	79.9	17.9	3.1	47.9	44.3
Washing face	47.0	46.1	5.5	38.7	40.0	18.6
Washing hands	100.0	----	----	99.0	1.0	0.0
Brushing teeth*	18.2	12.8	5.5	16.5	11.9	59.3
Changing clothes	14.4	77.5	8.1	4.1	55.2	36.6
Changing bedding	2.6	14.5	77.4	1.0	13.4	72.2

* 63.6% of the women and 59.3% of the men reported never brushing their teeth.

Similar caution should be exercised in the interpretation of the verbal respones on management of water. Table 26.2 indicates the quality and source of water, as well as its treatment. The assessment of potability is difficult to evaluate, and an argument could be made that none of the water in the communities is safe to drink without some treatment. The claim, by some 20% of women that they boil drinking water is not supported by the experiences of fieldworkers. Consistent water boiling is extremely rare, which is hardly surprising given the high cost of purchased fuel and the time and energy expenditure required to obtain firewood.

TABLE 26.2
HOUSEHOLD WATER SUPPLY AS REPORTED BY ADULT WOMEN TO PHYSICIANS: PERCENT OF RESPONDENTS (N = 234)

	Type of Water	
Water Characteristics	Cooking	Drinking
Origin of Water		
Piped, not potable	71.4	70.9
Well, spring	16.2	17.1
Piped, potable	12.0	11.5
Treatment		
None	82.5	78.2
Boiled	17.1	21.4

II. CONSTRUCTING THE SANITATION AND APPEARANCE SCORES

As described in Chapter 14, a series of observations on environmental and individual appearance and characteristics were made by every project fieldworker at every visit to a household. This yielded a very large number of measures over the course of a year.

In order to construct indices that summarize the multiple measurements, several steps were undertaken, as follows:

1. For each household, the mean for each of the items in the observation protocol was calculated. For example, the preschooler's appearance was rated at each observation on a three point scale: 1 = neat, clean; 2 = average; 3 = dirty, unkempt. An individual child's "appearance score" was calculated as the average of all ratings by all observers.

2. Frequency distributions and descriptive statistics of the households' mean values for each item in the protocol were generated (Table 26.3). The frequency distribution showed that nearly all of the variables had a large range and little skewing. The main exception to this generalization was the observation of "excrement on the floor inside the house." In most houses the observers reported the presence of excrement most of the time.

3. A principal components analysis was carried out with the environmental variables to identify the clusters of highly correlated items. With the exception of trash inside the house, all of the variables loaded on the first factor at a correlation of .68 or greater (Table 26.4).

Based on the results of the statistical exercise it would have been reasonable to construct a single "environmental cleanliness measure." However, the ethnographic data suggested that "internal environment" (within the house) and "external environment" (within the patio) could be culturally, as well as logically distinguished. Therefore, two environmental scales were created--one based on the five external characteristics and a second based on five internal conditions (excluding trash). A household's score for both variables was created by adding the means for each of the items in the scale and multipling the sum by 100. Higher values indicate higher levels of cleanliness.

In addition to the two environmental scores, three measures of personal appearance were created. These consist of the mean values (x 100) of all observations by all observers over the course of the study for the "mother," "preschool child," and "school child." In every household where both preschool and school age children were present, the observers were instructed to record a rating regardless of whether the children were target subjects in the study. As with the environment variables, higher values are associated with greater "cleanliness" of appearance.

As would be expected from the principal components analysis, there is a strong, positive correlation between the internal and external appearance of the household environment. There are also significant associations between personal appearance and household characteristics, as well as with all sanitation and appearance measures and socio-economic status. Table 26.5 shows the matrix of inter-correlations.

TABLE 26.3
DISTRIBUTION OF MEAN VALUES FOR ITEMS ON THE OBSERVATION PROTOCOL (N = 235)

Item	Mean	S.D.	Range
External Characteristics			
Appearance of patio	2.02	0.44	1 - 3
Patio plant waste	3.07	0.57	1 - 4
Patio animal waste	3.08	0.51	1 - 4
Patio trash	3.24	0.49	1 - 4
Patio food waste	3.55	0.34	1 - 4
Internal Characteristics			
Appearance of house	2.11	0.45	1 - 3
Appearance of walls	1.66	0.27	1 - 2
Presence of:			
animal waste	1.86	0.17	1 - 2
food waste	1.77	0.21	1 - 2
trash	1.59	0.26	1 - 2
Appearance of kitchen	2.09	0.44	1 - 3
Personal Characteristics			
Appearance of mother	2.26	0.42	1 - 3
Appearance of preschooler	1.88	0.48	1 - 3
Appearance of school child	1.92	0.47	1 - 3
Appearance of father	2.08	0.46	1 - 3

TABLE 26.4
FACTOR PATTERN FOR HOUSEHOLD CHARACTERISTICS BASED ON PRINCIPAL COMPONENTS

Variable	Correlation with Factor One
Appearance of patio	.92
Patio plant waste	.78
Patio animal waste	.79
Patio trash	.75
Patio food waste	.68
Appearance of house	.93
Appearance of walls	.85
Presence of:	
animal waste	.81
food waste	.86
trash	.14
Appearance of kitchen	.86

TABLE 26.5
CORRELATIONS OF SANITATION AND APPEARANCE VARIABLES*

		(1)	(2)	(3)	(4)	(5)	(6)
(1)	External Scale	-	.72	.66	.58	.63	.20
(2)	Internal Scale		-	.79	.69	.71	.37
(3)	Mother's Appearance			-	.82	.74	.35
(4)	Preschooler's Appearance				-	.71	.37
(5)	School Child's Appearance					-	.36
(6)	SES						-

* All correlations are significant at $p < .01$.

The magnitude of association between the internal and external household appearance scales suggests that household maintenance activities, which are carried out primarily by women, are fairly cohesive; however, the appearance of external environments is affected by factors in addition to women's domestic management, particularly by the level of agricultural and animal husbandry activities. Nonetheless, there is a great deal of variation in the extent to which households keep animals penned outside of the immediate living compound.

There are strong relationships between the appearance scores of family members. The correlation between mothers' appearance and the appearance scores of their school age children is r = .74, while the correlation of preschooler and mother appearance scores is r = .82. The correlation of younger and older children's appearance is r = .71.

There are significant, but more modest associations between the appearance variables and socioeconomic status. The relationship of SES and external environment is the weakest, at r = .20 (p = .004); while internal environment shows an association of r = .37. For personal appearance and SES the values are r = .35 (mothers' appearance) r = .36 (school age children) and r = .37 (preschool children). While it is not possible, with these data, to rule out the possibility that observers confounded SES in their judgments of cleanliness and appearance, the level of the associations indicates that something in addition to, or other than, SES was indeed being measured. One would expect to find some degree of association between the physical conditions of living, personal appearance and economic status not least because greater material resources make it easier to maintain cleanliness.

It is intriguing to affirm in the Solis data something that parents the world over know intuitively -- children are messy creatures, and the more children there are around, the more difficult it is to maintain a clean environment. In the subsample of 96 households in which a preschool child was studied longitudinally, we find significant correlations between the appearance measures and the number of children in the household under 12 years of age. The associations are r = -.31 (p = .002) for both internal and external environment scores. The appearance of mother and child is also affected, with r values of -.32 and -.33, respectively. These relationships appear not to be merely a function of household size because none of the associations with total household size in this subsample reached a level of statistical significance.

The measurement of "quality of child care" is a complex and difficult matter, in part because the concept is subject to a variety of interpretations. Maternal actions that are reflected in the appearance of children and of the physical environment in which they live may be regarded as one component of quality of care. In future analyses we will consider the variables described in this chapter as indicators of maternal caretaking, at the same time recognizing that they tap only a limited range of the broader concept of "care" and also that other factors, in addition to women's activities, influence the physical conditions and appearances of individuals and environments.

Chapter 27

PSYCHOLOGICAL DEVELOPMENT AND COGNITIVE PERFORMANCE

INTRODUCTION

The primary purpose of this chapter is to present a descriptive overview of the psychological data collected from all subjects. Each section begins with a brief discussion of the rationale for selecting the particular dimensions that were examined with respect to the goals of the CRSP research. For the presentation of data, the main criterion that guided the design of the tables was the provision of sufficient detail to enable the reader to obtain a picture of the total results.

While it may be argued that the selection of table and graph formats for data presentation represent "data analysis," it should be stressed that the tables and discussion that follow are not intended as analytic interpretations. Some key features of the results are highlighted, occasionally by reference to other sectors of data. However, such discussions are simply for the purpose of calling attention to aspects of the data that might profitably be explored in the future.

I. PSYCHOLOGICAL CHARACTERISTICS OF INFANTS

A. The Brazelton Neonatal Assessment Scale

Infant neuromotor development at birth is one area in which to investigate the functional consequences of low maternal intake during pregnancy. In earlier decades it was widely believed that neurological maturation was unaffected by intrauterine influences (27.1) However, more recent work has suggested that "retardation of neuromotor maturation occurs during altered pregnancy states and maternal undernutrition" (27.2). Working in Guatemala, Brazelton and colleagues found developmental differences among infants that suggest "effects in utero which may partially limit the baby's potential" and that may also account for "the inadequate responses the infant receives from an already overstressed environment" (27.3).

The Brazelton examination was administered at the Solis clinic to 59 infants in the study. Eighty-eight percent of the testing occurred within the first 4 days of life, while the remaining 7 infants were tested between 5 and 28 days. Table 27.1 provides descriptive statistics on the 52 infants who were tested in the first 4 days. In the table, the first seven variables are the scores for the clusters developed by Lester and colleagues (27.4).

TABLE 27.1
BRAZELTON NEONATAL ASSESSMENT SCALE
INFANTS IN SOLIS

Variable	Mean S.D.	Range
Habituation	6.2 ± 1.3	3.2 - 8.7
Orientation	4.1 ± 1.7	1.1 - 7.6
Motor Performance	4.6 ± 0.9	2.4 - 6.5
Range of States	4.0 ± 0.9	1.7 - 5.7
Regulation of States	6.1 ± 1.1	4.2 - 8.2
Autonomic Stability	5.4 ± 1.4	2.3 - 8.0
Reflex Score	1.6 ± 0.7	1.0 - 3.0
Processes of Interaction	2.2 ± 0.6	1.0 - 3.0
Motor Processes	1.9 ± 0.4	1.0 - 3.0
Control of States	2.1 ± 0.7	1.0 - 3.0
Response to Stress	1.5 ± 0.7	1.0 - 3.0

B. Social-Emotional Characteristics at Three and Six Months of Age

As described in the methodology section above, data for the assessment of infant social-emotional characteristics were elicited in a structured situation in which the mother was asked to hold her infant on her lap and play with the child. During the observation period, the psychologist coded both infant and maternal behaviors. Table 27.2 presents the results, first for infants, then for mothers.

While most of the infant and mother behaviors show a large spread in the distribution of values, there are a few that occur so rarely that the response range is quite limited. By comparing the data at three and six months, it is apparent that some of the distributional pattern is explained by developmental maturation. For example, as might be expected, infants at three months of age show a very low laughter response, while at six months it is a very common behavior. Yawning is a rare response in the three month olds, as is frowning, whereas fussing is very common in the later period. For mothers, variability is reduced with respect to looking, touching, and playing because it occurs so frequently. It should be noted that the categories selected for Table 27.2 were selected heuristically for the purpose of presenting data in this report. In future analysis some of these behaviors can be treated as continuous variables.

TABLE 27.2
MOTHER-INFANT INTERACTION: SOCIAL-EMOTIONAL CHARACTERISTICS
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)*

Behavior Item Observed	Three Months (n = 94) (Percent of Observation Time) 0	1-9	10-24	25-49	50+	Six Months (n = 96) (Percent of Observation Time) 0	1-9	10-24	25-49	50+
INFANT										
Looking at mother	22	13	18	19	28	21	20	19	28	12
Smiling	42	17	27	12	2	29	22	34	12	3
Vocalizing	24	26	26	17	7	36	18	33	6	7
Laughing	90	9	1	--	--	--	--	--	8	92
Yawning	76	19	5	--	--	29	22	34	12	3
Frowning	73	15	7	6	--	36	18	33	6	7
Fussing	56	13	19	9	4	--	--	--	8	92
Moving	19	15	25	18	23	29	22	34	12	3
Squirming	52	13	22	9	4	36	18	33	6	7
MOTHER										
Looking at infant	--	--	--	2	98	--	--	--	8	92
Smiling	42	17	27	12	2	29	22	34	12	3
Vocalizing	26	26	17	7	36	18	33	6	7	
Touching	--	--	--	2	98	--	--	--	8	92
Moving infant	42	17	27	12	2	29	22	34	12	3
Imitating	24	26	26	17	7	36	18	33	6	7
Playing	--	--	--	2	98	--	--	--	8	92

*Values represent percent of the sample which exhibited specific behaviors. Columns are ranges of proportion of time observed in the behaviors. For example, for three month olds, 22 percent of the infants never looked at the mother during the observation period, while 28 percent of the children spent at least 50 percent of the observation period looking at the mother. Similarly, only two percent of the infants were observed to be smiling during 50% of more of the observation period.

II. PSYCHOLOGICAL CHARACTERISTICS OF PRESCHOOL CHILDREN

A. The Bayley Mental and Motor Scales and the Infant Behavior Record

The figures in Table 27.3 provide descriptive statistics for both the Mental and Motor Scales, using the simple additive scoring system described in Chapter 15.

The table also shows the results for two components of the Infant Behavior Record, which is based on the ratings of the test administrator. The two factor scores are the cognitive factor and the extraversion factor.

TABLE 27.3
BAYLEY INFANT DEVELOPMENT SCALES AT 18, 24 AND 30 MONTHS

Measure	18 Months (n=94) Mean ± S.D. (Range)	24 Months (n=117) Mean ± S.D. (Range)	30 months (n=96) Mean ± S.D. (Range)
Mental Score*	21.3 ± 5.3 (9 - 39)	30.7 ± 7.9 (15 - 50)	42.8 ± 7.4 (19 - 56)
Motor Score*	5.3 ± 2.8 (0 - 12)	8.2 ± 2.5 (0 - 13)	11.9 ± 3.6 (0 - 18)
Cognitive	24.3 ± 7.6 (0 - 40)	28.1 ± 6.0 (12 - 43)	32.3 ± 4.7 (19 - 43)
Extraversion	11.5 ± 4.6 (0 - 23)	13.4 ± 4.1 (3 - 23)	16.3 ± 3.9 (5 - 23)

*Sum of items passed (It should be noted that the total number of items presented to the child is greater at 24 and 30 months than at 18 months. See Chapter 15 for a description of items.)

The results show a considerable increase in all components as children mature. This is seen not only in the mean scores but also in the range; with the exception of the Motor Score, the lower limit increases with age. However, it should be noted that even at the age of 30 months there were no children in the sample who passed all of the items on either the Mental or Motor Scales. On the other hand, there were quite a few who passed the "highest" item as defined by the standardized scoring procedure.

B. Social-Emotional Characteristics and Mother-Child Interaction

While the Bayley examination involves characteristics that have been more traditionally examined in studies of the relationship of malnutrition to psychological development, the data derived from the structured toy play situation are intended to measure social emotional traits and interaction modes. Tables 27.4 through 27.9 present data on 8 dimensions for the preschoolers and 9 characteristics for their mothers.

TABLE 27.4
SOCIAL EMOTIONAL CHARACTERISTICS AT 18 MONTHS; N=94
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME) *

Behavior Item Observed	Percent of Observation Time				
	0	1-9	10-24	25-49	50+
Constructive Play	3	3	14	29	51
Fantasy Play	44	25	19	9	3
Looking at Mother	18	36	36	10	-
Talking	26	24	30	19	1
Smiling	-	48	29	21	2
Playing Together	33	30	15	17	6
Seeking Help	85	11	4	-	-
Crying	58	26	12	3	-

*The numbers in the rows refer to the proportion of children in the sample, whereas the columns represent percent of time the child is observed exhibiting a particular behavior.

TABLE 27.5
SOCIAL EMOTIONAL CHARACTERISTICS AT 24 MONTHS; N=117
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Behavior Item Observed	Percent of Observation Time				
	0	1-9	10-24	25-49	50+
Constructive Play	1	1	10	21	67
Fantasy Play	52	19	14	12	3
Looking at Mother	35	39	19	7	1
Talking	26	31	23	16	4
Smiling	49	35	12	3	1
Playing Together	34	25	28	9	5
Seeking Help	89	9	2	-	-
Crying	74	21	4	2	-

TABLE 27.6
SOCIAL EMOTIONAL CHARACTERISTICS AT 30 MONTHS; N=96
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Behavior Item Observed	Percent of Observation Time				
	0	1-9	10-24	25-49	50+
Constructive Play	-	3	10	14	75
Fantasy Play	45	17	21	14	3
Looking at Mother	39	30	20	6	4
Talking	32	23	20	18	6
Smiling	65	20	12	3	-
Playing Together	51	18	20	9	2
Seeking Help	85	10	5	-	-
Crying	90	5	4	-	-

TABLE 27.7
MOTHERS' SOCIAL EMOTIONAL CHARACTERISTICS FOR 18 MONTH OLDS
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Behavior Item Observed	Percent of Observations				
	0	1-9	10-24	25-49	50+
Constructive Play	2	2	11	31	54
Fantasy Play	56	21	14	9	-
Contingent Responsivity	67	20	9	4	-
Looking at Child	6	19	21	40	15
Talking to Child	-	2	26	45	26
Smiling at Child	33	36	21	10	-
Demonstration with Verbalization	34	23	22	16	4
Coaxing	26	31	25	15	2
Commanding	40	22	21	11	7

TABLE 27.8
MOTHERS' SOCIAL EMOTIONAL CHARACTERISTICS FOR 24 MONTH OLDS:
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Behavior Item Observed	Percent of Observation Time				
	0	1-9	10-24	25-49	50+
Constructive Play	1	4	8	33	54
Fantasy Play	63	15	18	4	-
Contingent Responsivity	76	13	7	3	1
Looking at Child	12	13	27	21	27
Talking to Child	1	17	20	30	33
Smiling at Child	42	35	16	8	-
Demonstration with Verbalization	31	33	25	7	4
Coaxing	34	37	20	7	3
Commanding	31	27	26	10	6

TABLE 27.9
MOTHERS' SOCIAL EMOTIONAL CHARACTERISTICS FOR 30 MONTH OLDS
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Behavior Item Observed	Percent of Observation Time				
	0	1-9	10-24	25-49	50+
Constructive Play	2	9	15	23	51
Fantasy Play	62	21	14	4	-
Contingent Responsivity	77	13	9	1	1
Looking at Child	3	13	19	42	23
Talking to Child	1	19	25	33	22
Smiling at Child	54	33	10	3	-
Demonstration with Verbalization	50	26	16	7	1
Coaxing	50	40	9	1	-
Commanding	22	36	27	14	1

The distributions in these tables document a considerable range of variation for most of the variables. As they get older, children show an increase in the proportion of time spent in constructive play; however fantasy play does not increase. There are no changes in the distributions of looking and talking, both of which have a wide range. The proportion of time the child is observed smiling seems to decrease across the year from 18 to 30 months, and there is also some decrease in the percent of time children play together with their mothers. Seeking help from the mother is a very rare

activity at any of the three measurement points. Crying, which is very common at 18 months, is rarely exhibited in the structured play situation by the time the child is 30 months old.

Compared to their children, the mothers show less shift in the distribution of values over time. Constructive and fantasy play remain very constant; contingent responsivity is low throughout. Parallel to those of children, there are large spreads in the values in looking, talking and smiling, which don't change over time. Demonstrating with verbalization occurs about 20% of the time at a rate of 25% or more in the observations of the mothers at 18 months. By the time the child is 30 months old, the proportion of mothers engaging in even this modest level of verbally-assisted demonstration drops to 8%. At 24 months the percent is intermediate between the two other measures. Like demonstrating, coaxing also shows a sharp decline over time. The pattern of values for maternal commanding, which has a wide distribution, does not change between 18 and 30 months.

In addition to the specific items in the preceding tables, a number of other characteristics were assessed during the observation of structured toy play. The psychologists were asked to judge mothers and children on their level of affect and activity. A tape recorder was in operation during the interaction period, and verbal behavior has been coded in terms of a number of variables. Table 27.10 presents the data on activity and affect, as well as the results for verbal behavior.

III. PSYCHOLOGICAL CHARACTERISTICS OF SCHOOL AGE CHILDREN

Previous research on the consequences of malnutrition measured in school children has been primarily focussed on the effects of early malnutrition on later performance, particularly cognitive performance. One typical design is based on a comparison of children with a history of serious undernutrition and a control group of children who have not experienced a diagnosed episode of malnutrition in early life. The results of such studies have been somewhat mixed, with some showing strong effects while others have not demonstrated long-term consequences (27.6). Studies of current undernutrition and cognitive performance in school children are relatively rare in comparison with studies of the effect of early deprivation. There have been even fewer studies of the relationship of intake to noncognitive (social-emotional) aspects of psychological function. The work of Barrett and Yarrow (27.7, 27.8), and Chavez and Martinez (27.9) provide a framework for such studies, as well as evidence that intake is associated with performance in school-age children.

A. Cognitive Performance in School Age Children

The results of cognitive testing are presented in Table 27.11, separated for boys and girls. Mean values are shown for the first testing ("first year") and for the second round of testing ("second year"), which was carried out some 14-17 months later. The subjects in this table are limited to children who were tested twice, so that the comparisons are of the same children at two periods of time.

TABLE 27.10
ACTIVITY AND AFFECT LEVELS OF PRESCHOOLERS AND THEIR MOTHERS

Measure	Age at Observation 18 (n=91) Mean ± S.D (Range)	24 (n=112) Mean ± S.D. (Range)	30 (n=94) Mean ± S.D. (Range)
Child Affect	1.9 ± 0.6 (1 - 3)	2.0 ± 0.7 (1 - 3)	2.2 ± 0.7 (1 - 3)
Mother Affect	1.9 ± 0.6 (1 - 3)	1.9 ± 0.7 (1 - 3)	1.9 ± 0.7 (1 - 3)
Child Activity	1.7 ± 0.5 (1 - 3)	1.6 ± 0.5 (1 - 3)	2.0 ± 0.6 (1 - 3)
Mother Activity	1.8 ± 0.5 (1 - 3)	1.8 ± 0.5 (1 - 3)	1.8 ± 0.6 (1 - 3)
Mother Verbal Conduct	1.9 ± 0.7 (1 - 3)	1.7 ± 0.6 (1 - 3)	1.7 ± 0.6 (1 - 3)
Mother Total Words	174 ± 169 (7 - 908)	122 ± 112 (0 - 626)	102 ± 107 (0 - 619)
Mother Total Times Spoke	60 ± 55 (2 - 290)	48 ± 47 (0 - 282)	41 ± 45 (0 - 240)
Child Total Different Words	2 ± 3 (0 - 18)	3 ± 4 (0 - 34)	7 ± 10 (0 - 53)
Child Total Times Spoke	7 ± 22 (0 - 173)	8 ± 13 (0 - 63)	12 ± 21 (0 - 123)

For several of the test components there is no substantial change in test scores between the first and second testing; neither the mean values nor the range show much change for the Raven's matrices, the digit and vocabulary measures. However, in the block design, arithmetic and mazes tests, the scores are higher in the second round of testing. The attention span measure decreases for both boys and girls, which may simply reflect boredom with the test itself since it has lost its novelty value.

Although the year of schooling separating the first and second testing does not, at first examination, indicate a dramatic effect of exposure to schooling on test performance, it does not preclude the influence of school. In order to assess the relationship of level of schooling to performance, the scores for the first testing were disaggregated by grade in school. At the time of testing the mean age for both boys and girls was 7.6 years, with a standard deviation of 5 months; grade in school, however, ranged from no schooling (8 children) to grade 3 (15 children). The majority were either in first grade (49 children) or second grade (38 children).

When the test scores are examined by grade in school, we find that several of the test components show a clear linear increase with more schooling. For example, scores on digit repetition increase from a mean of 2.8 with no school to 6.4 in grade 3; vocabulary increases from 18.0 with no school to 26.0 in grade 3. Similarly, arithmetic means are 3.1 for children with no schooling while those in grade 3 have a mean score of 9.6, and block design scores increase from 2.0 in the no school category to 9.7 in grade 3. While performance on the mazes is very low for children with no schooling (mean of 5.5), there was no incremental effect of schooling after grade one, in spite of the fact that this measure

TABLE 27.11
SCHOOL-AGE CHILDREN'S COGNITIVE PERFORMANCE

Measure	GIRLS First Test Mean ± S.D. (Range)	GIRLS Second Test Mean ± S.D. (Range)	BOYS First Test Mean ± S.D. (Range)	BOYS Second Test Mean ± S.D. (Range)
Raven's Matrices	12.4 ± 3.9 (4 - 22)	12.5 ± 3.3 (5 - 20)	12.9 ± 4.6 (6 - 24)	13.2 ± 2.7 (7 - 19)
Digit Repetition:				
Forward	3.0 ± 1.4 (0 - 6)	38 ± 1.4 (0 - 6)	3.3 ± 1.3 (1 - 6)	3.6 ± 1.4 (2 - 8)
Backward	1.7 ± 1.4 (0 - 5)	2.2 ± 1.6 (0 - 5)	1.9 ± 1.2 (0 - 4)	2.4 ± 1.3 (0 - 6)
Vocabulary	24.1 ± 5.9 (9 - 39)	24.3 ± 4.7 (8 - 36)	24.4 ± 6.2 (9 - 39)	25.2 ± 4.6 (16 - 35)
Block Design	5.4 ± 5.6 (0 - 28)	7.4 ± 6.7 (0 - 38)	6.1 ± 4.1 (0 - 19)	8.1 ± 6.1 (0 - 27)
Arithmetic	6.4 ± 3.4 (0 - 14)	8.5 ± 3.0 (0 - 14)	7.3 ± 2.5 (2 - 14)	9.2 ± 2.6 (2 - 14)
Mazes	7.0 ± 5.1 (0 - 19)	11.8 ± 6.1 (0 - 24)	12.3 ± 5.6 (2 - 26)	15.1 ± 6.1 (2 - 27)
Attention Span (Crossing Task)	135.0 ± 36.0 (82 - 236)	114.0 ± 26.0 (71 - 185)	128.0 ± 37.0 (70 - 270)	110.0 ± 25.0 (60 - 170)

showed an improvement between the first and second testing. There is no relationship of school grade to performance on the Raven's matrices test, nor on the attention span test except that the 8 children with no schooling did very much better than the rest. There are no differences in attained school grade by boys and girls and no evidence that schooling is preferentially available to boys over girls, or the reverse.

For the interpretation of the results concerning the relationship of schooling to performance it is important to recall that a number of factors influence the attained school grade of the children. Children who are perceived as "slow" may be sent to school somewhat later, while bright children are encouraged to go to school at a younger age. Similarly attained school grade may be affected by intellectual capacity. Another factor to consider is that the value parents place on schooling may simultaneously and independently influence when a child enters school and their test performance.

B. Social/Emotional Characteristics Observed on the Playground

Following the work of Barrett and associates referred to above, one would expect to find differences in social-emotional characteristics of children related to food intake and nutritional status. These associations will be examined in future analyses using the data presented below from the playground observations. In viewing the frequency distributions in the tables, it should be recalled that these are all continuous variables, and the categories used in the tables were based on heuristic considerations of data presentation. The tables are constructed to show the distributions by sex and by first

and second observation periods. There was approximately 14 months on average between the first and second observation period.

TABLE 27.12
PLAYGROUND OBSERVATION: BOYS' BEHAVIOR IN RELATION TO ADULTS
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)*

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Seeks adults	79.8	13.5	4.5	1.1	1.1	83.3	5.6	3.7	5.6	1.9
Does not seek adults	6.7	0.0	0.0	0.0	93.3	9.3	1.9	3.7	7.4	77.8
Seeks physical contact	92.1	1.1	2.2	0.0	4.5	79.6	1.9	0.0	5.6	13.0

* Following the format utilized above for younger children, these tables are constructed with the values indicating the percent of the sample, in columns indicating the percent of observation time the child was observed to exhibit a specific behavior. For example, in Table 27.12, 79.8 percent of the boys did not seek adult attention during the period of observation, while 13.5 percent were coded as "seeks adults" between 1 and 9 percent of the time they were observed.

TABLE 27.13
PLAYGROUND OBSERVATION: GIRLS' BEHAVIOR IN RELATION TO ADULTS
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Seeks adults	55.3	17.3	16.0	0.0	1.3	72.5	17.6	5.9	3.9	0.0
Does not seek adults	1.3	0.0	1.3	1.3	96.0	3.9	3.9	2.0	19.6	70.6
Seeks physical contact	93.3	2.7	1.3	1.3	1.3	76.5	7.8	3.9	3.9	7.8

TABLE 27.14
PLAYGROUND OBSERVATION: BOYS' BEHAVIOR IN RELATION TO OTHER CHILDREN (PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Friendly interaction	1.1	3.4	6.7	10.1	78.7	11.1	7.4	9.3	18.5	53.7
Help/aid	88.8	9.0	2.2	0.0	0.0	94.4	3.7	1.9	0.0	0.0
Physically aggressive	76.4	16.9	5.6	0.0	1.1	74.1	22.2	1.9	1.9	0.0
Verbally aggressive	75.3	19.1	5.6	0.0	0.0	61.1	20.4	14.8	3.7	0.0
Aggressive play	75.3	12.4	2.2	4.5	5.6	61.1	16.7	7.4	1.9	13.0
Meddling	77.5	13.5	7.9	1.1	0.0	83.3	14.8	1.9	0.0	0.0
Domination	61.8	29.2	9.0	0.0	0.0	85.2	14.8	0.0	0.0	0.0
Asks for help or attention	75.3	13.5	5.6	5.6	0.0	88.9	5.6	3.7	1.9	0.0
Defends self	62.9	19.1	9.0	7.9	1.1	87.0	11.1	1.9	0.0	0.0
Submission/ obedience	82.0	9.0	5.6	3.4	0.0	90.7	9.3	0.0	0.0	0.0
"Yes" to request	80.9	15.7	3.4	0.0	0.0	85.2	13.0	1.9	0.0	0.0
"No" to request	88.8	10.1	1.1	0.0	0.0	85.2	13.0	1.9	0.0	0.0
No behavior	83.1	5.6	5.6	2.2	3.4	100.0	0.0	0.0	0.0	0.0

TABLE 27.15
PLAYGROUND OBSERVATION: GIRLS' BEHAVIOR IN RELATION TO OTHER CHILDREN (PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Friendly interaction	0.0	0.0	4.0	13.3	82.7	11.8	5.9	9.8	11.8	60.8
Help/aid	93.3	5.3	1.3	0.0	0.0	94.1	5.9	0.0	0.0	0.0
Physically aggressive	86.7	13.3	0.0	0.0	0.0	94.1	5.9	0.0	0.0	0.0
Verbally aggressive	82.7	17.3	0.0	0.0	0.0	96.1	3.9	0.0	0.0	0.0
Aggressive play	94.7	4.0	1.3	0.0	0.0	88.2	5.9	3.9	2.0	0.0
Meddling	80.0	18.7	1.3	0.0	0.0	82.4	17.6	0.0	0.0	0.0
Domination	77.3	18.7	1.3	0.0	0.0	80.4	17.6	2.0	0.0	0.0
Asks for help or attention	72.0	22.7	4.0	1.3	0.0	90.2	7.8	0.0	2.0	0.0
Defends self	69.3	25.3	4.0	1.3	0.0	92.2	7.8	0.0	0.0	0.0
Submission/ obedience	86.7	6.7	0.0	5.3	1.3	98.0	2.0	0.0	0.0	0.0
"Yes" to request	77.3	18.7	4.0	0.0	0.0	84.3	15.7	0.0	0.0	0.0
"No" to request	93.3	6.7	0.0	0.0	0.0	90.2	9.8	0.0	0.0	0.0
No behavior	81.3	5.3	5.3	5.3	2.7	100.0	0.0	0.0	0.0	0.0

TABLE 27.16
PLAYGROUND OBSERVATION: BOYS'RELATIONSHIP TO PHYSICAL ENVIRONMENT (PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Involved in activity	20.2	7.9	10.1	9.0	52.8	24.1	14.8	11.1	14.8	35.2
Plays with objects	49.4	23.6	7.9	7.9	11.2	61.1	3.7	1.9	5.6	27.8
Destroys objects	84.3	9.0	4.5	2.2	0.0	100.0	0.0	0.0	0.0	0.0
Wanders/ roams	31.5	29.2	25.8	9.0	4.5	29.6	25.9	31.5	11.1	1.9
Isolated physical play	66.3	22.5	9.0	2.2	0.0	68.5	27.8	3.7	0.0	0.0
Imaginative play	66.3	19.1	6.7	4.5	3.4	96.3	1.9	0.0	0.0	1.9
Distracted by outside events	52.8	20.2	21.3	5.6	0.0	88.9	9.3	1.9	0.0	0.0
Just observes	4.5	11.2	12.4	25.8	46.1	20.4	11.1	16.7	24.1	27.8
Inactive	25.8	15.7	29.2	16.9	12.4	31.5	7.4	11.1	14.8	35.2

TABLE 27.17
PLAYGROUND OBSERVATION: GIRLS' RELATIONSHIP TO PHYSICAL ENVIRONMENT (PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Involved in activity	20.0	12.0	13.3	18.7	36.0	33.3	19.6	13.7	11.8	21.6
Plays with objects	62.7	22.7	6.7	4.0	4.0	86.3	7.8	0.0	3.9	2.0
Destroys objects	86.7	10.7	1.3	1.3	0.0	100.0	0.0	0.0	0.0	0.0
Wanders/ roams	24.0	16.0	33.3	26.7	0.0	19.6	29.4	33.3	17.6	0.0
Isolated physical play	89.3	2.7	6.7	0.0	1.3	84.3	9.8	3.9	2.0	0.0
Imaginative play	68.0	24.0	5.3	1.3	1.3	92.2	5.9	2.0	0.0	0.0
Distracted by outside events	40.0	34.7	22.7	2.7	0.0	76.5	11.8	7.8	0.0	3.9
Just observes	2.7	6.7	16.0	21.3	53.3	15.7	13.7	25.5	17.6	27.5
Inactive	18.7	9.3	25.3	24.0	22.7	21.6	7.8	9.8	17.6	43.1

TABLE 27.18
PLAYGROUND OBSERVATION: BOYS' LEVEL OF ACTIVITY
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Low	12.4	2.2	13.5	33.7	38.2	38.9	5.6	9.3	13.0	33.3
Normal	10.1	6.7	19.1	24.7	39.3	13.0	16.7	9.3	11.1	50.0
Very High	36.0	28.1	11.2	18.0	6.7	75.9	14.8	1.9	3.7	3.7
Hyperactive/ agitated	89.9	5.6	3.4	1.1	0.0	100.0	0.0	0.0	0.0	0.0

TABLE 27.19
PLAYGROUND OBSERVATION: GIRLS' LEVEL OF ACTIVITY
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Low	6.7	2.7	9.3	24.0	57.3	23.5	3.9	5.9	19.6	47.1
Normal	6.7	8.0	16.0	34.7	34.7	33.3	9.8	9.8	15.7	31.4
Very High	44.0	21.3	26.7	8.0	0.0	90.2	5.9	3.9	0.0	0.0
Hyperactive/ agitated	94.7	4.0	1.3	0.0	0.0	98.0	2.0	0.0	0.0	0.0

TABLE 27.20
PLAYGROUND OBSERVATION: BOYS' EMOTIONAL STATE
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Very happy	33.7	25.8	22.5	12.4	5.6	68.5	18.5	7.4	1.9	3.7
Anxious	47.2	20.2	14.6	14.6	3.4	92.6	3.7	3.7	0.0	0.0
Hostile	74.2	16.9	5.6	3.4	0.0	79.6	13.0	5.6	1.9	0.0
Sad	84.3	11.2	0.0	1.1	3.4	87.0	1.9	0.0	5.6	5.6
Loses control	87.6	7.9	2.2	2.2	0.0	96.3	1.9	1.9	0.0	0.0
Content	6.7	2.2	9.0	10.1	71.9	9.3	1.9	1.9	20.4	66.7
Animated	77.5	9.0	4.5	5.6	3.4	85.2	13.0	0.0	1.9	0.0

TABLE 27.21
PLAYGROUND OBSERVATION: GIRLS' EMOTIONAL STATE
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	Percent of Observation Time									
	First Year					Second Year				
Behavior	0	1-9	10-24	25-49	50+	0	1-9	10-24	25-49	50+
Very happy	28.0	30.7	26.7	13.3	1.3	58.8	15.7	17.6	7.8	0.0
Anxious	50.7	12.0	21.3	13.3	2.7	90.2	2.0	2.0	2.0	3.9
Hostile	85.3	10.7	2.7	1.3	0.0	94.1	2.0	3.9	0.0	0.0
Sad	84.0	10.7	4.0	1.3	0.0	78.4	3.9	0.0	11.8	5.9
Loses control	96.0	1.3	0.0	0.0	2.7	100.0	0.0	0.0	0.0	0.0
Content	1.3	5.3	5.3	1.3	86.7	13.7	0.0	11.8	9.8	64.7
Animated	90.7	4.0	4.0	0.0	1.3	94.1	3.9	0.0	2.0	0.0

C. Classroom Behavior

As part of the assessment of social characteristics of the school children, observations were carried out in the classroom. As described in the methodology section above, the children's behavior was coded with respect to four characteristics - speaking, playing, off-task and out-of-the-room. Tables 27.22, 27.23 and 27.24 present the frequency distributions for the first three of these variables, separately for boys and girls, at each of the observation periods.

In contrast to the tables above in these tables, the columns refer to the percent of children in the sample, while the rows refer to the proportion of observation time a child was observed speaking (Table 27.22), playing (Table 27.23) or "off task (Table 27.24). This format was adopted to permit comparison of boys and girls at both time periods.

TABLE 27.22
CLASSROOM OBSERVATION OF SPEAKING
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

	First Year		Second Year	
Percent of Observation	Female (N = 55)	Male (N = 57)	Female (N = 51)	Male (N = 50)
0	18.2	15.8	25.5	26.0
1-9	21.8	29.8	37.2	20.0
10-24	40.0	24.6	19.7	40.0
25-49	16.4	24.5	17.6	14.0
50+	3.6	5.3	0.0	0.0

TABLE 27.23
CLASSROOM OBSERVATION OF PLAYING
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Percent of Observation	First Year Female (N = 55)	First Year Male (N = 57)	Second Year Female (N = 51)	Second Year Male (N = 50)
0	54.5	49.1	66.7	58.0
1-9	23.7	22.3	17.6	12.0
10-24	14.5	14.1	5.9	16.0
25-49	5.5	12.2	7.8	10.0
50+	1.8	1.8	2.0	4.0

TABLE 27.24
CLASSROOM OBSERVATION OF "OFF-TASK"
(PERCENT OF SUBJECTS BY PERCENT OF OBSERVATION TIME)

Percent of Observation	First Year Female (N = 55)	First Year Male (N = 57)	Second Year Female (N = 51)	Second Year Male (N = 50)
0	10.9	15.8	23.5	22.0
1-9	16.4	15.8	21.6	12.0
10-24	23.6	22.8	23.5	16.0
25-49	30.9	15.8	19.6	38.0
50+	18.2	29.8	11.8	12.0

IV. COGNITIVE PERFORMANCE IN ADULTS

In spite of the fact that cognitive testing of adults was perhaps the most difficult part of the study to explain and justify to the families in Solis, the vast majority of adults agreed to be tested. Table 27.25 shows the mean values of performance scores in the components of the cognitive battery, in which responses were obtained from 241 lead women and 190 lead men.

Comparing adult men and women, we find that men have a higher upper range in the Raven, digits, block, and arithmetic components. Women exceed men in the attention span test, both in range and mean value. With the exception of attention span, the mean values for men are higher than those for women on all the cognitive measures. A series of paired Student's T tests were calculated to assess these differences. We find that they are all highly significant (p .0001). The performance of adult men is significantly better than that of women for all of the cognitive measures except for attention span, in which the women have significantly higher scores.

Table 27.25
ADULT COGNITIVE PERFORMANCE

Measure	Female (N=241) Mean ± S.D.	Range	Male (N=190) Mean ± S.D.	Range
Raven's Matrices	14.5 ± 4.4	2 - 29	16.6 ± 5.5	7 - 33
Digit Repetition:				
Forward	3.5 ± 1.3	1 - 8	4.0 ± 1.5	0 -10
Backward	2.8 ± 1.5	0 - 6	3.5 ± 1.6	0 - 9
Vocabulary	33.0 ± 6.0	15 - 49	34.3 ± 5.9	15 - 48
Block Design	10.0 ± 6.7	0 - 36	12.9 ± 8.2	0 - 46
Arithmetic	8.1 ± 2.9	0 - 19	9.8 ± 3.6	0 - 25
Mazes	10.6 ± 3.5	0 - 17	12.4 ± 3.7	0 - 17
Attention Span (Crossing Task)	99.0 ± 35.0	45 - 250	85.0 ± 28.0	0 - 239

The explanation for the performance differences between the sexes does not lie simply in the matter of literacy. Approximately the same percent of men and women taking the tests report they are literate (ca. 50%). However, there are differences in the level of achieved schooling, as shown in Table 27.26.

TABLE 27.26
ADULT YEARS OF EDUCATION

Level of School	Male n	(N=190) (%)	Female n	(N=241) (%)
None	38	(20)	57	(24)
1 - 2 years	54	(29)	86	(36)
3 - 6 years	87	(46)	91	(38)
7+ years	11	(6)	7	(3)

When performance scores are compared by level of education, we find that years of schooling relate directly to cognitive performance. There are marked increases in performance scores for all measures, for both men and women, with increasing years of education. Thus, for example, the mean values for men in the Ravens matrices is 13.6 for men with no schooling, 15.2 for 1 - 2 years, 17.7 for 3-6 years and 26.2 for the group with 7 or more years.

As one way of assessing the extent to which male-female differences may be explained by differences in schooling, paired T tests were calculated for each of the test battery components, separately for the level of schooling categories shown in Table 27.26. In the group with no formal education there were no significant differences between men and

women in test performance. In the small group of 11 men and 7 women with more than primary school education, there were also no differences, except for arithmetic in which the men had significantly higher scores than women.

However, for the majority of adults - those with between 1 and 6 years of education - the mean scores for males and females remain significantly different. In the group with 1-2 years of schooling the men had significantly higher performance scores in 5 of the 9 cognitive measures. Among men and women with 3 - 6 years of education, the mean scores for men were higher in 8 of the 9 performance measures. Thus, it appears that other factors are influencing the performance differences between men and women. Undoubtedly, differences in access to information, experience beyond the valley, and opportunities for social interaction, as well as more subtle effects of gender-related self esteem are involved.

Some of these features are readily apparent in the data from the socio-cultural interview schedule. Table 27.27 shows the responses made by men and women to a series of questions aimed at ascertaining level of knowledge about the world in which they live. Some of the questions concerned national affairs and characteristics, while others involved local figures. A comparison of male-female differences shows that for all items, both national and local, a higher (and often much higher) percent of men are able to provide the correct answer.

TABLE 27.27
KNOWLEDGE OF LOCAL AND NATIONAL AFFAIRS:
PERCENT OF RESPONDENTS WITH CORRECT ANSWER

Information Item	Adult Men (N = 240)	Adult Women (N = 252)
Capital of Mexico	34	18
President of Mexico	35	25
Bus fare to Mexico City	18	11
Countries on border	15	5
Ejido leader	27	16
Former president (Mexico)	22	10
State governor	30	22
Town mayor	34	21

In addition to the ethnographic work, there are other quantitative data to confirm the proposition that women in the villages live in a much more restricted environment than do their spouses. This is reflected, for example, in patterns of travel outside of the community. The nearest large market center, a 45 minute bus ride, had been visited at least once in the previous year by 53% of men compared to 24% of women. Thirteen percent of men and 2% of women traveled there at least once a month. The state capital had been visited at least once in the previous year by 48% of men and 18% of women. Travel to Mexico City was also differentiated by sex, for 74% of the men reported they had been to the city in the past year, as compared with 37% of the women respondents. There are no reported differences in attendance at local school or town events, but 27% of the men are active in one or more local organizations (church, school, ejido or village groups) compared with 15% of women.

With respect to media exposure to news, the picture is somewhat mixed. More women than men report listening to radio news (44% to 36%), whereas more men watch television news (30%) compared to women (20%). It is possible that

men have greater access to television, particularly those who migrate to work in Mexico City. The differences in reported newspaper reading are stronger. Twenty percent of the men claim to have read a newspaper in the preceding month, as contrasted with 2% of the women respondents.

Taken together, these findings suggest a general picture of informational restriction in the lives of women in the Solis valley. The significance of this for intake-performance relationships should be explored in future analyses, particularly with respect to interaction with young children.

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Chapter 28

PRESCHOOLER - MOTHER ACTIVITY STUDY

I. INTRODUCTION

This chapter presents preliminary descriptive analyses of the observational data on activity patterns and social interactions collected on 41 target preschoolers (mean age at entry into study = 23 months) and their mothers, and on 3 target pregnant women (100% of the individuals observed for the Preschooler-Mother Activity Study). Hourly spot observations, each followed by 10 minutes of continuous observation, were carried out on each individual from 8:00 AM until 6:00 PM, one day per month for 13 months. The methodology for collection of these data is described in Chapter 16.

Activities were collapsed into activity groups for the purpose of this report. For example, the activities 'active play with objects' and 'active play without objects' were collapsed into 'active play' for preschoolers. The activities 'active child care' and 'teaching children and helping children to learn' were collapsed into 'active child care' for mothers. The majority of the activities observed during household visits had already been collapsed into activity groups when the data were coded. For example, the activities 'washing the child', 'dressing the child', 'combing the child's hair', 'bathing the child', 'spoon-feeding the child', etc. had all been coded as 'active child care' on the code forms.

II. ACTIVITY PATTERNS OF PRESCHOOLERS AND MOTHERS

For purpose of analysis, the frequencies with which individuals were observed to be performing selected activities were calculated. Data were used from the frequency of observation of selected activities in both spot and 10 minute observations of preschoolers and mothers. Only the principal activity of the 10 minute observation is examined in the present analyses. Principal activity is defined as the activity performed for the greatest length of time during the 10 minute segment (based on the judgement of observers).

A total of 143 spot and ten minute observations were scheduled for each mother over a 13 month study period (11 observations per day, one day per month for 13 months). Since some observations were missed, frequencies were calculated as the percent of observations in which the activity was observed to be the principal one. The mean number of observations completed for preschoolers and women was 136 and 134 respectively. A minimum of 93 observations were carried out on each individual studied.

Table 28.1 shows the mean and standard deviation of the percent of observations in which selected activities occurred during both the spot and 10 minute observations. The preschoolers studied were observed 'doing nothing' during an average of 19.3% of the spot observations, and this was the principal activity of 22% of the 10 minute observations. High mean percents are also shown for 'quiet play' (15.6% (spot) and 16.2% (10 min.)). Preschoolers were observed 'walking' during an average of 4.0% of the spot observations. However, 'walking' was the principal activity of only 2.0% of the 10-minute observations. This difference is probably due to the fact that preschoolers observed walking

during the entrance ('spot') observation often discontinued the activity after the observer arrived (the 10 minute segment).

As the data in Table 28.1 indicate, preschoolers were rarely (less than 1% of observations) observed performing other recreational activities, crawling, running, having an accident or being breastfed. Some of these activities might have been observed more frequently as 'secondary activities' during observations, and will be examined in future analyses.

Table 28.2 shows the mean and standard deviation of the percent of observations in which selected activities of the women (including mothers of preschoolers and the 3 pregnant women) were observed during the spot and 10 minute observations. Frequently the women were observed to be carrying out domestic and family maintenance activities (26.6% and 23.8% of the spot and 10 minute principal activity measures respectively) and preparing and distributing food (21.6% of spots and 20.7% of 10 minute observations). They were rarely observed performing health care and sanitation or resting activities (less than 1.5% of the spot and 10 minute observations), and on less than 1% of occasions were they running, travelling (transportation), performing recreational activities, doing craft work or sleeping. Again, the frequency of these activities as 'secondary activities' will be examined.

TABLE 28.1
PRESCHOOLERS: PERCENT OBSERVATIONS IN SELECTED ACTIVITIES (SPOT AND 10 MINUTE PRINCIPAL ACTIVITY MEASURES) (N=41)

	SPOT		10 MINUTE	
ACTIVITY	Mean %	S.D.	Mean %	S.D.
Doing Nothing*	19.3	6.2	22.0	10.1
Interacting Verbally	4.3	3.1	4.1	3.0
Active Play	4.8	3.8	6.0	4.8
Quiet Play	15.6	4.5	16.2	5.2
Other Recreation	0.2	1.8	0.3	1.9
Walking	4.0	2.1	2.0	1.7
Running	0.3	0.5	0.1	0.3
Crawling	0.0	0.2	0.0	0.0
Helping With A Task	6.8	3.9	6.7	4.1
Eating	8.2	3.5	8.5	3.2
Being Breastfed	0.1	0.2	0.1	0.4
Being Changed/Cleaned	1.5	1.1	1.9	1.3
Sleeping	8.3	4.3	8.4	4.4
Having An Accident	0.1	0.2	0.0	0.1
Resting Activities†	2.2	2.1	0.0	0.0

* 'Doing Nothing': the individual was not performing any activity

† 'Resting Activities' include watching television, listening to the radio, lying down to sleep, etc. (when no other activity was being performed concurrently)

TABLE 28.2
WOMEN: PERCENT OBSERVATIONS IN SELECTED ACTIVITIES (SPOT AND 10 MINUTE PRINCIPAL ACTIVITY MEASURES) (N=44)

	SPOT		10 MINUTE	
ACTIVITY	Mean	S.D.	Mean	S.D.
Doing Nothing*	11.7	1.7	0.7	1.0
Interacting Verbally	8.4	4.3	6.4	4.0
Active Child Care	5.2	2.7	5.7	3.3
Passive Child Care	1.5	1.7	1.3	1.4
Breastfeeding	2.4	3.0	2.7	3.2
Domestic Maintenance	26.6	7.3	23.8	7.2
Health & Sanitation	1.3	1.8	1.1	1.6
Prep & Distrib. Food	21.6	8.0	20.7	8.6
Income Generation	1.5	3.0	1.5	2.8
Home Improvement	0.2	0.5	0.2	0.5
Agriculture	3.1	3.7	2.8	3.6
Animal Care	4.5	4.4	4.3	4.2
Walking	1.7	1.3	0.4	0.6
Running	0.1	0.2	0.0	0.0
Transportation	0.0	0.2	0.0	0.1
Recreation	0.0	0.1	0.0	0.0
Craft Work	0.1	0.4	0.2	0.4
Eating	3.2	2.1	3.4	2.5
Sleeping	0.3	0.6	0.2	0.4
Resting Activities†	1.2	1.5	0.9	1.2

* 'Doing Nothing': the individual was not performing any activity

† 'Resting Activities' include watching television, listening to the radio, lying down to sleep, etc. (when no other activity was being performed concurrently)

III. ACTIVITY PATTERNS AND ANTHROPOMETRIC MEASURES

The relationship between the frequency of specific activities and anthropometric measures of preschoolers was examined using Spearman correlations. Mean weight-for-age and length-for-age percentiles were calculated for each preschooler using all measures taken during the study period (these data are shown in Table 28.3). Table 28.4 shows the correlations of these anthropometric variables for preschoolers and the mean percent of occasions that selected activities were observed during the spot and 10 minute observation segments. Significant relationships were found between the percent of occasions in which preschoolers were 'doing nothing', during both the spot and 10 minute observations, and mean weight for age, and length-for-age. Lighter and shorter (for age) preschoolers 'did nothing' with significantly greater frequency. Preschoolers with greater mean weight-for-age participated in quiet play more frequently during spots (p=.10) and significantly more frequently during the 10 minute observations (p=.03). Preschoolers with higher mean length-for-age were also observed in significantly more quiet play during spot (p=.02) and 10 minute observations (p=.00). Heavier and taller preschoolers also interacted verbally more frequently during 10 minute observations (p=.03 and p=.05 respectively). There is a significant positive correlation between the preschooler's mean length-for-age and frequency of 'being changed or cleaned' during the 10 minute observations (p=.03). This may reflect the nutritional status of the caretaker and/or the socioeconomic status of the family. Although not significant, heavier and taller preschoolers were more frequently observed in active play.

IV. ACTIVITY PATTERNS AND DIETARY INTAKE

Tables 28.5 and 28.6 present correlations of frequency of activities with dietary intake of the 41 preschoolers. Intake of energy and protein were averaged for available data on each individual over the entire period of the observational study (shown in Table 28.3). Table 28.5 shows the data on activities observed during the spots. There is no relationship between total intake of kilocalories and activity (with the exception of 'having an accident', which was observed with such little frequency that its significance is questionable). Mean protein intake is correlated only with 'helping with a task' ($r=-.35$, $p=.02$). Preschoolers who were observed in this activity were often following the mother around as she carried out her daily activities, helping her as a young child might (handing her clothes to wash, hang, etc.). "Helping" activity could be interpreted as imitating the mother as she carried out tasks, or as choosing to be with her instead of with other children. There are no significant relationships between any activity and mean kilocalories and mean protein from non-animal sources with the exception of 'having an accident'. Interestingly, significant correlations were found between various activities and both mean kilocalories from animal sources and protein from animal sources. This suggests that dietary quality, and not just quantity, is of importance in terms of the activity of preschoolers.

TABLE 28.3
PRESCHOOLERS AND WOMEN: DESCRIPTIVE DATA ON ANTHROPOMETRY AND DIET DURING STUDY PERIOD

	MEAN	S.D.	RANGE
PRESCHOOLERS (n=41)			
ANTHROPOMETRY			
Wt/age Percentile	10.0	12.2	0.0 - 49.6
Ht/age Percentile	20.1	20.0	0.0 - 87.3
KILOCALORIE INTAKE			
Total (kcal)	1115.4	282.4	522.4 - 1813.9
From animal (kcal)	137.9	112.0	10.6 - 428.8
From vegetable (kcal)	977.4	291.4	480.1 - 1740.5
PROTEIN INTAKE:			
Total protein (g)	33.7	8.4	15.4 - 54.6
Animal protein (g)	9.7	6.9	7 - 29.1
Vegetable protein (g)	24.1	8.2	9.3 - 48.5
WOMEN (n=44)			
KILOCALORIE INTAKE			
Total (kcal)	2551.6	610.3	1587.7 - 4585.0
From animal (kcal)	215.1	179.4	13.3 - 734.8
From vegetable (kcal)	2336.5	607.5	1252.8 - 4318.6
PROTEIN INTAKE			
Total protein (g)	74.2	18.3	50.3 - 129.3
Animal protein (g)	15.8	11.[illegible]	.9 - 49.5
Vegetable protein (g)	58.5	16.5	26.5 - 106.9

TABLE 28.4
PRESCHOOLERS: CORRELATIONS OF ACTIVITY AND MEAN ANTHROPOMETRY DURING STUDY PERIOD (N=41)

	SPOT OBSERVATIONS				PRINCIPAL ACTIVITY OF 10 MINUTE OBSERVATIONS			
	MNWT/AGE		MN LN/AGE		MN WT/AGE		MN LN/AGE	
ACTIVITY	r	(p)	r	(p)	r	(p)	r	(p)
Doing Nothing	-.52	(.00)	-.57	(.00)	-.39	(.01)	-.46	(.00)
Interacting Verbally	.18	(.27)	.27	(.09)	.33	(.03)	.30	(.05)
Active Play	.22	(.17)	.24	(.13)	.25	(.17)	.28	(.08)
Quiet Play	.26	(.10)	.36	(.02)	.34	(.03)	.51	(.00)
Other Recreation	.27	(.09)	.17	(.28)	.27	(.09)	.17	(.28)
Walking	.27	(.08)	.29	(.07)	.13	(.43)	.12	(.45)
Running	.18	(.26)	-.01	(.95)	.07	(.64)	.08	(.61)
Crawling*	-.27	(.08)	-.25	(.11)				
Helping With A Task	-.00	(.99)	-.08	(.60)	.10	(.52)	.05	(.74)
Eating	-.23	(.15)	.05	(.77)	-.20	(.20)	-.04	(.79)
Being Breastfed	-.13	(.40)	.05	(.77)	-.13	(.40)	.05	(.77)
Being Changed/Cleaned	-.17	(.30)	.24	(.12)	.21	(.18)	.33	(.03)
Sleeping	-.04	(.79)	-.00	(.98)	-.04	(.80)	-.01	(.96)
Having An Accident	-.15	(.35)	-.04	(.79)	-.09	(.56)	-.19	(.24)
Resting*	-.02	(.89)	.05	(.76)				

* Never observed as principal activity of 10-minute observations

Referring to Table 28.5, data indicate that preschoolers who received more kilocalories from animal sources were observed doing nothing less (p=.05), and interacting verbally and helping with tasks significantly more frequently (p=.02 and p=.01 respectively). These preschoolers were also participating in active play more often (p=.05). They were also observed being changed or cleaned (cared for physically) on significantly more occasions (p=.01). This supports the hypothesis that the quantity and quality of 'being cared for' may be a reflection of the nutritional status of their caretaker. These preschoolers were also less often observed helping with tasks (p=.03).

Preschoolers who consumed more protein from animal sources were also less frequently observed doing nothing (p=.06) and more frequently observed interacting verbally (p=.02). There was also a tendency for these preschoolers to participate more in active play (r=.27, p=.09). Preschoolers who consumed more protein from animal sources were also observed helping with a task and being changed or cleaned significantly more often (p=.02 and p=.01 respectively).

TABLE 28.5
PRESCHOOLERS: CORRELATIONS OF ACTIVITY DURING SPOT OBSERVATIONS AND MEAN DIETARY INTAKE DURING STUDY PERIOD (N=41)

		MEAN KCAL			MEAN PROTEIN		
ACTIVITY		TOTAL	Animal	Vegetable	TOTAL	Animal	Vegetable
Doing Nothing	r	.04	-.31	.16	-.03	-.29	.22
	(p)	(.81)	(.05)	(.32)	(.86)	(.06)	(.17)
Interacting Verbally	r	-.03	.37	-.17	.07	.35	-.23
	(p)	(.86)	(.02)	(.29)	(.68)	(.02)	(.15)
Active Play	r	.12	.31	-.01	.19	.27	-.04
	(p)	(.47)	(.05)	(.97)	(.24)	(.09)	(.82)
Quiet Play	r	-.12	.14	-.17	-.01	.13	-.12
	(p)	(.47)	(.38)	(.30)	(.94)	(.41)	(.44)
Other Recreational Activ.	r	-.10	.31	-.22	.04	.29	-.20
	(p)	(.52)	(.05)	(.17)	(.80)	(.07)	(.22)
Walking	r	.16	-.05	.18	.12	-.07	.18
	(p)	(.30)	(.76)	(.26)	(.46)	(.68)	(.27)
Running	r	.05	.15	-.01	.07	.17	-.07
	(p)	(.77)	(.34)	(.95)	(.66)	(.28)	(.65)
Crawling	r	.14	-.05	.15	.10	-.02	.12
	(p)	(.40)	(.74)	(.34)	(.54)	(.91)	(.47)
Helping With A Task	r	-.17	-.39	-.01	-.35	-.39	-.03
	(p)	(.29)	(.01)	(.93)	(.02)	(.01)	(.84)
Eating	r	.29	-.03	.29	.27	-.01	.29
	(p)	(.07)	(.84)	(.06)	(.08)	(.97)	(.07)
Being Breastfed	r	-.04	-.18	.03	-.22	-.18	-.07
	(p)	(.78)	(.27)	(.88)	(.17)	(.25)	(.65)
Being Changed Or Cleaned	r	-.13	.38	-.28	-.00	.35	-.30
	(p)	(.40)	(.01)	(.08)	(1.00)	(.02)	(.06)
Sleeping	r	.20	.01	.19	.23	.04	.20
	(p)	(.20)	(.94)	(.23)	(.14)	(.79)	(.20)
Having An Accident	r	.36	-.14	.41	.27	-.10	.36
	(p)	(.02)	(.38)	(.01)	(.08)	(.55)	(.02)
Resting Activities	r	-.01	-.05	.01	.01	-.04	.05
	(p)	(.95)	(.74)	(.94)	(.95)	(.79)	(.78)

TABLE 28.6
PRESCHOOLERS: CORRELATIONS OF PRINCIPAL ACTIVITY OF 10 MINUTE OBSERVATIONS AND MEAN DIETARY INTAKE DURING STUDY PERIOD (N=41)

ACTIVITY		MEAN KCAL TOTAL	MEAN KCAL Animal	MEAN KCAL Vegetable	MEAN PROTEIN TOTAL	MEAN PROTEIN Animal	MEAN PROTEIN Vegetable
Doing Nothing	r	.11	-.24	.20	.02	-.25	.22
	(p)	(.51)	(.12)	(.22)	(.92)	(.12)	(.16)
Interacting Verbally	r	-.18	.41	-.33	-.02	.42	-.37
	(p)	(.26)	(.01)	(.03)	(.88)	(.01)	(.02)
Active Play	r	.16	.37	.01	.23	.35	-.06
	(p)	(.31)	(.02)	(.93)	(.15)	(.02)	(.71)
Quiet Play	r	-.12	.09	-.15	-.06	.07	-.13
	(p)	(.47)	(.56)	(.36)	(.70)	(.65)	(.44)
Other Recreational Activi	r	-.10	.31	-.22	.04	.29	-.20
	(p)	(.52)	(.05)	(.17)	(.80)	(.07)	(.22)
Walking	r	.08	.15	.02	.13	.12	.03
	(p)	(.62)	(.35)	(.90)	(.42)	(.45)	(.85)
Running	r	.07	.04	.05	.08	.02	.07
	(p)	(.66)	(.81)	(.74)	(.61)	(.92)	(.66)
Helping With A Task	r	-.11	-.31	.01	-.27	-.30	-.03
	(p)	(.49)	(.05)	(.95)	(.08)	(.05)	(.87)
Eating	r	.27	-.07	.29	.27	-.02	.30
	(p)	(.09)	(.65)	(.07)	(.08)	(.90)	(.06)
Being Breastfed	r	-.10	-.18	-.02	-.30	-.19	-.14
	(p)	(.55)	(.26)	(.88)	(.06)	(.23)	(.37)
Being Changed Or Cleaned	r	-.18	.46	-.35	.02	.44	-.34
	(p)	(.26)	(.00)	(.02)	(.88)	(.00)	(.03)
Sleeping	r	.18	.01	.17	.21	.04	.18
	(p)	(.25)	(.97)	(.28)	(.20)	(.82)	(.26)
Having An Accident	r	.23	.16	.17	.22	.14	.11
	(p)	(.14)	(.33)	(.30)	(.16)	(.38)	(.49)
Resting Activities	r	-.05	-.01	-.05	-.04	.01	-.05
	(p)	(.74)	(.96)	(.76)	(.83)	(.93)	(.77)

Table 28.6 shows the correlations between dietary intake and frequency of activities during the 10 minute observations of preschoolers. Again, there are no significant correlations between total intake of kilocalories or protein. However, total kilocalories and total protein from animal sources correlates significantly with various activities. The influence of dietary quality is again suggested. Preschoolers who received more kilocalories from animal sources were observed doing nothing less frequently (r=-.24, p=.12). Although not significant, this may be an important relationship considering the size of the sample (n=41). These preschoolers also interacted verbally and participated in active play significantly more frequently (p=.01 and p= .02 respectively). They were also observed helping with a task and being changed or

cleaned significantly more (p=.05 and p=.00 respectively) during the course of the study. Again, the latter may be a reflection of the nutritional status of the caretaker. The significant relationship between dietary intake and participation in 'other recreational activities' should be interpreted with caution because of the low frequency of such activities (see Table 28.1).

Preschoolers who consumed more protein from animal sources were observed 'doing nothing' less frequently (r=-.25, p=.12), interacting verbally more frequently (p=.01), participating in more active play (p=.02), and helping with a task (p=.05) and being changed or cleaned more often (p=.00) during the 10 minute observations. Finally, preschoolers who consumed more kilocalories from non-animal sources were observed interacting verbally and being changed or cleaned less frequently (r=-.03 and p=.02 respectively). Preschoolers who consumed more protein from non-animal sources were also observed in these activities less frequently (p=.02 and p=.03 respectively). Very few correlations were found between the consumption of kilocalories or protein from non-animal sources and frequency of specific activities in the spot (Table 28.5) or 10 minute observations (Table 28.6). This might be explained by the fact that all children eat similar amounts of non-animal foods.

Tables 28.7 and 28.8 show correlations of activity and dietary intake data collected on the 44 mothers studied. As with the preschooler dietary data, mean dietary intake of the women was also calculated for the study period (shown in Table 28.3). Table 28.7 shows the data on activities observed during the spots. The activity 'doing nothing' is significantly correlated with several of the intake variables measured. Women who were more often observed 'doing nothing' consumed less total kilocalories (p=.01) and total protein (p=.01) and less kilocalories from animal (p=.05) and from non-animal (p=.05) sources. These women were also consuming less protein from animal and non-animal sources (r=-.27, p=.08 and r=-.25, p=1.0 respectively). In short, these women were eating less of everything. The data also show that women who were more frequently observed performing active child care consumed more total kilocalories (r=.21, p=.16) and significantly more protein (p=.05). They also consumed more kilocalories and protein from animal sources (r=.29, p=.06 and r=.27, p=.08 respectively). Women who consumed more total kilocalories were also observed breastfeeding a child more often (p=.01). There is also a positive correlation between total intake of protein and percent observation of breastfeeding (r=.33, p=.03). The intake of kilocalories and protein from non-animal sources also correlated positively with percent observation of breastfeeding (p=.00). Women who consumed more kilocalories from animal sources were observed performing more income generating activities (p=.00). Similarly, women who received more protein from animal sources were also observed performing more income generating (p=.01) and animal care activities (p=.06). There is a negative correlation between mean kilocalorie and protein consumption from non-animal sources and percent observation of women performing income generating activities (p=.01 and p=.00 respectively).

Table 28.8 shows correlations between dietary intake and the principal activity during the 10 minute observations of women. Again, the activity 'doing nothing' is significantly correlated with several of the intake variables. Women who were more frequently observed 'doing nothing' consumed less total kilocalories (p=.05), less total protein (p=.02) and less kilocalories (p=.02) and protein (p=.02) from animal sources. As in the spot observations, women who performed more active child care during the 10 minute observations also consumed more total protein (p=.02) and kilocalories and protein from animal sources (p=.01 and p=.02 respectively). Although not statistically significant, there was also a tendency for these women to have consumed more total kilocalories (r=.25, p=.10). Women consuming more total kilocalories and more total protein were also more frequently observed 'breastfeeding a child' (p=.00 and p=.01 respectively) and 'eating' (p=.05 and p=.05 respectively). Women consuming more kilocalories and protein from animal sources were more frequently observed performing income generating activities (p=.00 and p=.00 respectively). Finally, mean kilocalorie and protein intake from non-animal sources is again positively correlated with breastfeeding a child (p=.00 and p=.00 respectively) and negatively correlated with participation in income generating activities (p=.01 and p=.01 respectively). The effects of confounding variables, such as physiological status of the mother, socioeconomic status of the family and nutritional status of the preschooler, will be examined by multivariate analysis.

TABLE 28.7
OBSERVATIONS AND MEAN DIETARY INTAKE DURING STUDY PERIOD (N=44)

ACTIVITY		MEAN KCAL TOTAL	MEAN KCAL Animal	MEAN KCAL Vegetable	MEAN PROTEIN TOTAL	MEAN PROTEIN Animal	MEAN PROTEIN Vegetable
Doing Nothing	r	-.39	-.30	-.30	-.40	-.27	-.25
	(p)	(.01)	(.05)	(.05)	(.01)	(.08)	(.10)
Interacting Verbally	r	-.12	.08	-.15	-.12	.11	-.22
	(p)	(.43)	(.58)	(.34)	(.42)	(.47)	(.16)
Active Child Care	r	.21	.29	.13	.30	.27	.14
	(p)	(.16)	(.06)	(.40)	(.05)	(.08)	(.35)
Passive Child Care	r	-.11	-.29	-.02	-.15	-.28	.03
	(p)	(.48)	(.06)	(.87)	(.32)	(.07)	(.85)
Breastfeeding A Child	r	.38	-.16	.43	.33	-.14	.46
	(p)	(.01)	(.29)	(.00)	(.03)	(.36)	(.00)
Domestic & Fam Maintenance	r	.04	.04	.03	.04	-.01	.05
	(p)	(.80)	(.81)	(.85)	(.78)	(.96)	(.73)
Healthcare & Sanitation	r	-.12	.04	-.13	-.15	.03	-.19
	(p)	(.43)	(.79)	(.39)	(.34)	(.84)	(.23)
Preparation & Distrib. Food	r	.20	-.21	.27	.11	-.20	.26
	(p)	(.18)	(.17)	(.08)	(.50)	(.19)	(.09)
Income Generating Activ	r	-.25	.47	-.39	-.07	.46	-.41
	(p)	(.10)	(.00)	(.01)	(.64)	(.00)	(.01)
Home Improvement	r	.00	-.01	.01	-.03	.02	-.04
	(p)	(.99)	(.94)	(.97)	(.86)	(.92)	(.79)
Agricultural Activities	r	-.06	-.17	-.01	-.15	-.14	-.06
	(p)	(.70)	(.26)	(.95)	(.3[illegible])	(.36)	(.70)
Animal care	r	-.03	.24	-.10	.07	.21	-.07
	(p)	(.83)	(.12)	(.50)	(.66)	(.18)	(.65)
Walking	r	.02	.04	.00	.02	.03	-.00
	(p)	(.92)	(.79)	(.98)	(.92)	(.87)	(1.00)
Running	r	-.06	.22	-.12	.00	.20	-.14
	(p)	(.71)	(.15)	(.42)	(.98)	(.20)	(.38)
Transportation	r	-.20	.06	-.21	-.21	.06	-.28
	(p)	(.20)	(.69)	(.16)	(.18)	(.69)	(.07)

(Continued)

TABLE 28.7 continued

ACTIVITY		MEAN KCAL TOTAL	Animal	Vegetable	MEAN PROTEIN TOTAL	Animal	Vegetable
Recreation	r	-.12	-.05	-.11	-.15	-.02	-.15
	(p)	(.43)	(.77)	(.48)	(.34)	(.87)	(.34)
Craft Work	r	-.28	-.02	-.27	-.25	-.04	-.25
	(p)	(.07)	(.87)	(.08)	(.10)	(.80)	(.10)
Eating	r	.16	.20	.10	.19	.24	.04
	(p)	(.31)	(.19)	(.53)	(.23)	(.12)	(.80)
Sleeping	r	.04	.06	.03	.09	.07	.05
	(p)	(.78)	(.70)	(.87)	(.56)	(.64)	(.75)
Resting Activities	r	-.21	.23	-.28	-.12	.22	-.29
	(p)	(.17)	(.14)	(.07)	(.44)	(.16)	(.06)

TABLE 28.8
WOMEN: CORRELATIONS OF PRINCIPAL ACTIVITY OF 10 MINUTE OBSERVATIONS AND MEAN DIETARY INTAKE DURING STUDY PERIOD (N=44)

ACTIVITY		MEAN KCAL TOTAL	Animal	Vegetable	MEAN PROTEIN TOTAL	Animal	Vegetable
Doing Nothing	r	-.29	-.35	-.18	-.34	-.35	-.13
	(p)	(.06)	(.02)	(.23)	(.02)	(.02)	(.40)
Interacting Verbally	r	-.18	-.10	-.16	-.22	-.07	-.19
	(p)	(.25)	(.72)	(.29)	(.15)	(.64)	(.21)
Active Child Care	r	.25	.37	.14	.36	.35	.15
	(p)	(.10)	(.01)	(.35)	(.02)	(.02)	(.32)
Passive Child Care	r	-.14	-.25	-.07	-.18	-.24	-.02
	(p)	(.35)	(.10)	(.65)	(.25)	(.11)	(.88)
Breastfeeding A Child	r	.43	-.12	.47	.39	-.10	.51
	(p)	(.00)	(.44)	(.00)	(.01)	(.51)	(.00)
Domestic & Fam Maintenance	r	.05	.13	.01	.08	.10	.02
	(p)	(.76)	(.40)	(.96)	(.59)	(.51)	(.90)
Healthcare & Sanitation	r	-.07	-.03	-.06	-.13	-.03	-.12
	(p)	(.64)	(.87)	(.68)	(.42)	(.86)	(.44)

(Continued)

TABLE 28.8 continued

ACTIVITY		MEAN KCAL TOTAL	MEAN KCAL Animal	MEAN KCAL Vegetable	MEAN PROTEIN TOTAL	MEAN PROTEIN Animal	MEAN PROTEIN Vegetable
Preparation & Distrib. Food	r	.16	-.20	.22	.08	-.19	.23
	(p)	(.31)	(.20)	(.16)	(.59)	(.22)	(.14)
Income Generating Activ.	r	-.24	.47	-.38	-.07	.45	-.40
	(p)	(.11)	(.00)	(.01)	(.65)	(.00)	(.01)
Home Improvement	r	.08	-.03	.09	.02	-.01	.03
	(p)	(.60)	(.83)	(.56)	(.88)	(.97)	(.85)
Agricultural Activities	r	-.03	-.19	.02	-.13	-.16	-.03
	(p)	(.84)	(.23)	(.88)	(.39)	(.30)	(.83)
Animal Care	r	-.05	.19	-.10	.04	.15	-.07
	(p)	(.76)	(.21)	(.50)	(.82)	(.32)	(.66)
Walking	r	.08	-.21	.14	.01	-.21	.16
	(p)	(.61)	(.16)	(.36)	(.93)	(.17)	(.29)
Transportation	r	-.15	.12	-.19	-.14	.10	-.23
	(p)	(.33)	(.42)	(.22)	(.35)	(.50)	(.13)
Craft Work	r	-.27	.05	-.29	-.23	.00	-.25
	(p)	(.07)	(.76)	(.06)	(.14)	(.98)	(.10)
Eating	r	.29	.19	.24	.30	.21	.19
	(p)	(.05)	(.21)	(.12)	(.05)	(.18)	(.23)
Sleeping	r	-.06	.02	-.07	-.03	.02	-.05
	(p)	(.68)	(.91)	(.65)	(.85)	(.89)	(.76)
Resting Activities	r	-.14	.25	-.22	-.05	.23	-.22
	(p)	(.36)	(.11)	(.16)	(.76)	(.13)	(.15)

V. SUMMARY

Preliminary descriptive statistics on the preschooler - mother activity data found a number of significant correlations between activity patterns, anthropometric and diet intake variables. These data suggest that body size of the preschooler and dietary intake of the preschooler and the mother may be an important predictor of activity patterns. Activity patterns in turn may prove to be an important indicator of nutritional status in the evaluation of individuals and populations.

Chapter 29

INTAKE, GROWTH AND MORBIDITY IN PRESCHOOLERS

I. INTRODUCTION

The relationship between the food intake of preschoolers and their growth and morbidity is one of the central questions investigated by the Nutrition CRSP. This chapter presents in-depth analyses of these relationships.

Three different approaches are used to investigate the association between intake and growth. The first approach uses slopes of weight and length change between 18 and 30 months of age as measures of growth, and compares these to food intake and morbidity data averaged over the same period. The second approach uses attained weight and length at 30 months of age as the outcome measures, and average food intake and morbidity experience during the previous 12 months as predictors of attained size. Finally, an autoregression model is employed to investigate causal relationships, using food intake and morbidity in a previous one or three month period to predict weight and length in the subsequent one or three month period.

A. Intake per Kg Body Weight

It was frequently necessary to express food intake on a per kg body weight basis, e.g. kcal/kg, g protein/kg, etc. Since body weight and food intake measures were rarely taken on the same day, and children grow rapidly, simple linear regressions of weight over time were fit for each preschooler so that body weight could be estimated on each day of food intake. This approach - in which weights are estimated by interpolation between the actual weights of each subject - provides the closest estimate of the weight of each individual child. The approach is preferable to using the same, average sex-specific slope for all preschoolers, since there is large variation among the individual weight slopes.

Initially, weight data from all preschoolers with at least two weight measures between 18 months (547 days) and 30 months (913 days) (N=141) were used to fit the simple regressions, and the resulting slopes (on an annual basis) and intercepts (at 18 months) were obtained. Extreme values of the slopes and intercepts only occurred when there was a combination of the following: a) only a few weight measures on a subject, and b) weight measures that were closely spaced.

In order to judge when the slope and intercept measures were sufficiently stable to permit weight prediction, plots were made of a) weight slope versus the interval between the first and last measures for each subject, b) slope versus the number of weight measures per subject, and c) slope versus the mean square error from the regression model. As a result of these plots, it was decided that slopes and intercepts were acceptable in those preschoolers who had at least two weight measures, when these were separated by 90 days or more. Of the 119 preschoolers that met these criteria, predicted weight at 18 months ranged from 6.04 kg to 13.17 kg, with an average of 9.47 kg. The annual weight change ranged from -3.55 kg per year to 5.81 kg per year, with an average of 2.16 kg per year. (Similar results were obtained when the criterion was at least 182 days between weight measures).

B. Effect of the Interviewer Change on Nutrient Intakes of Preschoolers

Since the interviewer change in January, 1985 resulted in significantly increased estimates of energy and protein intake in three of the five communities participating at that time (Chapter 20), for the following analyses the decision was made to use only the dietary data obtained after January 1, 1985. Of the 110 preschoolers who were studied between 18 and 30 months of age, 39 entered the study after January 1, 1985 and therefore had 12 months of dietary data collected after the interviewer change. Data from these 39 children who had intake data over a whole year were used in analyses of the relationship between food intake and the annual slope of growth. However, for testing relationships between growth and morbidity, and growth and maternal characteristics, with dietary variables excluded, analyses used data from all 110 children studied between 18 and 30 months of age. Finally, for examining the relationship of food intake to attained size, and in the autoregression models, all data collected after January 1, 1985 were used. As long as there were at least four measures of food intake, and the child was weaned, the child was used as a subject in the analyses.

II. APPROACH 1. RELATIONSHIP OF WEIGHT AND LENGTH SLOPES TO INTAKE AND MORBIDITY

A. Introduction

A simple way to characterize growth over time is the rate of change of weight and length. This section examines the relationship between intake, morbidity, and annual weight or length slopes. The hypothesis to be tested is that:

> The slope of weight and/or length between 18 and 30 months of age is related to food intake and/or morbidity experience during the same period of time.

The subjects are preschoolers who met the following criteria: were between 18 and 30 months of age; had at least two measures of weight separated by at least 90 days; or, two measures of length separated by at least 90 days; had at least 4 intake measures after Jan 1, 1985; and, had data on morbidity, maternal age, and anthropometry.

Data on preschooler anthropometry, intake, and morbidity were summarized in terms of analysis variables and control variables.

B. Variables

1. Anthropometry Variables

Analysis variables for preschooler anthropometry include the average weight (length), and slope of weight (length) (expressed on an annual basis and estimated from simple linear regressions). Control variables for anthropometry include the preschoolers age at average weight (length) measure, the number of days between the first and last weight (length) measure, the number of weight (length) measures, and the square root of the mean square error (RMSE) from the linear regression of weight (length) on age. The RMSE is included as an indicator of the variability in the growth rate of individual children during the 12 month period.

2. Intake Variables

Analysis variables for intake were constructed as average daily intake during the 18-30 month age period. Only measures of intake made after January 1, 1985, and after weaning, were used in estimating the average intake of each individual. Variables used in the following analyses include:

i) kcal/day, g protein/day,
ii) kcal and protein per kg body weight, with weight estimated on the day of food intake by simple regression of weight against time,
iii) kcal and g protein from animal sources (explained in Chapter 6)
iv) % kcal and % protein from animal sources.

Control intake variables included the preschooler's age at average intake measure and the number of intake measures.

3. Morbidity Variables

Morbidity analysis variables include the ratio of days ill over days observed, for the following illnesses: total illnesses, diarrhea, fever, acute lower respiratory, acute upper respiratory (excluding runny nose), and runny nose. It should be remembered that these morbidity variables are estimates of days ill, etc. (Chapter 22). Control morbidity variables are: the number of days of morbidity collection, the average age at morbidity measure, and the number of months in which morbidity was measured.

C. Number of Subjects

A total of 110 preschoolers were in the longitudinal subset for possible inclusion in the analysis, of which 95 remained, after setting the criteria of two measures taken at least 90 days apart, for both weight and length. An additional two preschoolers were excluded from the length analyses because the RMSE of their length slopes was 1,000, a value twice as high as that of the other individuals. Presumably, the high variability of these regressions was due to measurement error on one or more of the length measures.

Analyses of weight and length slopes will be presented separately. Weight and length slopes were not significantly correlated ($r = 0.19$, $p = 0.07$), although mean weight and mean length were highly correlated ($r = 0.83$, $p < 0.001$). The correlation of weight and length was slightly higher among females ($r = 0.24$, $p = 0.11$) than males ($r = 0.12$, $p = 0.43$). The weight slopes were not significantly different by sex ($p = 0.52$), although the length slopes showed evidence of a sex effect ($p = 0.046$), with females growing faster than males.

Analyses of annual weight slopes are presented first, followed by analyses of length slopes.

D. Annual Weight Change

TABLE 29.1
ANNUAL WEIGHT CHANGE OF MALE AND FEMALE PRESCHOOLERS

(kg/yr)	Mean	S.D.	Median	Min	Max	25th %ile	75th %ile
All	2.13	.98	2.18	-0.67	3.93	1.41	2.92
Male	2.06	.98	2.04	-0.67	3.91	1.39	2.87
Female	2.19	.98	2.23	-0.35	3.93	1.78	3.00

As shown in Table 29.1, using the weight change data of males and females combined, the mean annual weight change was 2.13 kg/year, with a range of -0.67 to 3.93 kg/year. Negative slopes were estimated for only one male and one female subject. Females grew significantly faster than males.

There were on average 11.6 weight measures per subject (range 4 to 17 measures). The median number of days between the first and last weight measurement was 309, and all subjects had at least 190 days between their first and last weight measures.

1. Correlations of Weight Slope with Age

The average age at weight measure was calculated for each subject. The median age across all subjects was 24.7 months, and ranged from 22.9 months to 27.3 months. There was no evidence of differences in slopes by age at weaning. Correlations were calculated for weight slope with mean weight, average age at the time of weight measurement, interval between first and last weight measure, number of weight measures and root mean square error (RMSE) of a regression of weight on age. Correlations with mean weight and mean age at measurement were statistically significant at the 0.05 level, with the strongest relationship being that between the RMSE and weight slope (Table 29.2).

TABLE 29.2
CORRELATION OF WEIGHT SLOPE WITH MEAN WEIGHT AND AGE AT WEIGHT MEASURE, INTERVAL BETWEEN FIRST AND LAST WEIGHT MEASURE, NUMBER OF WEIGHT MEASURES, AND RMSE OF SLOPE. (N=95)

Variable	r	p
Mean Weight	.19	.06
Mean Age	.22	.03*
Interval between 1st and last wt.	-.17	.09
Number of weight measures	-.14	.18
Root MSE	-.32	.001*

* $p < 0.05$

These results indicate increasing weight slope with increasing average age at time of weight measurement, and suggest that the rate of change of weight may increase with age. The relationship of weight slope with age was still present controlling for mean weight ($p = 0.05$), supporting the hypothesis that weight slope increases with age, and that the increase cannot be explained simply by the faster growth of larger children.

It also appears that larger children are growing at a faster rate; controlling for mean age at measurement, this relationship between mean weight slope and mean weight remained significant.

2. Effect of Age at Weaning on Weight Slope

There was no significant correlation between the age at weaning and weight slope when male and female data were combined, or analyzed separately.

3. The Variability of Weight Change and Annual Slope

Weight slope was negatively correlated with the root mean square error (RMSE) of a regression of weight on age ($r = -0.33$, $p = 0.001$). A scatter plot of weight slope versus RMSE (Figure 29.1) illustrates that preschoolers with more variable weight have a lower rate of annual growth. This relationship remained significant, even with control in multiple regression analyses for number of weight measures, number of days from first to last weight, sex, and average age at weight measure. A possible explanation for this relationship is that the more erratic growth patterns are caused by morbidity, which in turn results in poor growth. This hypothesis is examined later in this chapter.

FIGURE 29.1. PLOT OF ANNUAL WEIGHT SLOPE VS RMSE

Legend: A = 1 obs, B = 2 obs, etc.

```
WT. SLOPE
 (kg/yr)

1   4 +        A  A      A
8     |          A  B A               A
-     |        BABB B         B
3     |       A  D AB  C           A
0     |       BBB   CB  A   B A A
    2 +      A   DBA  BA  A  A  A A
m     |           ABBAA   A A    A                    A
t     |            AAA B     A   AA   A
h     |          B       A A  B               A
      |            AA
a   0 +                    A   A
n     |               A
n     |                           A
u     |
a     |
l  -2 +
      -+-------+-------+-------+-------+-------+-------+-
       0       100     200     300     400     500     600
```

Square Root of Mean Square Error of Linear Regression of Weight on Age

4. Correlations of Weight Slope with Maternal Age and Size.

Correlations of maternal age, maternal head circumference, maternal length, and maternal weight with preschoolers weight slope were all non-significant (p >.20). This suggests that maternal age and size had little influence on the increase in preschoolers' weight between 18 and 30 months of age.

5. Descriptive Analysis of Food Intake Data

Table 29.3 describes the average intakes of weaned preschoolers used in the slope analyses, between 18 and 30 months of age. As explained above, all data were collected after January 1, 1985. Simple t-tests of male-female values for all intake variables showed that there were no significant sex differences in intake. For this reason, the following analyses used combined male and female data.

On average, 19.9 diet measures were made on each subject (range 7 to 26), at an average age of 24.7 months (range 22.7 to 28 3 months). The mean intake was 104 kcal/kg, with only 13.6 % of the energy coming from animal sources. (This is very close to the 102 kcal/kg average when all dietary data - including those collected prior to January 1985 - were used on the 95 preschoolers. It is probable that all dietary data are useable from preschoolers, but this remains to be verified). Protein intake averaged 3.2 g/kg.

TABLE 29.3
DIETARY DATA OF PRESCHOOLERS

	AVERAGE INTAKES (N=36)			
	Mean	Min	Max	S.D.
Kcal/d				
Total	1085	624	1664	269
Animal	140	31	443	89
G Protein/d				
Total	33	18	47	8
Animal	10	3	29	6
Kcal/kg				
Total	104	52	162	28
Animal	13.2	3.4	36.2	7.5
G Protein/kg:				
Total	3.2	1.7	4.6	0.8
Animal	0.9	0.3	2.4	0.5
% animal kcal	13.6	3.1	48.1	9.5
% animal protein	29.0	10.0	75.9	15.1

6. Intake by Age and Number of Measures

Correlations were calculated between intake and the number of diet measures, and mean age at diet measure (Table 29.4). Intake from animal sources was higher in those children who had more diet measures, and whose mean age at

measurement was lower. One interpretation of these associations is that younger preschoolers consumed relatively more animal foods than older preschoolers.

TABLE 29.4
CORRELATION OF INTAKE WITH NUMBER OF DIET MEASURES AND MEAN AGE AT MEASURE (N=36)

	# of Diet Measures	P Value	Average Age	P Value
Total kcal	.174	.309	-.039	.820
Animal kcal	.330	.049*	-.270	.111
Protein, g	.213	.212	-.048	.783
Animal protein, g	.336	.045*	-.272	.108
Kcal/kg:				
Total	.242	.156	-.117	.496
Animal	.396	.017*	-.334	.046*
Protein g/kg:				
Total	.299	.076	-.143	.407
Animal	.399	.047*	-.333	.047*
% Animal kcal	.257	.129	-.242	.155
% Animal protein	.281	.097	-.300	.078

* $p < 0.05$

7. Slope and intake

As shown in Table 29.5, there are a number of significant correlations between intake from animal sources and weight slope. The average consumption of energy and protein from animal sources, and the percent of total energy and protein consumed in animal products, were significantly correlated with weight slope. In contrast, neither total energy nor total protein consumed were correlated with the weight slope.

Additional analyses were performed to examine possible relationships of intake with weight slope, controlling for the number of intake measures. The intake of animal kcal and animal protein were positively related ($p = 0.01$) to weight slope, after controlling for the number of diet measures. The same was true of animal kcal/kg ($p = 0.03$) and animal protein/kg ($p = 0.02$), and percent kcal and protein from animal sources ($p = 0.04$ and 0.03 respectively). Similarly, all animal variables were positively related to weight slope, after control for age. Correlations between the other diet variables in Table 29.5 and weight slope remained non-significant, when controlled for number of diet measures and mean age at measurement.

TABLE 29.5
CORRELATIONS OF INTAKE VARIABLES WITH WEIGHT SLOPE (N=36)

	Correlation	p-value
Total kcal	.15	.38
Animal kcal	.37	.02*
Protein, g	.21	.21
Animal protein, g	.39	.02*
Kcal/kg:		
Total	-.04	.83
Animal	.32	.05*
Protein g/kg:		
Total	.00	.99
Animal	.33	.05*
% Animal kcal	.35	.03*
% Animal protein	.35	.03*

* $p < 0.05$

Figure 29.2 provides a plot of weight slope against the intake of animal kcal per kg body weight.

FIGURE 29.2: PLOT OF WEIGHT SLOPE vs ANIMAL KCAL/KG

Legend: A = 1 obs, B = 2 obs, etc.

```
WEIGHT SLOPE
(kg/year)

1    |
8    |
-    |
3 4  +
0    |
     |       A                 A              A
m 3  +           A      B
t    |                A   A     A A                    A
h    |     1        AA     AB          A
   2 +       AA    BA              B
a    |         A           A
n    |        A       A
n 1  +     A      A   A  A         A
u    |             A
a    |        A
l 0  +
     -+-----+-----+-----+-----+-----+-----+-----+-----+--
      0     5    10    15    20    25    30    35    40
```

8. Weight Slope and Social and Environmental Variables

For the group of 36 children that had 12 months of food intake data after January 1, 1985, significant correlations were found between weight slope and the number of teenage women in the household ($r = -0.37$, $p = 0.03$), and between slope and the literacy (literate vs illiterate) of the mother ($r = 0.41$, $p = 0.01$). Thus, the more rapidly growing children had more literate mothers; the growth rates were 2.27 kg/yr for the literate group vs 1.52 kg/yr for children of illiterate mothers. There no significant correlations between weight slope and socioeconomic status, family size, number of children under 12 years, mother's age, or with any sanitation or "appearance" (cleanliness) variables.

Since maternal literacy was strongly associated with the weight slope of the child, the question was whether the correlation might be explained by the poorer diets of children in households with less literate women. The intakes of energy and protein from animal sources were found to be correlated with socioeconomic status ($r = 0.44$, $p = 0.009$ for energy and $r = 0.42$, $p = 0.01$ for protein, respectively), as well as with maternal literacy ($r = 0.36$, $p = 0.03$ and $r = 0.33$, $p = 0.05$, respectively).

There is a dramatic difference in the amount of animal foods consumed by the children of literate (N=26) vs illiterate (N=8) mothers. In the case of animal kcal, mean intake was 159 vs 83 kcal; while for percent of kcal from animal sources, it was 16 vs 7%, respectively.

Multiple regression models were used to test the association between weight slope and animal intake variables, while controlling for the number of diet measures and maternal literacy. Even after controlling for these variables, the following dietary variables were significantly positively related to weight slope: animal kcal ($p = 0.02$), animal kcal/kg ($p = 0.02$), animal protein ($p = 0.01$), animal protein/kg ($p = 0.02$), and the percent kcal ($p = 0.03$) and protein ($p = 0.01$) from animal sources. No other diet variables were related to slope in these models. Thus, both maternal literacy and the intake of animal foods are important correlates of preschooler weight slope.

In the entire sample of preschoolers (N=88), there was a weak negative correlation between weight slope and external sanitation ($r = 0.17$, $p = 0.11$). Length slope correlated with the appearance of the young child ($r = 0.22$, $p = 0.04$). Additional multiple regression models were therefore fit for weight slope vs intake variables in the group of 36 children with dietary data after January 1, 1985, simultaneously controlling for the number of diet measures, external sanitation, and the appearance of the young child. Again, all variables that measured the intake of animal foods remained significantly correlated with weight slope, after controlling for the other variables. Associations with measures of total energy and protein intake remained non-significant.

9. Weight Slope and Morbidity

The following analysis explores the relationship between weight slope and morbidity. Since dietary variables are not included, slopes and morbidity data from the 95 weaned children between 18 and 30 months of age are used in these analyses.

The mean number of days that morbidity data were collected for a subject was 297, with a minimum of 166 and a maximum of 351. In general, the number of days ill reported will underestimate the actual number of days ill in the population, due to the methodology used in the study (as explained in Chapter 22). Thirty seven of the 48 (77%) males and the same number of the 47 (79%) females reported some illness over the year.

Rank correlations of the percent of days ill (i.e. % of days observed that a preschooler was ill) with specific illnesses were evaluated against weight slopes. Rank correlations were used because of the skewness of the morbidity data that occurred because many children had no illness. However, use of simple linear regressions produced a virtually identical pattern of significant associations.

The only illness that was significantly correlated with weight slope was diarrhea; preschoolers with more diarrhea grew less (Table 29.6).

TABLE 29.6
CORRELATIONS OF WEIGHT SLOPE WITH MORBIDITY (N=95)

% of days ill	Correlation	p-value
Total	-.04	.71
Diarrhea	-.27	.007*
Fever	.05	.62
Lower respiratory	-.004	.97
Upper respiratory	-.02	.86
Runny nose	-.005	.96

* $p < .01$

10. Weight Slope and Morbidity--ANOVA

One way analysis of variance was used to examine differences in annual weight slopes for (male) preschoolers who reported an illness vs. those who did not report an illness. The results are summarized in Table 29.7.

TABLE 29.7
MEAN ANNUAL WEIGHT SLOPE BY PRESENCE OR ABSENCE OF ILLNESS SYMPTOMS (N=95)

	Mean Annual Weight Slope (kg/yr)				
	No Symptom		Some Symptom		
Symptom	n	Mean	n	Mean	p-value
Any Illness	21	1.97	74	2.16	0.42
Runny Nose	43	2.10	52	2.15	0.82
Lower Resp.	51	2.10	44	2.16	0.76
Fever	63	2.12	32	2.13	0.96
Diarrhea	54	2.33	41	1.85	0.02*
Upper Resp.	83	2.13	12	2.06	0.82

* $p < 0.05$

Mean weight slopes are lower for those preschoolers who had at least one episode of diarrhea.

It was hypothesized that diarrhea episodes might cause erratic growth, which would be reflected in the estimate of the root mean square error (RMSE) of the linear regression of weight on age. In Table 29.2 above, RMSE was shown to be negatively correlated with weight slope for the entire group of children (N=95), although the correlation was not significant in the smaller group used for diet analyses. To test the hypothesis, RMSE values were tested in a simple linear correlation against the percent of days that each preschooler had diarrhea. The association was significant ($r = -0.36$, $p = 0.03$) in the smaller group (N=36), and remained negative but was non-significant in the larger group (N=95).

An even stronger association was noted between RMSE of weight slope and a number of diet variables, including total kcal and protein, and kcal/kg and protein/kg (all approximately $r = 0.40$, $p = 0.20$). The association was also significant

with some animal intake variables, i.e. animal kcal and protein per kg body weight ($r = 0.28$ and 0.34, $p = 0.09$ and 0.04), but not others such as the total and percentage of kcal from animal sources.

It would therefore appear that diarrhea is associated with less erratic growth (but only in the smaller sample of children), while a higher food intake is associated with more growth variability. There is no obvious explanation for these surprising relationships. However, growth is variable even in healthy, well-nourished children and it is conceivable that diarrhea attenuates this variability.

11. Inter-relationships among Weight Slope, Intake, and Morbidity.

The above analyses show that weight slope is positively related to the intake of animal sources of energy and protein, and negatively related to diarrhea. A multiple regression model was used to examine the effect of animal food intake controlling for the percent of days that a child had diarrhea. All animal intake variables remained significantly correlated with weight slope when controlling for diarrhea. Thus, the relationship between the consumption of animal products and growth cannot be explained by a lower intake of these foods by children with diarrhea. In addition, no significant correlations were found between any diet variable and the percent of days ill with diarrhea.

When diarrhea was expressed as a dichotomous variable (i.e. either the child had diarrhea during the study or he/she did not), a different picture emerges. Controlling for diarrhea eliminates the effect of all the diet variables, suggesting that intake and diarrhea (dichotemized) are sufficiently related so that there is no variance left between slope and intake. The effect of diarrhea on slope is over and above that of intake.

T-tests of the presence or absence of diarrhea against the intake of animal foods show that children who had at least one diarrhea event had significantly less ($p < 0.05$) animal kcal (106 vs 171 kcal/day), animal protein (7.8 vs 12.2 g/day), animal kcal/kg (10 vs 16 kcal/kg), animal protein/kg (0.8 vs 1.1 g/kg), and a marginally lower percentage of kcal (10.9 vs 16.1 %) and protein (24.3 vs 33.2 %) from animal sources ($p < 0.10$). No such differences were seen in the intake of total kcal and protein. One interpretation of the negative relationship between the intake of animal foods and the presence of diarrhea is that children who consume less of these foods are more susceptible to diarrhea, or have environments associated with a greater risk of diarrhea. An alternative interpretation is that children consume less animal foods when they have diarrhea; this explanation is less probable since there was a very small chance that food intake was measured during the actual diarrheal events.

E. Annual Length Change

Table 29.8 illustrates the annual length slopes for male and female preschoolers, separately and combined.

TABLE 29.8
ANNUAL LENGTH SLOPES OF MALE AND FEMALE PRESCHOOLERS

	N	Mean (cm/yr)	S.D.	Median	Min	Max	25th %ile	75th %ile
All	95	8.85	2.63	8.95	3.16	14.91	6.98	10.44
Male	48	8.32	2.63	8.05	3.35	14.07	6.47	10.24
Female	47	9.40	2.54	9.30	3.16	14.91	8.26	10.67

Using the length change data of males and females combined, the mean annual length slope was 8.85 cm/year, with a range of 3.16 to 14.91 cm/year. On average, there were 3.85 (median 4.0) measures per subject, with a range of 3 to 6 measures. The median number of days between the first and last measure was 267 (mean 261), with a minimum of 142 and a maximum of 357 days. Median and mean age at length measure was 24.3 months, with a range of 21.4 to 26.4 months.

The average female slope was significantly greater than that of males. In an analysis of variance, controlling for mean length, mean age at length measure, number of length measures, interval between the first and last measure, and the RMSE of length slope, the sex effect remained marginally significant at $p < 0.10$. Thus, none of the variables tested clearly accounted for the sex difference.

1. Slope and Maternal Characteristics

There was no evidence of correlation of length slope with maternal age or head circumference. Maternal height had a low correlation with length slope ($r = 0.14$, $p = 0.17$), as did maternal weight ($r = 0.16$, $p = 0.12$).

2. Slope and Age, and Number of Measures

Length slope was not significantly correlated with the preschooler's age at the time of mean length measure, the value of mean length, the number of days between the first and last length measure, the number of length measures, or the root mean square error of the regression of length on age (Table 29.9).

TABLE 29.9
CORRELATION OF LENGTH SLOPE WITH MEAN LENGTH, MEAN AGE AT MEASUREMENT, INTERVAL BETWEEN FIRST AND LAST MEASURE, NUMBER OF MEASURES, AND RMSE OF SLOPE LENGTH (N=77)

Variable	r	p
Mean Length	.00	.96
Mean Age	-.06	.60
Interval between 1st and last ht.	-.04	.72
Number of length measures	-.07	.52
Root MSE	-.13	.22

3. Slope and Intake

Intake data have been summarized in Table 29.3. The relationship of intake and length slope was evaluated for the weaned subjects who had 12 months of food intake data after January 1, 1985. As shown in Table 29.10, the relationships between length slope and intake show a similar pattern to those between weight slope and intake (Table 29.5). Again, there is no association between total energy or total protein intake and length slope. There are significant correlations between length slope and the percentage of animal kcal and protein, although the other animal variables show a weaker relationship with length slope than they did with weight slope.

TABLE 29.10
CORRELATIONS OF INTAKE VARIABLES WITH LENGTH SLOPE (N=36)

	Correlation	p-value
Total kcal	-.19	.25
Animal kcal	.29	.08
Protein, g	-.17	.32
Animal protein, g	.27	.11
Kcal/kg:		
Total	-.17	.33
Animal	.27	.11
Protein g/kg:		
Total	-.17	.31
Animal	.25	.15
% Animal kcal	.35	.04*
% Animal protein	.33	.05*

* $p < 0.05$

4. Length Slope and Social and Environmental Variables

In the entire sample of preschoolers (N=95), length slope was correlated with mother's literacy ($r = 0.29$, $p = 0.008$), and with external sanitation of the house ($r = 0.22$, $p = 0.04$). No significant associations were found with any other variables that measured household demographics, socioeconomic status, mother's age, sanitation, or the cleanliness of the mother and children.

Thus, as with weight slope, literate mothers have preschoolers who grow faster than those of illiterate women. Increase in length averaged 9.7 cm/yr for children of literate mothers, compared to 7.7 cm/yr when the mother was illiterate. The significant correlation with maternal literacy persisted even in the smaller group used for diet analyses ($r = 0.35$, $p = 0.04$, $N = 35$).

Controlling for the external sanitation of the household and the appearance of the young child, the only diet variables to be significantly related to length slope were percent of kcal ($p = 0.04$) and percent of protein from animal sources ($p = 0.05$).

5. Slope and Morbidity

There were no significant correlations between the percent of days ill with any illness and length slope (Table 29.11). Table 29.12 also shows a lack of a relationship between morbidity variables and length slope when each illness was coded either as having occurred at least once, or not at all during the period of study. Difference in root mean square error of length measures comparing presence/absence of morbidity was examined, using one way analysis of variance. There were no significant differences in root mean square error for any symptoms.

TABLE 29.11
CORRELATIONS OF LENGTH SLOPE WITH % DAYS ILL (N=95)

% of days ill	Correlation	p-value
Total	-.05	.64
Diarrhea	-.05	.66
Fever	-.07	.52
Lower respiratory	-.10	.33
Upper respiratory	-.02	.86
Runny nose	-.03	.81

TABLE 29.12
MEAN ANNUAL LENGTH SLOPE BY PRESENCE OR ABSENCE OF ILLNESS SYMPTOMS (N=95)

	Mean Annual Length Slope(cm/yr)		
Symptom	No Symptom	Some Symptom	p-value*
Any Illness	8.79	8.87	0.897
Runny Nose	8.76	8.93	0.758
Lower Resp.	8.57	9.17	0.268
Fever	8.99	8.62	0.545
Diarrhea	8.83	8.87	0.948
Upper Resp.	8.86	8.76	0.901

* One way analysis of variance

6. Summary of Slopes Models

There was a large amount of inter-individual variability in both the weight and the length slopes of preschoolers. Children who consumed more animal kcal and protein, and had diets with a higher percentage of animal foods, grew faster as reflected in their higher weight and length slopes, but the association was weaker with length than with weight. Total energy and protein intakes from all sources were not associated with growth in weight or length. Children with more diarrhea had a lower weight slope. When children were categorized according to the presence or absence of diarrhea between 18 and 30 months, it emerged that children who had suffered diarrhea consumed less animal products but not less total energy or protein. However, the percent of days that children had diarrhea was not associated with the intake of animal foods. Length slopes were not related to the presence or absence of diarrhea or to the percent of days ill with this condition.

Weight and length slopes were steeper in the children of more literate mothers, who fed their children more animal products. Neither weight nor length slopes were associated with socioeconomic status, family size variables, or household sanitation and child care scores, except for a positive relationship between external sanitation of the household and length slope.

III. APPROACH 2: RELATIONSHIP OF ATTAINED WEIGHT AND LENGTH AT 30 MONTHS TO INTAKE AND MORBIDITY

A. Introduction

In this analysis, the outcome is attained weight or length at 30 months of age. The hypothesis to be tested is:

> weight and/or length at 30 months of age are related to food intake and morbidity experience during the previous 12 months

B. Variables

1. Anthropometry Variables

Analysis variables for anthropometry include the average weight (length), and the Z score for weight (length) closest to 30 months of age. The Z score, calculated from NCHS standards for age in days (Chapter 7), was used to correct for the age of the child at which the measure was made. A window of ± 45 days from 30 months was permitted. When two or more measures existed within this window, the measure closest to 30 months was used. The age when the measures used in the Z scores were recorded (as number of days difference from 30 months) was used as a control variable.

2. Intake Variables

Analysis variables for intake were again constructed as average daily intake during the 18-30 month age period. Only measures of intake made after January 1, 1985, and after weaning, were used in estimating the average intake of each individual. Variables used in the following analyses were the same as used in the slope model, and include:

i) kcal/day, g protein/day,
ii) kcal and protein per kg body weight, with weight estimated on the day of food intake by simple regression of weight against time,
iii) kcal and g protein from animal sources,
iv) % kcal and % protein from animal sources.

Control intake variables included the preschooler's age at average intake measure, and the number of intake measures.

3. Morbidity Variables

Morbidity analysis variables include the ratio of days ill over days observed, for the following illnesses: total illnesses, diarrhea, fever, acute lower respiratory, acute upper respiratory (excluding runny nose), and runny nose. Control morbidity variables are: the number of days of morbidity collection, the average age at morbidity measure, and the number of months in which morbidity was measured.

C. Number of Subjects

A total of 110 preschoolers were in the longitudinal subset for possible inclusion in the analysis, of which 107 had weight measures within ± 45 days of 30 months, and 102 had length measures.

D. Description of the Z Scores

Analyses of the weight and length data will be presented together. Weight and length Z scores were highly correlated ($r = 0.81$, $p = 0.001$).

TABLE 29.13
Z SCORES FOR WEIGHT AND LENGTH AT 30 MONTHS

	Mean	S.D.	Minimum	Maximum	Mean # Days From 30 Mths
Weight	-1.25	0.90	-3.02	0.98	-18.24
Length	-1.86	1.02	-3.68	0.68	-40.14

Table 29.13 illustrates that on average the children were well below the NCHS standards for weight, and especially for length, at 30 months of age. The attained weight Z was measured on average at 18 days before 30 months (range -41 to +9 days), while length was taken 40 days on average before 30 months (range -90 to +9 days). There was no significant correlation between the attained Z score and the number of days from the child's 30-month birthday, so that time of measurement should not confound the interpretation of the analyses.

E. Correlation of Intake with Attained Weight and Length

The average food intake values for this group of preschoolers are virtually identical to those presented in Table 29.3. There were 85 preschoolers with diet data between the age of 18 and 30 months after weaning, and after January 1, 1985. The mean age at which food intake was measured was 26.0 months. For each child, age at mean date of diet measure was used as a control variable in multiple regression analyses to control for the fact that children were different ages on January 1,1985. Attained weight and length scores were not significantly correlated with age at mean date of food intake measurement. Average energy intakes were 1094 ± 282 kcal/day, and mean protein intakes were 33.1 ± 8.4 g/day.

Table 29.14 shows the correlations of average food intake measures between 18 and 30 months with attained weight and length closest to 30 months.

The associations between attained size and intake are similar to those between growth slopes and intake (Approach I). Total energy and protein intakes were not associated with size at 30 months, but intakes from animal sources were significantly correlated with attained weight and length. An intriguing outcome of analyses presented in Table 29.14 is the strongly negative correlation between attained size, and energy and protein intakes, expressed per kg body weight. In addition, the association between Z scores and the consumption of energy and protein from animal sources changes from a significant positive correlation to one that is non-significant. The following section explores some possible explanations for these relationships.

TABLE 29.14
CORRELATIONS OF INTAKE VARIABLES WITH WEIGHT AND LENGTH Z SCORES

	WEIGHT Z SCORE (N=85) Correlation	LENGTH Z SCORE (N=82) Correlation
Total kcal	-.05	-.07
Animal kcal	.29*	.31*
Protein, g	-.01	-.02
Animal protein, g	-.25†	.25†
Kcal/kg:		
Total	-.38‡	-.36‡
Animal	.17	.20
Grams protein/kg:		
Total	-.33‡	-.33‡
Animal	.11	.11
% Animal kcal	.30*	.30*
% Animal protein	.28†	.27†

* $p < 0.01$
† $p < 0.05$
‡ $p < 0.001$

1. The Relationship Between Current Intake and Body Weight

The first possibility explored was that the negative associations between attained size and kcal or protein intake, expressed per kg body weight, could be explained by the fact that the intake of preschoolers is unrelated to their body weight. If this is so, then expressing intake on a per kg basis would cause the intake of larger children to be artificially low, thus resulting in a negative correlation between intake per kg and size.

Toddlers were grouped by quartiles according to their 18 month weight (and length) and their 24 month weight (and length). These groupings were based on the following classifications:

18 month groups		24 month groups	
Weight (kg)	Length (cm)	Weight (kg)	Length (cm)
<8.85	<72.75	<10	<77
8.85 - 9.40	72.75 - 75	10 -10.5	77 - 79.5
9.40 - 10.14	75 - 77	10.5 - 11.25	79.5 - 82
10.14+	77+	11.25+	82+

The mean intake of each quartile at 18 and 24 months was calculated. The results at 18 months and 24 months were similar, and the 18 month values are shown in Table 29.15.

TABLE 29.15
MEAN INTAKE BETWEEN 18 AND 30 MONTHS BY WEIGHT QUARTILE AT 18 MONTHS

18 month quartile	mean weight (kg)	kcal/day	kcal/kg	animal kcal/day	animal kcal/kg
1	8.1	1179	120	96	9.7
2	9.1	1079	102	108	10.4
3	9.8	1060	97	121	10.9
4	10.9	1087	89	162	13.3

From Table 29.15, it appears that the average daily intake of kcal between 18 and 30 months bears no relationship to weight quartile position at 18 months, whereas the daily intake of animal kcal increases by each quartile. It follows that expressing kcal intake on a per kg basis will produce apparently lower intakes in the larger children and a negative correlation with body size. However, the intake of animal kcal is sufficiently high in the upper quartile children that this variable remains positively associated with size, when expressed on a per kg basis.

The relationships between the food intake variables (as mean intakes for the 18 to 30 month period) and Z scores at 30 months were re-examined, controlling for weight at 18 and 24 months in a regression analysis. The results are presented in Table 29.16, and should be compared with those in Table 29.14.

When the effect of previous size is controlled, there is no longer a negative relationship between kcal and protein intake per kg body weight and attained Z scores. The generally positive associations of animal foods with higher attained size at 30 months persists, especially with attained weight. Although this association is weaker (compared to the analysis in Table 29.14) when previous weight is controlled, there must be some additional contribution of animal food intake to attained size at 30 months, over and above any effect it had on size at 18 months.

TABLE 29.16
SUMMARY P VALUES OF REGRESSION COEFFICIENTS OBTAINED BY ANALYSES OF INTAKE vs 30 MONTH Z SCORES CONTROLLING FOR PREVIOUS WEIGHT AND LENGTH AT 18 AND 24 MONTHS

	30 month weight Z		30 month length Z	
Controlling for	18 mth wt	24 mth wt	18 mth ht	24 mth ht
Kcal/day	0.989	0.898	0.794	+ 0.090
Protein, g/day	0.361	0.510	0.653	+ 0.049*
Kcal/kg	0.152	0.898	0.230	0.404
Protein/kg	0.565	0.700	0.319	0.269
Animal kcal	+ 0.075	0.606	+ 0.046*	+ 0.088
Animal protein	+ 0.048*	0.606	+ 0.064	+ 0.098
Animal kcal/kg	0.179	0.610	0.144	0.185
Animal protein/kg	0.142	0.626	0.209	0.213
% animal kcal	+ 0.044*	0.778	+ 0.099	0.404
% animal protein	+ 0.025*	0.819	+ 0.084	0.455

+ = regression coefficient positive and significant; * $p < 0.05$

The most probable explanation for these relationships is that the size of the children is primarily determined prior to 18 months of age, and that the dietary pattern and quality that is associated with size at 18 months is continued through the 18 to 30 month period. Additional analyses of the importance of size at 18 months are presented in a subsequent section of this chapter.

2. Correlations of Attained Size with Morbidity

This analysis was conducted on data from the 102 preschoolers who had weight Z scores, and 96 who had length Z scores close to 30 months (Table 29.17). From the rank correlations, it appears that the tendency is for children who have more total illness, fever, and runny nose between 18 and 30 months to be heavier and taller at 30 months of age. Diarrhea was not associated with attained size when expressed as % of days ill, nor when scored as the presence or absence of one or more episodes of diarrhea.

While there is no definitive explanation of these relationships between annual morbidity and attained size at 30 months, it bears repeating that size at 30 months is a reflection of growth over 30 months, and that it is predicted by size at 18 months. Thus, the impact of diarrhea between 18 and 30 months on size attained at 30 months may be small and difficult to detect. The role of size at 18 months is explored in the following section.

TABLE 29.17
RANK CORRELATIONS OF WEIGHT AND LENGTH Z SCORES WITH % DAYS ILL

	WEIGHT Z SCORE (N=92)		LENGTH Z SCORE (N=87)	
% of days ill	r	p-value	r	p-value
Total	.16	.12	.29	.006*
Diarrhea	-.03	.78	.11	.30
Fever	.27	.008*	.26	.01*
Lower respiratory	.07	.53	.19	.07
Upper respiratory	.04	.67	.14	.21
Runny nose	.18	.09	.25	.02†

* $p < 0.01$
† $p < 0.05$.

3. The Importance of Body Size at 18 Months of Age

The purpose of the preliminary analyses presented in this section is to determine the extent to which size at 18 months - and environmental variables related to this - explains attained size at 30 months. If there is a strong association between earlier and later size, it will be more difficult to see the effect of morbidity and food intake on attained size at 30 months. Attained size reflects the cumulative experience of the child, and compared to weight and length slopes (examined in the slope models above) or short-term changes in weight or length (used in the autoregression model presented later in this chapter), it will be relatively insensitive to diet and morbidity during the 18 to 30 month period of the child's life.

Weight at 18.0 months was estimated by interpolation from the regression equation derived from subjects' available weight data during the 18-30 month window. The correlation between estimated weight at 18 months and the Z score

for weig[illegible]30 months was 0.68 ($p < 0.001$), while the relationship between length at the same ages and attained Z score for length showed a correlation of 0.77 ($p < 0.001$). Thus, 18 month size is a strong predictor of 30 month size.

Each subjects' weight and length quartiles at 18 months were tabulated against these quartiles at 24 months in order to evaluate the extent of change in quartile position over time. The quartile tables indicated a fair degree of tracking, with about 60% of the subjects maintaining their relative quartile positions between 18 and 24 months. For example, comparing weight quartile at 18 months with weight quartile at 24 months, 19% of 103 preschoolers increased, and 18% decreased their quartile position at 24 months, while the remainder stayed in the same quartile. These quartile variables were used as the indicators in plots of attained weight and length versus intake. Figure 29.3 is a plot of weight Z score at 30 months vs the intake of animal kcal/kg, showing the quartile position of each child at 24 months.

It is apparent from this plot that the relative quartile position at 24 months tends to be retained at 30 months. Those children in the lowest quartiles at 24 months had the lowest intake of animal kcal per kg, and the lowest Z scores at 30 months. A similar pattern was seen for all of the other animal variables, whereas the total kcal and protein values were not associated with either weight quartile at 24 months or Z score at 30 months.

FIGURE 29.3: PLOT OF ANIMAL KCAL/KG vs 30-MONTH WEIGHT Z SCORE, SHOWING WEIGHT QUARTILE AT 24 MONTHS

```
30 MONTH Z

      |
    2 +
      |
      |          4
      |             4
      |      4  4        4                  4        4
    0 +            4  44                        4
      |   3  4 34  4 3                         2  4
      |24 333 343 3    3      3           4  4
      |    232 322 2 3  42   3  2
      |   132 1    2    22      3  2
   -2 +    1 1 12 1 11 22       1
      |      1    1               1
      |    1  1  1  11
      !              1
      |
   -4 +
     -+-----+-----+-----+-----+-----+-----+-----+-----+-
      0     5    10    15    20    25    30    35    40
                       ANIMAL KCAL/KG
```

1 = lowest quartile at 24 months, 2 = next highest quartile etc.

4. Correlations Between Attained Weight and Length, and Environmental Variables

In order to further explore the relationships between food intake, morbidity and attained size at 30 months, a number of other independent variables were tested in simple correlations against the Z scores. Variables that showed no correlation with attained size included: family size, number of adult or teenage women, maternal age, and external sanitation. Those variables that were significantly associated with 30-month Z scores are shown in Table 29.18.

It is evident that those children who are small at 30 months of age are more likely to come from poorer homes, homes with more children under 12 years of age, homes in which the mother is illiterate, and where there is less sanitation and child care.

TABLE 29.18
CORRELATIONS BETWEEN ATTAINED WEIGHT AND LENGTH AT 30 MONTHS WITH ENVIRONMENTAL VARIABLES

Variable	Weight Z (N=86)	Length Z (N=82)
Number of children	-.23*	-.21
Mothers literacy	.25*	.32†
Internal sanitation	.30†	.31†
Socioeconomic status	.31†	.36†
Schooler's appearance	.31†	.32†
Mother's appearance	.34†	.40†
Youngest's appearance	.41‡	.45*

* $p < 0.05$
† $p < 0.01$
‡ $p < 0.001$

The sanitation and appearance variables shown in Table 29.18 were all correlated with each other ($p < 0.001$), so that in future models one of these may suffice to represent the others. Interestingly, a principal component analysis showed that socioeconomic status, literacy, and number of children were correlated with different variables from the sanitation component, indicating that they were measuring different sources of Z score variability.

Table 29.19 provides more detail of the strong associations between conditions in the child's environment and the intake of animal foods.

TABLE 29.19
CORRELATIONS OF ENVIRONMENTAL VARIABLES WITH INTAKE

	animal kcal	animal kcal/kg	% animal kcal	% animal protein
SES	.490‡	.454‡	.521‡	.522‡
Mothers literacy	.252*	.249*	.288*	.331†
Internal sanit	.246*	.204	.257*	.305†
Mother's appear.	.349†	.316†	.322†	.362†
Schoolers appear	.316†	.267*	.319†	.378‡

* $p < 0.05$
† $p < 0.01$
‡ $p < 0.001$

As shown in Table 29.20, an initially contradictory relationship emerged between the number of children in the household and the intake and attained size variables.

TABLE 29.20
CORRELATIONS BETWEEN THE NUMBER OF CHILDREN IN HOUSEHOLD, INTAKE AND 30-MONTH Z SCORES (N=88)

	Weight Z	Length Z	# of children
# children	-.229*	-.208	1.00
Kcal	-.050	-.069	.113
Protein	.006	-.024	.110
Kcal/kg	-.380†	-.364†	.233*
Protein/kg	.332†	-.326†	.250*

* $p < 0.05$
† $p < 0.001$

These correlations might be interpreted as indicating that preschoolers from families with more children are lighter and shorter at 30 months, but consume more energy and protein per kg. While these results appear to be contradictory, they can be explained by the fact that the 18 month weights of the preschoolers from families with more children are already low. As indicated by analyses in the preceding sections of this chapter, on average these smaller preschoolers remain small at 24 and 30 months, but consume the same total kcal and protein per day as larger children. Therefore, between 18 and 30 months there is a negative correlation between daily kcal and protein intake per kg body weight and attained size at 30 months.

Once 18 month weight or 24 month weight was controlled for in multiple regression analyses, there was no relationship between attained weight or length at 30 months and the number of children in the household. Since the number of children was negatively correlated with 18 month weight and length, the effect of the number of children on attained

size must have occurred prior to 18 months of age. Future analyses will attempt to determine whether this is attributable to parity or to worse dietary and environmental conditions in the households with more children.

IV. APPROACH 3: THE AUTOREGRESSION MODEL

A. Introduction

Autoregression models are used here to explore the short-term relationships between weight in the current month and nutrient intake and morbidity in the previous month. For length, a similar model is used to examine the relationship between length in the current three months and intake and morbidity in the previous three months. Longer periods were necessary in the length model because there were fewer length measures on the children. Finally, three-month models were also tested on weight in order to compare the results with those of the three-month length model.

From a biological perspective these models can be conceived of as a way to predict size in the current time period (1 or 3 months) from events (illness and intake) that occurred in the previous time period. Thus, they are an attempt to define a causal relationship between weight (length) and events in the recent past. This contrasts to the previous two approaches described in this chapter, in which we explored relationships with factors that may have had a cumulative effect on growth or attained size over a relatively long period of time, and that may have had their main impact before the time in which our data were collected.

Thus, the autoregression models are regression models where the dependent variable (weight or length) is predicted from a set of other variables, including anthropometry, diet and morbidity in the previous time period. The model assumes that the same relationship applies between adjacent months for all subjects at all times. Among the advantages offered by the autoregression approach is that only two consecutive periods are necessary for observations to be included in the analysis. Also, by treating the observations at consecutive time points as independent observations, the sample size reflects the number of measures made, and not the number of subjects. Controlling for subject effects in these models also controls for cross-sectional variables (such as socioeconomic status and sanitation) in the sense that they cannot be simple confounders of relationships.

Autoregression models were fit for weight and length measures on toddlers in the longitudinal data set. For both weight and length, two models were fit using different sets of the data. One set of data corresponded to all observations on longitudinal subjects, but excluded diet variables. The second set was a subset of the first, including measures when diet was recorded after January 1, 1985. Thus, analyses that included diet variables were performed only on the data set where dietary data had been collected after the interviewer change. The models will be presented first for weight and then for length.

B. Results of the Weight Model

Autoregressive models were developed following the method presented by Rosner et al. (29.1). Data for each subject were summarized as a sequence of months between 18 and 30 months of age, where a month corresponded to a 30 day interval. Within each month, measures of each individual toddler's weight and intake were averaged. Measures of morbidity were also summarized in terms of presence or absence of specific symptoms. Intake and morbidity measures from the previous month were used to predict weight in the current month.

The first model fit for weight included previous month's weight, subject effects, age, and morbidity variables, in addition to a control variable corresponding to the number of days from the actual date of weight measure to the midpoint of the month. Morbidity variables corresponded to presence or absence of reported six symptoms (fever, diarrhea, upper respiratory, lower respiratory, runny nose or other) in the month. The model did not include any diet variables and hence made use of anthropometric and morbidity data over the entire study period. The second model fit for weight included

diet variables in addition to the variables in the first model, and only included observations on weaned toddlers that were taken after January 1, 1985.

1. Results of the First Model

Principal variables in the first model were weight, previous month's weight and previous month's morbidity. On 109 longitudinal subjects, on average weight was recorded for 9.3 months per subject, previous weight for 6.8 months, and morbidity for 9.0 months. For a month to be included in an analysis, not only had weight to be recorded in that month, but also weight and morbidity had to be recorded in the previous month. When this requirement was made, there were on average 7 months of complete data per preschooler in 106 cases. The following analysis is based on these 106 preschoolers who have a total of 740 months of observation.

There were 56 male and 50 female preschoolers. The number of months of observation per subject ranged from 1 to 12, with 74% of individuals having 5 or more months of observation. The data included for analysis were not uniformly distributed over the age period, with 48% of the data collected between age 26-30 months, compared with 25% of the data at ages between 18 and 22 months. Seventy eight percent of the toddlers were weaned prior to 18 months of age. There were at most three weight measures in a given month, with a single weight measure being reported in 71% of the months. More weight measures were reported per month at older ages. Weight measures were made on average 1 day (S.D. = 7.60) later than the midpoint of the month.

Mean weight of this group was 10.93 kg (S.D. = 1.10) compared to the mean weight in the previous month of 10.71 kg (S.D. = 1.10). Average weight change over the one month period was 0.21 kg. Illness occurred in 22% of the months. The symptoms of runny nose were reported in 11% of the months; diarrhea, 7%; lower respiratory, 7%; fever, 4%; and upper respiratory and other illnesses each occurred in 2% of the months.

First, the model examined the effect of previous weight, subject effects, and age in months. The initial model included only previous weight as an independent variable. As expected, this variable was highly predictive of subsequent weight ($p < 0.0001$), explaining 74% of the variance in subsequent weight. Next, subject effects were included in the model, where the purpose of the subject effect was to recognize that different subjects have different mean weights. The subject effect was highly significant ($p < 0.0001$), as anticipated by preliminary models. The combination of previous weight and subject effects explained 80% of the variance in weight. Age (in months) of the toddler was next entered in the model (as a continuous variable) and found to be significant ($p < 0.0001$). (Age (in months) was also added as a categorical variable (using 12 categories), but this did not explain significantly more weight than did the continuous age variable).

The next step in building the model tested whether the relationship between weight and previous weight differed by age. This was implemented by adding an interaction term for previous weight and age. The interaction term was statistically significant ($p=0.03$), although practically unimportant since the proportion of variance explained only increased from 84.9% to 85.0% by inclusion of the interaction.

Other variables were examined for possible interaction with previous weight and age. Sex of the toddler did not significantly alter the relationship of weight with previous weight ($p = 0.64$), nor the relationship with age ($p = 0.34$). The number of days from the date of weight measure to the midpoint of the month was included as a control variable in the regression, and was significantly related to weight ($p=0.0156$), but only increased the variance explained by 0.1% (to 85.1%). The relationship between previous weight and weight in children who were already weaned was stronger than in those who were not ($p = 0.047$), but once again, the proportion of variance explained by the model was changed minimally (increasing to 85.9%).

After these explorations of which variables should be included as independent variables, the relationship between the presence of morbidity symptoms in the previous month and weight in the current month was investigated. The basic autoregressive model included a subject effect, previous weight, age, and a variable to correct for the fact that measures

were not always made at the midpoint of the month. All of these variables were confirmed to be significant ($p < 0.05$), and there was no evidence of interaction of these variables with sex ($p > 0.05$).

Morbidity variables were entered in the model one at a time. A variable was created for each morbidity symptom, with value of '1' if the morbidity symptom was present in the previous month, and '0' if it was not. The results are reported as the regression coefficients from the fitted models, where a negative coefficient indicates lower weight when symptoms were present in the previous month, and a positive coefficient indicates higher weight when symptoms were present in the previous month (Table 29.21).

Diarrhea in the previous month was negatively associated with subsequent weight ($p = 0.0007$). Presence (absence) of any of the other symptoms was not significantly related to subject's subsequent weight. There was no evidence of sex differences in the relationships between morbidity and subsequent weight.

TABLE 29.21
REGRESSION COEFFICIENT ESTIMATES FOR PREVIOUS MORBIDITY AND SUBSEQUENT WEIGHT CONTROLLING FOR PREVIOUS WEIGHT, AGE, AND TIME THAT WEIGHT WAS MEASURED (N = 89 SUBJECTS)

	Regression Coefficient Estimates of Morbidity with Weight (n=740)	
	Coefficient	p-value
Any Illness	-0.047	0.4080
Diarrhea	-0.288*	0.0007
Fever	-0.039	0.7290
Upper Respiratory	-0.250	0.1216
Lower Respiratory	0.059	0.4971
Runny Nose	0.131	0.0784
Other Illness	-0.143	0.3722

* $p < 0.05$

2. Results of the Second Model with Diet Variables Included

The second autoregressive weight model included measures of previous intake in addition to the other variables. This model was fit only to data collected after January 1, 1985, since a change in diet methodology was made at that time, and only on weaned subjects. Weight, previous weight, morbidity, and intake measures were recorded on average for 5.5 months per subject for 89 longitudinal subjects. There were 44 male toddlers and 45 female toddlers. There were 3 or more months of measures in 74% of the subjects, while 59% of them had 5 or more months. Most data were collected for older toddlers, with 52% of the data occurring between age 26-30 months, compared to 21% between age 18-22 months. There were at most 3 weight measures in a given month, with a single weight measure reported 70% of the time. On average, weight measures were made one half day later than the midpoint of the month. Two or more diet measures were made per month 91% of the time, with three or more diet measures reported in 16% of the months.

A total of 492 months of complete data were reported on the 89 toddlers. Table 29.22 summarizes the average weight and nutrient intake data for the group. Symptoms of diarrhea were reported in 8% of the months; fever, 4%; upper respiratory, 2%; lower respiratory, 7%; runny nose, 9%; and other illness, in 1% of the months. Overall, some symptom was reported in 23% of the months.

TABLE 29.22
AVERAGE WEIGHTS, INTAKES, AND MORBIDITY (N = 89 SUBJECTS)

	Mean	S.D.	Min	Max
Weight (kg)	11.11	1.19	8.31	14.23
Previous weight	10.93	1.18	8.25	13.74
Kcal/day	1083	306	628	2387
Protein, g/day	33	9	15	61
Animal kcal	119	96	4	443
Animal protein	8.6	6	0.3	29.2
Percent animal kcal	11.5	9.3	0.3	54.7
Percent animal protein	24.8	14.6	0.8	82.1
Kcal/kg	100	30	49	189
Protein, g/kg	3.0	0.9	1.4	5.3
Kcal from animal/kg	10.9	8.2	0.4	38.7
Protein from animal/kg	0.8	0.5	0.03	2.3

Models for this sample of 89 preschoolers (492 months of data) were fit using the same process as described above for the entire sample. Initial fit to weight included the independent variables of age, subject, previous weight, and a variable corresponding to the number of days from weight measure to the midpoint of the months. As with the larger group of 106 subjects, all of these variables were statistically significant ($p < 0.01$), and hence were included in all subsequent models. Collectively, these variables explained 87.7% of the variation in weight. Morbidity variables were next evaluated for inclusion in the regression equation. A positive coefficient for morbidity indicates an increase in weight in the month following a reported symptom The resulting regression coefficients and p-values are given in Table 29.23. As in the larger group of subjects, only diarrhea in the previous month predicts weight in the subsequent month.

TABLE 29.23
REGRESSION COEFFICIENT ESTIMATES OF MORBIDITY WITH SUBSEQUENT WEIGHT (N = 492 MONTHS).

	coefficient	p-value
Any Illness	-0.091	0.1621
Diarrhea	-0.404‡	0.0001
Fever	-0.069	0.6170
Upper Respiratory	-0.254	0.2097
Lower Respiratory	-0.067	0.5358
Runny Nose	0.167	0.0783
Other Illness	-0.025	0.9147

‡ $p < 0.001$

A second set of auto-regressive models were fit to weight to evaluate the effect of previous intake. The regression model included other independent variables corresponding to age, subject, previous weight, and a variable corresponding to the number of days from weight measure to the midpoint of the month. The resulting regression coefficients for intake (and p-values) are given in Table 29.24. In no case was there a significant relationship between previous intake and subsequent weight. When a variable for sex was included in the model (as an interaction with intake), there was no evidence of a significant sex effect.

TABLE 29.24
REGRESSION COEFFICIENTS FOR MODEL OF SUBSEQUENT WEIGHT WITH PREVIOUS INTAKE CONTROLLING FOR AGE, PREVIOUS WEIGHT, AND TIME THAT WEIGHT WAS MEASURED (N = 492 MONTHS)

	Regression Coefficient	p-value
Kcal/day	0.0001	0.3037
Protein, g/day	0.0046	0.1217
Animal kcal	0.0004	0.2428
Animal protein	0.0047	0.2540
% animal kcal	0.0036	0.3048
% animal protein	0.0010	0.6070
Kcal/kg	0.001	0.3576
Protein/kg	0.043	0.1498
Animal kcal/kg	0.004	0.2720
Animal protein/kg	0.043	0.2885

A final set of autoregression models were fit for previous intake, controlling for presence of previous diarrhea. Although diarrhea remained highly significant in all models, in no case was intake significantly related to weight.

C. Results of the Length Model

The procedures used were similar to those described for the weight model. The main difference was that measures of morbidity and intake from the previous three months were used to predict length in the subsequent three months. The longer time periods were used because there were fewer length measures taken than there were weight measures. Independent variables such as previous weight are also calculated for three month periods.

Following the previous weight example, the entire sample of preschoolers was used in the first model to explore the relationship between previous morbidity and subsequent length. Then a subsample was used in a second model with data collected only after January 1, 1985 to examine the relationship between previous diet and subsequent growth.

1. Results of the First Model.

For a three month period to be included in an analysis, both length and morbidity had to be recorded in the previous period, as well as length in the subsequent period. There were 90 preschoolers (45 male and 45 female) with data that met these criteria, and 195 three-month sets of data. Each child had from 2 to 4 periods of data, with 60% having 2 or 3 periods. On average lengths were measured 1 day prior to the three month mid-point (S.D. = 24.8 days). Mean dif-

ference between months was 2.38 cm. Illness rates (as percent of months in which the symptom occurred) were: diarrhea, 7%; fever, 5%; upper respiratory, 3%; lower respiratory, 6%; runny nose, 12%; and other illness, 1%. Some symptom was reported in 25% of the months.

In the series of models that were fit to examine the effects of independent variables on subsequent length, the significant variables were previous length ($p = 0.0001$, explaining 87% of the variance), subject effects ($p = 0.0001$, explaining an additional 5% of the variance), and age in months ($p = 0.0001$, explaining another 5% of the variance). The total variance in subsequent length explained by these variables was therefore 97%. No other independent variables added substantially to this model.

When this model was used to investigate the effect of morbidity symptoms in the previous period on subsequent length, no significant effects of any illness symptoms were found.

2. Results of the Second Model with Diet Variables Included

There were 73 subjects who had data collected after January 1, 1985, 34 males and 39 females. A total of 140 three-month periods of complete data were available from these children. On average there were 1.08 length measures per period, taken one day (S.D. = 25.7) prior to the middle of the three month period. Mean length was 81.2 (S.D. = 3.1) cm, and mean length in the previous period was 79.1 (S.D. = 3.1) cm. Mean daily intakes were similar to those described for the weight models and Table 29.22, i.e. 1037 kcal, 31 g protein, and 12.2% of kcal from animal sources. Diarrhea symptoms were reported in 5% of the months; fever, 5%; upper respiratory, 1%; lower respiratory, 7%; runny nose, 9%; and other illness, 4 % of the months. There was at least one symptom in 20% of the months. One point was given for each of the three months in which a symptom appeared, for example if diarrhea occurred at least once in each three months of a period, the score would be 3. Thus, each symptom could have a score between 0 and 3.

The independent variables used in the model were the same as those used in the larger group of 90 subjects, i.e. previous length (instead of weight) which explained 90% of the variance, subject effects, number of days from the midpoint of the period, and age in months. These variables together explained 98.1% of the variance in subsequent length. The resulting regressions for intake are shown in Table 29.25.

TABLE 29.25
REGRESSION COEFFICIENTS FOR MODEL OF SUBSEQUENT LENGTH WITH PREVIOUS INTAKE CONTROLLING FOR AGE, PREVIOUS WEIGHT, AND TIME THAT WEIGHT WAS MEASURED (N = 140 PERIODS)

	Regression Coefficient	p-value
Kcal/day	0.0004	0.3649
Protein, g/day	0.0164	0.3087
Animal kcal	0.0026	0.1197
Animal protein	0.0371	0.1320
% animal kcal	0.0312	0.0571*
% animal protein	0.0199	0.0513*
Kcal/kg	0.0043	0.4158
Protein/kg	0.1481	0.3825
Animal kcal/kg	0.0227	0.1761
Animal protein/kg	0.3130	0.2124

* $p < .06$

The only two dietary predictors of length in the subsequent month were the percentage of kcal and of protein from animal sources, although the association is not strong ($p < .06$).

D. Results of a Weight Model Using Three-Month Periods

Since the length model showed an effect of diet quality (percent of kcal and protein from animal foods) on length in the subsequent three months, but the weight model failed to find an effect of diet on weight in the subsequent month, we applied a three-month model to the weight data. The rationale was that one month (2 days) of food intake data may not have been sufficient to estimate usual intake over a month, and one weight measure may not have reflected average weight during a month.

Models were fit as described for the length models above. Subsequent weight was calculated as the mean of all weight measures in the three-month period. There were no significant effects of either diet or morbidity in the previous three months on weight in the subsequent three months.

E. Conclusions from the Autoregression Models

The use of these models permits the following conclusions to be made:

a) diarrhea in the previous month has a negative effect on weight in the subsequent month, whereas no food intake variables predict subsequent weight;

b) diets with a higher percentage of kcal and protein from animal sources predict length in the subsequent three months, but there is no effect of morbidity on subsequent length;

c) neither morbidity nor diet in the previous three months predict weight during the subsequent three months.

The explanation for these apparent inconsistencies probably lies in the biology and timing of the effector and its response. In the first weight model the negative impact of a relatively recent diarrheal event was still detectable in the subsequent month, whereas in the three-month weight model the diarrhea may have occurred up to approximately four months before the mid-point of the next three-month period. This may have been too long for the impact of the diarrhea on weight to be detected. On the other hand, the two days of food intake data that were available in the previous month were probably not sufficient to estimate usual intake during the month, so that the effect of previous month's food intake on subsequent month's growth could not be detected.

In the length model, three-month periods were used. In this case, previous morbidity did not predict subsequent length, which again may be explained by the potentially long period that may have elapsed between an illness and the subsequent length measure. However, using three months of previous diet data was probably sufficient to estimate usual intake and a relationship between diet and subsequent length was detected.

In the final, three-month weight model, the longer time lag between the mid-points of periods may again explain the failure to detect an effect on subsequent weight, but the six days of food intake data should have been sufficient to estimate usual intake. At this point in these preliminary analyses, our hypothesis is that the effect of food intake on subsequent weight is sufficiently small that it can easily be obscured by variability in the weight measure caused by such factors as hydration status, time since the last meal, illness closer to the time of the weight measure, and measurement error. The average monthly increase in weight is about 200 g so that the difference between well-nourished and poorly-nourished children would be extremely hard to detect. This explanation assumes that intra-subject variability in length is smaller than that of weight, which is why the second autoregression approach detected a relationship between previous intake and subsequent length. It may be impossible to detect the effects of both intake and morbidity on subsequent size in the same autoregression model, since intake needs to be measured over a relatively long time, whereas morbidity events should occur as close as possible to the time of subsequent anthropometric measure.

V. SUMMARY AND CONCLUSIONS FROM THE THREE MODELS

The three approaches used here differ in the sensitivity with which they might detect relationships between diet, morbidity and the growth of preschoolers. The slope model compares the average annual dietary and morbidity experience of the child with the average change (growth) in weight and length during the same period of time. Using this approach, the intake of animal products was related to a higher rate of weight growth, and the percent of energy and protein from animal foods was positively related to length change. Diarrhea was the only illness to have a negative impact on weight slope, while no illnesses were related to length slope. Children with lower slopes came from households with less literate mothers but no other environmental variables were strongly associated with the slopes.

The second approach is the least sensitive of the three, both intuitively and based on the results. Attained weight and length at 30 months of age (expressed as Z scores) were used as the outcome variables, and compared to intake and morbidity during the 18 to 30 month period. Again the consumption of animal foods appeared to be important determinants of child growth, since the animal food variables were significantly correlated with both weight and length at 30 months. Strong negative correlations between attained size at 30 months and total energy and protein intake expressed on a per kg body weight basis can be explained by the fact that the smaller children (most of whom were already small by 18 months) have the same intake of energy and protein during the 18 to 30 month period as do larger children. Controlling for weight at 18 months eliminates these negative relationships. Diarrhea had no relationship to attained size, while more total illness, fever and runny nose were associated with higher Z scores.

Several analyses demonstrated the importance of previous size (at 18 months) as a predictor of size at 30 months. The correlation between size at 18 and 30 months is strong, and the majority of preschoolers maintain their weight quartile position at 18 months until at least 24 months of age. Size at 18 months is positively related to the intake of animal products during the subsequent 18 months, suggesting that the higher quality diets of larger children are consumed prior to 18 months as well as during the study period. By 18 months of age it is also apparent that children are smaller if they come from households with more children. By controlling for size at 18 months, the negative relationship between number of children and size at 30 months disappeared. The children with the lowest Z scores come from households that have lower socioeconomic status, poorer sanitation and child care, and a lower intake of animal foods. The effect of these environmental conditions is cumulative over the 30 months of the children's life and the 30-month Z scores reflect that cumulative experience. Nevertheless, the consumption of animal foods remained associated with attained size at 30 months even controlling for size at 18 months.

Finally, the autoregression models represent an attempt to define causal relationships between intake and morbidity in a previous period to weight and length in the subsequent period. One- and three-month periods of time were used. The general picture that emerges is a negative impact of diarrhea in the previous month on the subsequent month's weight, and a positive impact of animal food consumption in the previous three-month period with length in the subsequent three months. Different results were obtained depending on the time intervals used, and these have been discussed in relation to the conflicting requirements of having a sufficiently long period of food intake data so that usual intake can be estimated, as opposed to the need to measure size as soon as possible after a morbidity event if the impact of that event is to be detected.

In general, we conclude that the consumption of animal foods has a positive relationship with weight and length change during 18 to 30 months of age, while the association with diarrhea is negative. Results of the autoregression analyses suggest that food intake and diarrhea are causal factors in explaining growth rate.

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Chapter 30

COGNITIVE PERFORMANCE AND INTAKE IN PRESCHOOLERS

I. INTRODUCTION

This chapter presents a preliminary examination of one of the primary CRSP issues: the relationship between intake and cognitive development. Specifically, the focus of the analyses is on the mental component of the Bayley Scale of Infant Development at 30 months of age, which is used here as the indicator of cognitive development. Performance at 30 months of age was selected as the dependent variable because at that age a child had been followed in the study for 12 months. This feature permits us to introduce a longitudinal component into the analysis.

The preschoolers in this analysis consist of 78 children (38 males and 40 females) in the longitudinal sample, all of whom were weaned prior to 27 months of age. The analysis utilizes "recent dietary intake," which is operationalized as the mean intake for 27-29 months of age--the 3 months preceding the psychological measurement. In this sample, all of the dietary intake measures were collected after December, 1984; that is, after the methodological change in intake procedures was instituted (see Chapter 20).

II. THE DEPENDENT VARIABLE

As described in Chapter 15, the Bayley examination requires children to respond to a series of challenges that reflect their ability to process information and produce appropriate actions, such as identifying and manipulating objects. In other words, it samples a child's cognitive organization. While the Bayley Scales have been used cross-culturally, the standardization for age is based on a U.S. sample. Therefore, for the reasons discussed previously, the scoring system we have adopted is a simple numerical summary of "items successfully passed." Since all of the children were presented with the full battery of items and the age of testing was closely controlled, comparison of the raw scores across the sample is justified.

Table 30.1 shows the mean and range of mental scores for the 78 children in the analyses that follow. While the range of scores for girls is slightly larger, there is no significant difference between the sexes.

TABLE 30.1
MENTAL SCORE AT 30 MONTHS

	N	Mean	S.D.	Range
Males	38	43	(6.5)	31-54
Females	40	43	(6.0)	29-56

III. INTAKE VARIABLES AND MENTAL SCORE

A primary hypothesis relating performance to energy intake can be phrased as follows:

> There will be a positive association between recent energy intake and Bayley mental performance scores.

To test this hypothesis, "recent intake" was calculated as the mean energy intake assessed from the dietary measures taken at 27 - 29 months of age, expressed on a per kilogram basis. Table 30.2 presents the correlation coefficients for this variable (kcal/kg) and the mental score.

TABLE 30.2
CORRELATIONS OF KCAL/KG AND MENTAL SCORES

	n	r	(p)
Males	38	-.22	(ns)
Females	40	-.12	(ns)
Total	78	-.17	(ns)

While the signs on these coefficients are negative (indicating a tendency for higher intake to occur in children with lower scores), none of the correlations are significant. In fact, calculating a regression equation for the total sample yielded an r-square value of .001. Thus, we find that there is no association between recent energy intake and mental performance scores. Children with low intakes do not appear to have lower test scores compared to peers with higher intakes.

When we shift attention from energy to other components of intake, a different picture emerges. Table 30.3 shows the results of regression analyses of two additional dietary variables. The first regression uses the ratio of animal protein (in grams) to total grams of protein in the 3 month average of the children's intake records between 27 and 29 months. The second is the ratio of calories from animal sources to total calories for the same period of time.

TABLE 30.3
REGRESSION MODELS--EFFECTS OF ANIMAL FOOD RATIOS ON COGNITIVE SCORES (N = 78)

Independent Variables	p-value
% Animal Protein (R-SQUARE: = .10; Root MSE = 6.02)	.006
% Animal Kcal (R-SQUARE: = .12; Root MSE = 6.02)	.004

As can be seen in the table, the relationship between the animal intake measures and cognitive performance is positive and highly significant, although the magnitude of the association is modest, accounting for 10 - 12 percent of the variance. The interpretation of these findings is discussed below, after they have been assessed in the context of other variables.

IV. ANTHROPOMETRY AND COGNITIVE PERFORMANCE

While the interpretation of anthropometric data, as an indicator of past nutritional history and current nutritional status, is a complex matter, a child's size at a given time can be regarded as a reflection of the cumulative experiences -- nutritional, medical, and behavioral -- that influence physical development. Since these features may all influence psychological development, both independently and more importantly, interactively, it is important to assess the relationship of cognitive performance to child size. Two hypotheses are proposed for testing:

1) Current body size, measured by the indicators: length-for-age and weight-for-age (at 30 months) will be positively associated with Bayley mental score (at 30 months).

2) Previous body size, measured by the indicators: length-for-age and weight-for-age (at 18 months) will be positively associated with current Bayley mental score (at 30 months).

The thrust of the second hypothesis is to emphasize the continuous nature of development. An assessment at 18 months is a year prior to the 30 month performance measure and is the earliest measure that we have on the preschool children in the sample. Thus, it is of interest to examine the extent to which the child's status at the start of the study predicts later performance.

Table 30.4 shows the correlation coefficients and associated p-values for length and weight measures at 30 months with Bayley mental performance at 30 months, while Table 30.5 presents these associations for anthropometry at 18 months with cognitive performance at 30 months. The correlations are shown for the percentiles and Z score values of the NCHS standards, as well as the raw scores of weight and length.

TABLE 30.4
CORRELATION OF WEIGHT AND LENGTH VARIABLES AT 30 MONTHS WITH MENTAL SCORES AT 30 MONTHS (N = 78)

	Mental Score at 30 Months					
	Total		Girls		Boys	
	r	(p)	r	(p)	r	(p)
Weight	.42	(.0001)	.41	(.01)	.46	(.0001)
Weight Z	.42	(.0002)	.39	(.01)	.47	(.003)
Weight %ile	.40	(.0003)	.40	(.01)	.43	(.007)
Length	.45	(.0001)	.52	(.001)	.40	(.02)
Length Z	.46	(.0001)	.52	(.001)	.40	(.02)
Length %ile	.35	(.003)	.41	(.01)	.36	(.03)

TABLE 30.5
CORRELATION OF WEIGHT AND LENGTH VARIABLES AT 18 MONTHS WITH MENTAL SCORES AT 30 MONTHS (N = 79)

	Mental Score at 30 Months					
	Total		Girls		Boys	
	r	(p)	r	(p)	r	(p)
Weight	.50	(.0001)	.40	(.01)	.63	(.0001)
Weight Z	.47	(.0001)	.40	(.01)	.60	(.0001)
Weight %ile	.38	(.0008)	.36	(.03)	.49	(.002)
Length	.48	(.0001)	.52	(.001)	.46	(.006)
Length Z	.47	(.0001)	.51	(.001)	.42	(.01)
Length %ile	.31	(.008)	.46	(.003)	.32	(.06)

The results of these bivariate analyses are striking. For boys and girls, larger size (length and weight) is associated with better performance.

The level and pattern of association between size at 18 months and mental performance score at 30 months is very similar to the pattern of the concurrent size/performance relationships. We find that for both boys and girls, weight and length at the start of the study predict later performance in a consistent, positive fashion.

Table 30.6 shows that other anthropometric characteristics at the beginning of the study (between 18 and 21 months) are also associated with psychological performance.

TABLE 30.6
CORRELATIONS OF HEAD AND ARM CIRCUMFERENCE AT 18 MONTHS AND 30 MONTH COGNITIVE PERFORMANCE (N = 85)

	Bayley Mental	
	r	(p)
Head Circumference	.29	(.01)
Lower Arm Circum.	.29	(.007)
Upper Arm Circ.	.35	(.001)

Since length and weight are both strongly correlated with scores on the Bayley mental scale and with each other, we tested their potential "substitutability" in analyses that examine body size in relation to other factors. We calculated simple regression models with both length and weight on mental score. In regressions with the mental score as the dependent variable, once either length or weight is in the model, the other variable is nonsignificant.

The following table (30.7) provides another test of the hypothesis linking previous size (length at the earliest measure between 18 and 21 months) with performance at 30 months. Here, regression analysis rather than correlation coefficients are used. The analysis uses the Z score values for length rather than the raw score or the percentile. Use of the raw score was rejected because of the range in age at the time of the initial length measurement. The percentile scores were not used for regression analysis because the distribution is so highly skewed, with more than 50% of the sample below the 3rd percentile.

TABLE 30.7
REGRESSION MODEL--EFFECT OF LENGTH (18 MONTHS) ON COGNITIVE SCORE AT 30 MONTHS (N = 70)

Independent Variable	p-value
Length Z Score	.0001
R-SQUARE: = .22	Root MSE = 6.5

When current length (30 months) is substituted for initial length in this regression equation, the result is virtually identical. Adding the slope of length (growth over the year of the study) failed to contribute new information.

From the results of the regression analysis, we conclude that the conditions that permit a child to grow physically larger also support cognitive growth. To the extent that food intake is a primary factor influencing physical growth, it must also be regarded as an influence in the association of size and psychological performance. An additional question is whether intake affects cognitive performance over and above its contribution to growth. In operational terms, this can be tested in a multivariate regression model with both length and intake. Table 30.8 presents the results using the Z scores for length at 18 months and the ratio of animal protein to total protein (% animal protein) in the period of 27 - 29 months. In this model (and in those presented below), "Type I" refers to the procedure in which the p-value of the independent variables is cumulative, based on the order in which they are entered in the equation, while the "Type III" analysis shows the p-values for the independent variables contingent on all other variables in the model.

TABLE 30.8
REGRESSION MODEL--EFFECT OF LENGTH AND PROTEIN RATIO ON COGNITIVE SCORE (N = 70)

Independent Variables	p-value (Type I)	p-value (Type III)
% Animal Protein	.003	.05
Length Z Score	.0003	.0003
R-SQUARE: = .26	Root MSE = 5.60	

From Table 30.8, we see that the effects of length and intake are additive. While length alone produced an R-square value of 22%, adding current intake (% animal protein) improves the predictability of the model by 4%. The contribution of the intake variable remains significant at .05 even when it is contingent on length.

V. COGNITIVE PERFORMANCE AND MORBIDITY

Illness is one of the primary factors that interact with intake to influence growth. It may also be hypothesized that illness influences cognitive development independently of intake-growth interactions by affecting the nature of child-caretaker relationships and the relationships of the child to his or her environment. Therefore, as part of an exploration of intake-performance relationships, it is necessary to assess the role of morbidity, particularly in third world settings. Table 30.9 shows the mean days of illness per month in the subsample of 78 children described in this chapter. Three morbidity variables are included: total illness, days ill with diarrhea, and days ill with fever. For example, the average number of days ill with diarrhea was less than one day per month (.33 of a day). The table also shows the r-values and p-values for the correlations of these variables with cognitive performance.

TABLE 30.9
MORBIDITY AND COGNITIVE PERFORMANCE (N=78)

	Days per Month		
	Total Illness	Diarrhea	Fever
Mean	1.37	.32	.23
S.D.	1.17	.49	.35
Correlation with Cognitive Score	.08	.06	.14
p-value	n.s.	n.s.	n.s.

The previous table suggests that there is no association between a child's morbidity experience and cognitive development. However, when the correlation coefficients are examined separately by sex, we find that for one variable--number of diarrhea days--there is an association ($r = .33$, $p = .05$) for males only ($N = 38$). Boys with more reported days of diarrhea have a tendency toward higher cognitive scores. Whether this relationship has meaning or is simply a chance event is difficult to assess with the present evidence. The fact that there is no association for females suggests the latter explanation may be more appropriate.

VI. COGNITIVE PERFORMANCE AND SELECTED SOCIAL CONDITIONS

While the purpose of this analysis is to describe the effect of chronic low intake on cognitive development, the research has been undertaken from a theoretical perspective that stresses the dynamic, multi-factored nature of behavior and development. For example, one pathway by which low intake may affect development is through subtle effects on the young child's manner of interacting with his or her environment, including reduced activity, attentiveness and social responsiveness. These behaviors, which lead to reduced stimulation and hence reduced opportunity for more complex

responses, may also affect the child's intake, perpetuating continued low intake because he or she does not actively "demand" food. Similarly, development may be compromised by an interaction between child passivity and maternal time allocation in households where child care time is limited because the caretakers are pushed by economic necessity to long hours of work. In such a situation, low intake in the child interacts with the behavioral consequences of poor economic resources, with each component contributing to and reinforcing a less than optimal outcome.

Recently, Pollitt has contrasted earlier research efforts to define the link between undernutrition and behavioral development with current approaches that stress the interactive nature of the developmental process (30.1). He suggests that, "The approach or the blueprint of the main effect model (in which the central hypothesis is framed as a simple bivariate function) was too narrow and lacked the sensitivity to account for some findings as well as for what was observed in the field. The dynamic aspect of the developmental process and the plasticity of the organism were not integrated into the model." With respect to contradictory evidence concerning the impact of undernutrition and the evidence for "the influential role of social environmental factors," he suggests that rather than concluding nutrition plays little or no part in development, a stronger model is an interactive one. "...the interactive effects between nutrition and socioeconomic circumstances are more powerful than the main effects of nutrition. Socioeconomic deprivation apparently potentiates the effects of early undernutrition."

In the section that follows, we broaden the scope of analysis outside of the child herself or himself. The conditions in which the child is developing can be conceptualized at a number of levels. Here we chose to consider two levels--the child's primary caretaker, which in the Solis Valley is the mother, and secondly, the household in which the child spends most of his or her time. For this preliminary assessment, we have selected several variables of mother characteristics and household characteristics as indicators of the complex "environmental" conditions that affect child development. Specifically, we have examined the following maternal and household characteristics:

Mother:	Age
	Birthplace
	Literacy
	Caretaking skill, as judged from the child's physical appearance score
Household:	Total size
	Number of children under 12
	Family structure (nuclear vs. extended)
	Marriage location (patrilocal, matrilocal or neolocal)
	Socioeconomic status (see Chapter 19 for scale construction)

Bivariate correlations and analysis of variance were used first to assess the relationships of these variables to the cognitive development scores. A primary purpose of this step was to identify variables to be used in developing multivariate models.

With respect to maternal variables, there are no significant associations between cognitive scores of preschoolers and mother's age, birthplace, or literacy. However, cognitive performance score is strongly associated with children's physical appearance. The correlation coefficient is .37 ($p = .001$). This measure is the "Young Child Appearance" variable, derived from the sanitation and hygiene observations. For households that were in the study because of a target preschooler, the observers were instructed to make their ratings of the "young child's appearance" based on the target subject. In these analyses, we may assume that the measure applies directly to the children for whom we have cognitive data. However, as previously discussed, we suggest that this variable may be regarded as an indicator of maternal caretaking behavior and have therefore classified it as a "maternal characteristic."

Concerning the household level indicators, there are no associations between total household size or composition and cognitive performance. Girls in matrilocal households have significantly higher scores than girls in patrilocal or neolocal families. However, there are only 7 girls in this group and the relationship does not hold up for boys, so that it is

[illegible] relationship to preschooler cognitive scores.

Based on the bivariate analyses, we selected two social variables for use in building a multivariate model of cognitive performance. These are socio-economic status and child appearance.

VII. MODELS OF DEVELOPMENT INCLUDING SOCIOECONOMIC STATUS

Table 30.10 presents the regression model for the effect of socioeconomic status on cognitive performance. The p-value is highly significant, but the r-square value is lower than that achieved with either animal intake or preschooler length. In Table 30.11, in which % animal protein or % animal kcal is added to the model, the r-square is strengthened but the p-value for both the intake and SES measures is greater than .05. The third model, shown in Table 30.12, adds length at 18 months to the model, which greatly improves the proportion of variance the model accounts for. Although neither socioeconomic status nor intake maintain p-values less than .05, the explanatory power of the model is greater than that achieved by using length alone.

TABLE 30.10
REGRESSION MODEL: EFFECT OF SOCIOECONOMIC STATUS ON COGNITIVE SCORE AT 30 MONTHS (n = 70)

Independent Variables	p-value (Type I)	p-value (Type III)
Socioeconomic Status	.009	.009
R-SQUARE: = .09	Root MSE = 6.05	

TABLE 30.11
REGRESSION MODEL: EFFECT OF SES AND ANIMAL FOOD INTAKE ON COGNITIVE SCORE (N = 70)

Independent Variables	p-value (Type I)	p-value (Type III)
% Animal Protein	.02	.14
Socioeconomic Status	.07	.07
R-SQUARE: = .12	Root MSE = 5.99	
% Animal Kcal	.007	.09
Socioeconomic Status	.11	.11
R-SQUARE: = .13	Root MSE = 5.96	

TABLE 30.12
REGRESSION MODEL: EFFECT OF LENGTH, SES AND PROTEIN RATIO ON COGNITIVE SCORE (N = 67)

Independent Variables	p-value (Type I)	p-value (Type III)
% Animal Protein	.003	.20
Length Z Score	.0009	.007
Socioeconomic Status	.15	.15
R-SQUARE: = .27	Root MSE = 5.6	

VIII. MODELS OF DEVELOPMENT INCLUDING MATERNAL CARETAKING

The following table (30.13) provides the results of a regression analyses that includes both the child's length and appearance score. In this model, the p-values for both variables remain very significant and the r-square reaches .27.

TABLE 30.13
REGRESSION MODEL: EFFECT OF LENGTH AND CHILD APPEARANCE ON COGNITIVE SCORE AT 30 MONTHS (N = 67)

Independent Variables	p-value (Type I)	p-value (Type III)
Length Z Score	.0001	.004
Child Appearance	.02	.02
R-SQUARE: = .27	Root MSE = 5.5	

The addition of the protein ratio variable to the model (Table 30.14) increases the r-square, although the p-value for 2 of the 3 variables rises above .05 when intake is added.

TABLE 30.14
REGRESSION MODEL: EFFECT OF LENGTH, CHILD APPEARANCE, AND PROTEIN RATIO ON COGNITIVE SCORE (N = 67)

Independent Variables	p-value (Type I)	p-value (Type III)
% Animal Protein	.002	.14
Length Z Score	.0007	.009
Child Appearance	.06	.06
R-SQUARE: = .29	Root MSE = 5.4	

To construct the next model, intake was removed as an independent variable and the socioeconomic measure was added. Table 30.15 shows the inter-correlations of the three independent variables and Table 30.16 presents the results of the regression. Here we see that although the independent variables are significantly correlated, they still contribute additively to the prediction of cognitive performance. Together they account for more than 30% of the variance in performance.

TABLE 30.15
INTER-CORRELATIONS OF SES, LENGTH AT 18 MONTHS AND CHILD APPEARANCE (N=70)

	Length		Child Appearance		SES	
	r	p	r	p	r	p
Length	-		.38	(.001)	.42	(.0004)
Appearance			-		.25	(.03)

TABLE 30.16
REGRESSION MODEL: EFFECT OF LENGTH, CHILD APPEARANCE AND SES ON COGNITIVE SCORE AT 30 MONTHS (N = 67)

Independent Variables	p-value (Type I)	p-value (Type III)
Length Z Score	.0001	.04
Child Appearance	.02	.03
Socioeconomic Status	.05	.05
R-SQUARE: = .31	Root MSE = 5.4	

In the final model, we have restored the intake variable (% animal protein) and included length at 18 months, maternal caretaking, and socioeconomic status. The intake variable has a very high p-value when it is contingent on the other three variables in the model (Type III regression). Also, the contribution of socioeconomic status fails to maintain a p-value less than .05 when it is contingent on the variables that precede it in the equation. Nonetheless, adding the intake variable to the others increases the r-square by 1 percent, indicating that it has a slight additive predictability over and above its contributions to the other variables.

TABLE 30.17
REGRESSION MODEL: EFFECT OF LENGTH, CHILD APPEARANCE, SES, AND PROTEIN RATIO ON COGNITIVE SCORE (N = 67)

Independent Variables	p-value (Type I)	p-value (Type III)
% Animal Protein	.002	.41
Length Z Score	.0007	.04
Child Appearance	.05	.05
Socioeconomic Status	.12	.12
R-SQUARE: = .32	Root MSE = 5.4	

IX. CONCLUSIONS

On the basis of the analysis to date, it seems clear that poor growth, as reflected in short stature, at the very least leads to delays in cognitive development. Children who are short at 18 months of age perform more poorly at 30 months on tests that challenge their cognitive organization. While the statistical models presented above all utilize length-for-age as the measure of size, the strong correlation between length and weight suggests that low weight-for-age will be similarly associated with compromised development. Growth is a global measure, reflecting a child's physical and behavioral experience. It appears that in the Solis Valley, as in many other parts of the world, the features of life experience that lead to small size also lead to delayed cognitive development.

The influence of the social environment on the children's cognitive development, is strongly confirmed in the significance of the two social variables in the models. The socioeconomic status and maternal caretaking measures reflect conditions in the household, both behavioral and material, which affect the child's progress toward greater complexity of cognitive organization.

Intake of animal protein (% protein or % calories from animal sources) plays a small role in current performance, even when some features of the social environment are statistically accounted for, as we saw in the regression equations in Table 30.11. The absence of any association between energy intake and cognitive performance may be the result of measurement error or may reflect a general adequacy of energy intake, despite the apparently low levels of intake reported for a portion of the sample. That is, if there is a threshold above which energy intake does not affect the complex mechanisms potentially linking intake to cognitive development, it may be the case that the great majority of the children in the sample are above this "cut-off."

Nutrition also plays a role in development through another mechanism. In the preceding chapter, the relationships of intake and growth in preschoolers were explored. Growth over the year of the study (length and weight change) and attained length and weight at 30 months were associated with the intake of animal foods (see Tables 29.5, 29.10, and 29.16). Intake, in interaction with other factors, influences growth, which, in turn, is strongly associated with cognitive development.

The analyses presented in this chapter lend strong support to an interactive model of nutrition and development, as proposed by Pollitt and others. Social-environmental conditions of the household (as measured by socioeconomic status indicators and maternal care-giving) clearly affect development. The biological and behavioral experiences of the child, as reflected in growth, also affect development. The mechanism of these effects is probably synergistic. That is, child nutrition, health, and activity (reflected in growth) have a synergistic relationship with social and social-relational conditions, with respect to risk of poor or delayed cognitive development. The model is analogous to the dynamic interac-

tion of infection and malnutrition, which have a synergistic relationship with respect to risk of mortality. Our future work will be directed to further explication of this model.

REFERENCE

30.1. Pollitt, E. A critical view of three decades of research on the effects of chronic energy malnutrition on behavioral development. Paper presented at Meeting of the International Dietary Energy Consultancy Group. Guatemala City, Guatemala. August, 1987.

Chapter 31

PREGNANCY OUTCOME

I. INTRODUCTION

This chapter presents preliminary analyses of the "Pregnancy Outcome" hypotheses that the three CRSP projects (Mexico, Egypt and Kenya) agreed to explore in common. The University of Connecticut and INN in Mexico both participated in these analyses. Connecticut's emphasis has been on descriptive statistics, and on analyses relating to the postpartum period, while that of Mexico was on pregnancy outcome models. Variable definitions were mutually agreed on by both UConn and INN groups.

The analyses discussed below are preliminary, serving only to suggest logical approaches to future, in-depth analysis. The data sets are large. For example, UConn analyses used about 440 core variables on 134 mother-infant pairs, but only a few of these could be entered into a model at the same time for reasons of collinearity. The process of identifying variables and variable constructs that best represent a theory is necessarily slow.

Generally, UConn has started this process by looking at two variables at one time, plotting the data, noting apparent non-linearities, eliminating outliers, and building single then multiple equation models. Simple correlations were run between outcome and anticipated explanatory variables, followed by bivariate analyses to examine residuals. The benefit of this approach is that the maximum number of observations is left in each regression. Variables that are highly correlated with each other were identified, and those that are not collinear were selected for entry into later models.

The Mexico approach was to examine groups of core variables for relationships that may or may not be expected. Using stepwise regression in SAS, the Mexican group worked with a set of about 228 core variables. The benefit of this approach is that the explanatory power of a large number of variables could be explored within the limited time available.

II. DEFINITION OF VARIABLES

The infant growth data are examined from two perspectives. First, infant size at 1 and 3 months of age is considered to be predominantly the result of the pregnancy experience, and a measure of pregnancy outcome. Between 3 and 6 months the factors that have most impact on infant size are hypothesized to be: maternal size and nutritional status (diet and percent body fat), illness, and supplemental feeding. Supplemental feeding data have not yet been used in these analyses. These factors may all be a result of, or associated with, the behavioral and environmental circumstances that affect sanitation and child care.

The variables employed in these analyses and their definitions are as follows:

PREGNANCY

Conception = birth minus 280 days except for abortions.
Trimester: I = 0 - 92 days, II = 93 - 186 days, III = 187 - 280 days.
Pre-pregnancy weight = weight at 0 ± 60 days.
Mid-pregnancy weight = weight at 137 ± 15 days.
Late-pregnancy weight = weight at 250 - 280 days.

LACTATION

Lactation trimester I weight = weight at 30 ± 15 - 91 ± 21 days of lactation.
Trimester II weight = weight at 92 ± 21 - 183 ± 21 days of lactation.
Trimester III weight = weight at 184 ± 21 - 254 ± 21 days of lactation.

INFANCY

Birth measures were defined as those nearest to birth but only within 8 days of birth; 30 day measures had to be nearest to and within ± 15 days of 30 days after birth; 90 day measures nearest to and within ± 15 days of 90 days of birth; and 195 day measures nearest to and within ± 15 days from 195 days. While data are available on most mothers and infants up to 254 days postpartum, few analyses have been conducted here beyond 6 months postpartum in order to preserve commonality with the Egypt and Kenya projects.

From original data sets containing information on 134 target infants and their mothers, 69 mother-infant pairs had data within all the windows representing 0, 30, 90 and 195 days postpartum.

FATNESS

Maternal body composition (% fat) was estimated at 30, 90 and 195 days of lactation from skinfold measures (biceps, triceps, subscapular and suprailiac) at these time intervals. The equations of Durnin and Womersley were used to calculate body density (31.1) and that of Siri (31.2) to calculate percent body fat from density. The formulae were based on maternal age at 195 days postpartum for each individual. Infant fatness was estimated from the sum of the four skinfolds at each age.

In the Mexico analyses, the percent fat of pregnant women was also calculated from skinfolds, although it is recognized that for this group the calculated values are only useful as "fatness indicators" since the Durnin and Womersley formulae are not applicable to pregnant women.

MORBIDITY

Morbidity data on infants were generated for each calendar month starting at the calendar month of birth. Morbidity data were also averaged over all pregnancy for the target mothers and for infants during 7 months postpartum. The variables used by UConn were the estimates of total days ill, and days of diarrhea, days of fever, upper respiratory infection, lower respiratory infection, and other diseases, calculated as described in Chapters 8 and 22. Actual outcome variables were constructed by dividing the days ill in each month by the number of days observed in that month.

Mexico included additional morbidity variables for pregnant women such as illness duration, degree of incapacity and appetite change, and medications.

DIETARY VARIABLES

For reasons explained in Chapter 20, analyses involving dietary variables were restricted to food intake data collected after January 1, 1985. The variables used are; total kcal, kcal from animal sources, kcal from vegetable sources, grams

of protein /day, grams of protein from animal sources, grams of protein from vegetable sources, and percent total kcal and protein from animal sources.

All diet variables were calculated as average intakes per day over the time periods in question. For example, in one trimester of pregnancy there may be between one and eight daily measures used, with an expected number of 6.

AVAILABLE ENERGY

This was calculated for each mother separately during pregnancy and lactation. It is the average kcal intake per day during pregnancy or lactation minus the average RMR (kcal per day) for the same period.

PREGNANCY COMPLICATIONS

These are expressed as the total number of the following conditions: edema, excessive vomiting, proteinuria, transvaginal hemorrhage, and "blood in urine". One point is assigned for the presence of each condition during pregnancy. The detailed monthly clinical examination data from pregnant women have not all been included at this time.

III. DESCRIPTIVE STATISTICS

Descriptive statistics on the major outcome and explanatory variables in the pregnancy outcome model are shown in Table 31.1.

For most variables, all longitudinal pregnant and lactating subjects and their infants were used. In contrast, not all of these subjects had dietary data collected after January, 1985, as is apparent from the number of subjects associated with the descriptive statistics on dietary variables.

The mean pregnancy total weight gain is only 7.7 kg, substantially lower than the 12.5 kg recommended in the United States. The number of measures in the time windows specified in the model is quite small, partly as a result of the difficulty of identifying pregnancy at an early stage, and partly because the monthly scheduled visits to the clinic (where most weights were taken on this group) often fell outside the windows used for these analyses. Since RMR measures were planned to occur at 5 months, there were many 5 month measures that fall slightly outside of the analysis windows used here. In future analyses, curves will be fit to the weight data of individual women so that weight change can be better estimated at specific time points. (The Mexico group has already used this approach in their stepwise regression models discussed below).

During lactation, average weight change is negligible between the first and third months, but a loss of about 0.7 kg occurs between months 3 and 6. The percent body fat in lactation shows a slight gain between months 1 and 3, with an overall loss of about 0.5 kg between 1 and 6 months.

Birth weights averaged 3.15 kg, with 7% "low birth weights" (less than 2.5 kg). Anthropometric data on infants are described in more detail in Chapter 21. It is important to note that on average infants actually increase their weight percentile compared to NCHS standards during the first month of life, then undergo a slight loss between months 1 and 3, and a rapid fall in average percentile between months 3 and 6. This pattern should be considered when attempting to explain infant growth, and suggests that environmental variables act most adversely on growth after the third month of life.

Infant fatness increased between the first and third month, with little change occurring between 3 and 6 months.

Maternal RMR changes have been discussed in greater detail in Chapter 25. RMR did not increase until late pregnancy, and in this group of women the difference between average RMR in pregnancy and in lactation is only 53 kcal/day.

Maternal energy intake was higher throughout lactation than pregnancy, and was highest at 6 to 8 months postpartum. The difference in intake between pregnancy and lactation was 300 to 400 kcal/day, so that "available energy" in lactation was increased by the same amount. This increase in available energy, plus the small loss in maternal body fat that occurs during lactation, is presumably used for milk synthesis (assuming no substantial change in the physical activity of the mother during lactation).

Average total kcal and protein intakes appear to meet the US-RDAs for both pregnancy and lactation, although there is a wide range in intake. Consumption does not increase with trimester of pregnancy, but as discussed above, it increases immediately after birth and at least up to 8 months of lactation. The intake of kcal and protein from animal sources is very low during both pregnancy and lactation--the percent kcal from animal products is 6.7% in pregnancy and 6.4% in lactation. It appears that lactation is characterized by an increase in the quantity of food consumed, but no change in the quality as judged from the consumption of animal products.

Infant morbidity increased from 4% of observation days with reported illness in the first postpartum month, to about 11% at 6 months. A large number (108 out of 134) of the infants had no recorded diarrhea, so that the skewed distribution of diarrhea data may confound the interpretation of analyses using these data. For this reason, in the multiple regression analyses, morbidity variables were also coded as 0/1 for absence or presence of the illness. The average postpartum maternal morbidity rate (days ill / days observed) was 2 to 8%, depending on the month of lactation.

TABLE 31.1
DESCRIPTIVE STATISTICS ON PREGNANCY OUTCOME DATA

Variable	N	Mean	S.D.	Min	Max
MATERNAL HEIGHT (cm)					
	130	152.5	4.96	138.6	165.6
MATERNAL WEIGHT (kg)					
Prepregnancy	45	54.4	7.23	41.0	70.3
Trimester I	29	54.5	7.19	41.6	73.7
Midpregnancy	41	57.0	6.54	42.2	72.8
Trimester II	68	59.0	7.03	41.8	73.3
Late pregnancy	88	62.0	8.23	43.4	81.7
Lactation 30 days	111	57.1	7.59	40.6	77.2
Lactation 90 days	115	57.3	8.03	40.5	81.2
Lactation 195 days	116	56.4	8.65	39.1	82.0
MATERNAL WEIGHT CHANGE (kg)					
Trimester I	18	0.18	2.12	-4.0	4.2
Trimester II	20	4.48	2.60	-2.7	8.6
Trimester III	52	2.86	1.85	-2.9	6.9
Mid- to end	31	5.47	2.31	1.8	10.8
Total gain in preg.	34	7.66	3.80	-3.6	15.9
LACTATION WEIGHT CHANGE (kg)					
Lactation 30 - 90 d	99	-0.04	2.22	- 7.6	7.5
91 - 195 d	105	-0.71	1.87	- 6.9	5.4
30 - 195 d	99	-0.92	3.45	-12.9	10.1

TABLE 31.1 continued

Variable	N	Mean	S.D.	Min	Max
MATERNAL FATNESS IN LACTATION (% body fat)					
Lactation 30	101	32.50	4.62	16.12	40.19
90	108	33.65	4.46	17.92	42.46
195	88	32.38	5.09	18.86	42.67
Change 30 - 90	89	+0.89	2.73	-7.43	6.59
90 - 195	78	-1.16	3.41	-6.75	9.47
30 - 195	75	-0.48	4.38	-11.52	9.20
INFANT WEIGHTS					
Birth	94	3.15	0.40	2.1	4.3
30 days	102	4.07	0.69	2.1	7.7
90 days	103	5.52	0.81	3.5	7.7
195 days	91	7.01	1.04	5.0	10.2
INFANT WEIGHT PERCENTILES					
Birth	90	38.9	24.1	0.5	96.5
30 days	99	43.4	24.1	0.1	97.3
90 days	102	42.6	25.3	0.4	96.9
195 days	90	29.5	25.6	0.1	97.5
INFANT WEIGHT CHANGE					
0 - 30 days	87	0.97	0.62	-0.6	3.8
30 - 90	92	1.43	0.61	-0.2	4.2
90 - 195	82	1.48	0.61	0.0	2.9
0 - 195	74	3.98	0.92	2.0	6.3
30 - 195	79	2.91	0.83	0.6	5.2
CHANGE IN WEIGHT PERCENTILES					
0 - 30 days	87	6.0	24.4	-58.7	71.7
30 - 90	89	-3.6	17.7	-67.1	34.3
90 - 195	80	-12.6	17.5	-71.3	33.1
0 - 195	70	-7.5	29.6	-78.9	52.9
INFANT LENGTH (cm)					
Birth	81	49.44	2.20	44.0	55.2
30 days	100	51.86	2.26	46.0	57.3
90	104	57.67	2.50	51.0	63.3
195	90	63.64	2.66	58.0	69.5

TABLE 31.1 continued

Variable	N	Mean	S.D.	Min	Max
INFANT LENGTH CHANGE (cm)					
0 - 30 days	73	2.30	2.00	-3.0	6.7
30 - 90	91	5.90	1.62	1.2	9.6
90 - 195	82	5.73	1.35	1.4	8.9
0 - 195	64	13.94	2.28	9.0	20.5
30 - 195	78	11.54	2.07	7.1	16.0
SUM OF SKINFOLDS (4) FOR INFANTS (mm)					
30 days	93	19.25	5.13	7.5	36.5
90	98	25.33	6.38	9.0	41.5
195	84	26.92	5.92	16.5	43.0
CHANGE IN INFANT SKINFOLDS (mm)					
30 - 90 days	86	5.85	5.20	-10.0	16.0
90 - 195	80	1.20	4.32	-9.0	12.5
30 - 195	72	7.36	5.98	-5.5	23.5
MATERNAL RMR (kcal/day)					
Pregnancy mean	75	1352	208	936	2104
Lactation mean	112	1299	177	942	1824
AVAILABLE ENERGY (kcal/day)					
Pregnancy mean	75	1032	559	-211	2441
Lactation mean	112	1410	623	- 28	3850
MATERNAL ENERGY INTAKE (kcal/day)					
Pregnancy Tri I	23	2636	689	1595	4133
Tri II	44	2300	506	1352	3789
Tri III	76	2425	605	1106	4303
Mean I+II+III	81	2418	579	1264	3960
Lactation 0 - 90 days	98	2720	696	1448	5547
90 - 195	101	2694	666	814	5042
195 - 254	101	2831	782	1297	5182
0 - 195	121	2739	660	1247	5182

TABLE 31.1 continued

Variable	N	Mean	S.D.	Min	Max
MATERNAL ENERGY INTAKE FROM ANIMAL SOURCES (kcal/day)					
Pregnancy Tri I	23	150	117	0	524
Tri II	44	143	116	4	589
Tri III	76	170	131	4	625
Mean I+II+III	81	160	113	16	607
Lactation 0 - 90 days	98	185	167	0	987
90 - 195	101	170	155	0	934
195 - 254	101	169	161	0	911
0 - 195	121	171	143	6	733
MEAN % KCAL FROM VEG SOURCES					
Pregnancy mean	81	2258	555	1055	3760
Lactation mean	121	2567	651	1208	5061
MEAN % KCAL FROM ANIMAL SOURCES					
Pregnancy Tri I	23	5.6	4.0	0	15.9
Tri II	44	6.0	4.0	0	15.5
Tri III	76	7.1	5.1	0	21.0
I+II+III	81	6.7	4.5	0	20.4
Lactation 0 - 90 days	98	6.8	5.9	0	28.3
90 - 195	101	6.3	5.7	0	40.0
195 - 254	101	6.4	6.8	0	42.5
0 - 195	121	6.4	5.4	0	31.4
MATERNAL PROTEIN INTAKE (g/day)					
Pregnancy Tri I	23	75	23.2	41	118
Tri II	44	65	41.6	39	106
Tri III	76	71	18.8	29	147
I+II+III	81	70	17.2	40	115
Lactation 0 - 90 days	98	76	20.8	34	156
90 - 195	101	76	20.3	22	152
195 - 254	101	79	20.8	35	134
0 - 195	121	77	18.5	29	136

TABLE 31.1 continued

Variable	N	Mean	SD	Min	Max
MATERNAL PROTEIN INTAKE FROM ANIMAL SOURCES (g/day)					
Pregnancy Tri I	23	12	8.2	0	41
Tri II	44	12	8.6	0	42
Tri III	76	14	10.6	0	55
I+II+III	81	13	8.7	1	45
Lactation 0 - 90 days	98	6.9	5.9	0	25
90 - 195	101	6.3	5.7	0	34
195 - 254	101	6.3	6.8	0	42
0 - 195	121	6.4	15.4	0	31
INFANT: TOTAL DAYS ILL / TOTAL DAYS OBSERVED					
Month					
1	97	04	.13	0	79
2	116	.05	.14	0	.71
3	116	.05	.13	0	.74
4	116	.09	.18	0	.75
5	116	.08	.14	0	.68
6	120	.11	.19	0	.81
7	116	.10	.18	0	.81
MOTHER: TOTAL DAYS ILL / TOTAL DAYS OBSERVED					
Month					
1	124	.03	.18	0	.56
2	122	.03	.10	0	.58
3	124	.02	.06	0	.29
4	122	.07	.22	0	1.00
5	120	.08	.20	0	1.00
6	124	.05	.12	0	.52
7	120	.03	.12	0	.88

IV. SIMPLE CORRELATIONS BETWEEN MATERNAL AND ENVIRONMENTAL VARIABLES AND INFANT ANTHROPOMETRY

Tables 31.2 through 31.5 show the correlation coefficients of maternal variables in pregnancy and lactation with infant weight and length between 0 and 6 months postpartum. The numbers shown are the correlation coefficient (Pearson's), p-value and N in each case. Similar tables were completed using change in infant weight and length as the outcome in each period. While the significant correlations from the change tables will be reported here, the actual tables are not presented due to their size. The percentiles, and change in percentiles, for infant weight and length at each age were also tested for correlation with the same maternal variables. The correlations were very similar to those found using the actual weight and height measures, so they are not reported here.

A. Maternal Characteristics During Pregnancy and Infant Anthropometry

1. Maternal weight, height and weight change.

These correlations are summarized in Table 31.2. Maternal weight had a strong association with the weight and length of the infant. Maternal weight at 186 and 280 days of pregnancy was significantly correlated with both the weight and the length of the infant at birth, and at 1, 3 and 6 months of age.
The mother's weight during the first half of pregnancy was not associated with birth weight, but was correlated with both infant weight and height at most postpartum intervals. Maternal weight at all except mid-pregnancy was correlated with birth length.

Maternal height was highly predictive of the weight of her child when he/she reached 6 months of age, and of the length of the infant at every point from birth to 6 months.

Total maternal weight gain during pregnancy was not an important predictor of infant size, being associated only with birth length ($r = 0.37$, $p = 0.04$). However, weight gain during the third trimester was correlated with infant weight at 1, 3 and 6 months, and gain from mid- to late-pregnancy with infant length at birth ($r = 0.36$, $p = 0.08$) and 195 days.

When entered into a multivariate regression analysis with maternal height, these correlations between maternal weight gain and infant size lost their significance. In the multivariate analyses presented below, mother's weight at the end of pregnancy is the most robust indicator of not only the size of the child at 6 months of age, but also of infant growth rate.

TABLE 31.2
CORRELATIONS OF MATERNAL PREGNANCY ANTHROPOMETRY AND RMR WITH INFANT WEIGHT AND LENGTH†

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
WEIGHT								
Day 0	0.172	0.345	0.30	0.414	0.292	0.400	0.410	0.450
	0.27	0.02*	0.04*	0.01*	0.08*	0.00*	0.00*	0.00*
	42	41	43	37	36	41	43	37
Day 93	0.264	0.325	0.348	0.275	0.613	0.234	0.369	0.199
	0.19	0.10*	0.08*	0.20	0.00*	0.24	0.06*	0.36
	26	26	26	23	20	26	26	23
Day 137	0.124	0.345	0.168	0.403	0.235	0.338	0.199	0.329
	0.48	0.03*	0.31	0.03*	0.22	0.04*	0.23	0.08*
	34	36	38	28	28	35	38	28
Day 186	0.288	0.367	0.364	0.602	0.302	0.292	0.372	0.519
	0.02*	0.00*	0.00*	0.00*	0.03*	0.02*	0.00*	0.00*
	60	61	64	53	50	61	64	53
Day 280	0.276	0.271	0.407	0.525	0.228	0.176	0.308	0.384
	0.01*	0.01*	0.00*	0.00*	0.06*	0.12	0.00*	0.00*
	76	81	79	68	66	79	79	68

TABLE 31.2 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
HEIGHT	0.037	0.020	0.147	**0.288**	**0.245**	**0.191**	**0.302**	**0.405**
	0.72	0.83	0.13	**0.00***	**0.02***	**0.05***	**0.00***	**0.00***
	91	100	103	90	79	98	104	89
WEIGHT CHANGE								
Tri I	0.057	0.087	-0.024	-0.153	0.266	0.287	0.071	0.060
	0.82	0.74	0.92	0.60	0.40	0.28	0.78	0.83
	17	16	17	14	12	16	17	14
Tri II	0.018	-0.074	-0.148	-0.064	-0.049	-0.076	-0.143	0.169
	0.94	0.77	0.54	0.81	0.86	0.77	0.55	0.54
	19	17	19	15	14	17	19	5
Tri III	0.027	0.359	0.320	0.327	0.084	0.189	0.105	0.155
	0.85	**0.01***	**0.02***	**0.03***	**0.60**	**0.19**	**0.47**	**0.33**
	48	48	49	40	40	48	49	40
Mid-end	-0.008	0.027	0.146	0.238	0.365	0.113	0.043	0.329
	0.96	0.88	0.44	0.29	0.08*	0.57	0.82	0.14
	27	28	29	21	23	27	29	21
Tri I+II+III	0.046	0.036	-0.045	0.082	**0.371**	0.133	-0.043	0.083
	0.79	0.84	0.80	0.68	**0.04***	**0.47**	**0.81**	**0.68**
	32	31	32	27	29	31	32	27
MEAN RMR	0.181	0.350	0.241	**0.429**	0.088	**0.25**	**0.295**	**0.403**
	0.15	**0.00***	**0.04***	**0.00***	**0.52**	**0.03***	**0.01***	**0.00***
	63	68	69	57	54	68	69	56
MEAN AVAILABLE ENERGY	0.100	-0.182	-0.178	**-0.251**	-0.026	-0.193	-0.146	-0.062
	0.43	0.13	0.14	**0.05***	0.84	0.11	0.23	0.64
	63	68	69	57	54	68	69	56

† For each pair of variables, the first value shown is the correlation coefficient (r), the second is the p value (* identifies p <0 .10), and the third is the number of subjects.

2. Maternal diet.

Correlations of infant size with maternal intake are provided in Table 31.3. Maternal total kcal intake in the first trimester was only weakly correlated with infant weight at 90 days of age (r = -0.41, p = 0.08) but this negative correlation is probably spurious due to the small number of subjects (N = 19). Maternal intake of kcal from animal sources showed a much stronger association; animal kcal consumption in trimester I correlated with infant weight at 6 months, in trimester II with weight at birth, 3 and 6 months, and in trimester III with length at 6 months. Correlations with the amount of animal protein consumed were very similar to those with animal kcal. In every trimester, the percentage of kcal and of protein from animal sources correlated with infant weight at 6 months, and in trimester II it predicted length at 6 months. No associations were seen between consumption of kcal from vegetable sources and any infant anthropometric measures.

3. Maternal RMR and available energy.

Mean RMR in pregnancy was associated with infant weight and length at every age except birth. Mean available energy was negatively correlated with infant weights and lengths after birth. The higher the RMR, the lower is the available energy. The correlations between mean RMR, mean available energy, and all infant outcomes lose their significance when maternal height is introduced in a multivariate regression analysis to account for mother's size. RMR and available energy are acting as indicators of maternal size. RMR expressed as kcal/kg has yet to be used in these analyses.

TABLE 31.3
SIGNIFICANT CORRELATIONS BETWEEN MATERNAL NUTRIENT INTAKE IN PREGNANCY AND INFANT WEIGHT AND LENGTH

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
ENERGY INTAKE								
Tri I	-0.253	0.052	-0.406	-0.264	-0.190	-0.115	-0.239	0.098
	0.29	0.82	0.08*	0.34	0.46	0.63	0.32	0.73
	19	19	19	15	17	19	19	14
Tri II	0.111	-0.098	0.004	0.117	0.033	-0.041	0.041	0.102
	0.51	0.55	0.98	0.53	0.85	0.80	0.80	0.59
	37	38	39	30	33	38	39	29
Tri III	0.151	-0.029	-0.073	-0.057	0.004	-0.033	-0.067	0.020
	0.21	0.80	0.54	0.67	0.97	0.77	0.57	0.87
	68	73	71	57	57	73	71	57
Tri I+II+III	0.193	-0.007	-0.003	-0.006	0.027	-0.010	-0.001	0.117
	0.11	0.94	0.97	0.95	0.84	0.92	0.9	0.37
	69	74	73	60	58	74	73	59
ANIMAL KCAL								
Tri I	0.124	0.138	0.206	0.467	-0.023	0.212	0.116	0.063
	0.61	0.57	0.39	0.07*	0.92	0.38	0.63	0.83
	19	19	19	15	17	19	19	14
Tri II	0.291	0.189	0.361	0.381	0.219	0.280	0.38	0.316
	0.07*	0.25	0.02*	0.03*	0.22	0.08*	0.01*	0.09*
	37	38	39	30	33	38	39	29
Tri III	-0.121	0.096	0.135	0.189	0.151	0.076	0.093	0.256
	0.32	0.41	0.26	0.15	0.26	0.51	0.43	0.05*
	68	73	71	57	57	73	71	57
Tri I+II+III	-0.013	0.105	0.190	0.257	0.157	0.131	0.173	0.269
	0.91	0.36	0.10*	0.04*	0.23	0.26	0.14	0.03*
	69	74	73	60	58	74	73	59

TABLE 31.3 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
MEAN VEG KCAL								
	0.204	-0.030	-0.043	-0.056	-0.007	-0.039	-0.037	0.069
	0.09*	0.79	0.71	0.66	0.95	0.74	0.75	0.60
	69	74	73	60	58	74	73	59
% ANIMAL KCAL								
Tri I	0.244	0.158	0.286	0.556	0.043	0.283	0.179	0.047
	0.31	0.51	0.23	0.03*	0.86	0.23	0.46	0.87
	19	19	19	15	17	19	19	14
Tri II	0.305	0.230	0.363	0.455	0.204	0.273	0.372	0.350
	0.06*	0.16	0.02*	0.01*	0.25	0.09*	0.01*	0.06*
	37	38	39	30	33	38	39	29
Tri III	-0.224	0.076	0.147	0.236	0.078	0.028	0.080	0.231
	0.06*	0.52	0.22	0.07*	0.56	0.80	0.50	0.08
	68	73	71	57	57	73	71	57
Tri I+II+III	-0.150	0.054	0.150	0.269	0.061	0.046	0.111	0.196
	0.21	0.64	0.20	0.03*	0.64	0.69	0.34	0.13
	69	74	73	60	58	74	73	59
PROTEIN, g								
Tri I	-0.286	-0.004	-0.314	-0.097	-0.218	-0.055	-0.317	0.133
	0.23	0.98	0.18	0.72	0.40	0.82	0.18	0.64
	19	19	19	15	17	19	19	14
Tri II	0.179	0.036	0.134	0.282	0.047	0.070	0.099	0.176
	0.28	0.82	0.41	0.13	0.79	0.67	0.54	0.35
	37	38	39	30	33	38	39	29
Tri III	0.061	0.006	-0.063	-0.038	0.044	-0.063	-0.094	0.026
	0.61	0.95	0.59	0.77	0.74	0.59	0.43	0.84
	68	73	71	57	57	73	71	57
Tri I+II+III	0.110	0.013	0.010	0.036	0.042	-0.044	-0.040	0.130
	0.36	0.91	0.93	0.78	0.75	0.70	0.73	0.32
	69	74	73	60	58	74	73	59

TABLE 31.3 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
ANIMAL PROTEIN, g								
Tri I	0.178	0.180	0.295	0.424	-0.041	0.241	0.180	0.113
	0.46	0.46	0.21	0.11	0.87	0.31	0.45	0.70
	19	19	19	15	17	19	19	14
Tri II	**0.272**	0.228	**0.440**	**0.421**	0.224	**0.271**	**0.378**	**0.314**
	0.10*	0.16	**0.00***	**0.02***	0.20	**0.09***	**0.01***	**0.09***
	37	38	39	30	33	38	39	29
Tri III	-0.111	0.046	0.072	0.116	0.156	0.038	0.051	0.178
	0.36	0.69	0.54	0.38	0.24	0.74	0.67	0.18
	68	73	71	57	57	73	71	57
Tri I+II+III	-0.013	0.093	0.166	**0.209**	0.180	0.111	0.139	**0.235**
	0.91	0.42	0.15	**0.10***	0.17	0.34	0.24	**0.07***
	69	74	73	60	58	74	73	59
% ANIMAL KCAL								
Tri I	**0.419**	0.290	**0.434**	**0.601**	0.087	**0.381**	0.321	0.092
	0.07*	0.22	**0.06***	**0.01***	0.73	**0.10***	0.17	0.75
	19	19	19	15	17	19	19	14
Tri II	**0.271**	0.233	**0.464**	**0.477**	0.217	0.255	**0.377**	**0.362**
	0.10*	0.15	**0.00***	**0.00***	0.22	0.12	**0.01***	**0.05***
	37	38	39	30	33	38	39	29
Tri III	**-0.200**	0.009	0.094	0.187	0.096	-0.001	0.061	0.194
	0.10*	0.93	0.43	0.16	0.47	0.98	0.60	0.14
	68	73	71	57	57	73	71	57
Tri I+II+III	-0.100	0.050	0.155	**0.250**	0.109	0.059	0.118	0.205
	0.41	0.66	0.19	**0.04***	0.41	0.61	0.31	0.11
	69	74	73	60	58	74	73	5

B. Maternal Characteristics During Pregnancy and Infant Growth

1. Maternal height, weight and weight change.

Maternal weight during pregnancy was strongly associated with the change in infant weight between 90 and 195, 0 and 195, and 30 and 195 days of age. The pattern was for the correlation to become increasingly strong between maternal weights later in pregnancy and infant weight increase after 90 days. The correlation between total infant weight gain in the first 6 months and maternal weight at the end of pregnancy was 0.56 ($p < .001$).

Maternal height is strongly associated with infant weight changes between the third and sixth month of age ($r = 0.31$, $p < .001$), and infant length change between the first and third postpartum months ($r = 0.35$, $p < .001$). Correlations between maternal weight gain in pregnancy and infant growth were not strong, except between maternal gain in the third trimester and infant weight change ($r = 0.33$, $p = 0.04$ for change between 0 and 6 months).

2. Maternal diet.

The only significant correlation between maternal kcal intake in pregnancy and postnatal growth was in trimester I (negative with weight change from 0 to 30 days, but with only 17 subjects). However, in the first and second trimesters and overall, maternal intake of animal kcal was associated with infant weight change after 3 months of age ($r = 0.40$, $p = 0.04$ for animal kcal intake in trimester III and infant weight change during the first 6 months). Kcal from animal sources in trimester 3 and overall was also associated with change in infant length between 1 and 6 months. In every trimester, percent of kcal and protein from animal sources were correlated with infant weight change and length change after 3 months ($r = 0.33$, $p = 0.01$ for overall percent animal kcal and weight change between 3 and 6 months). At no point in time did kcal from vegetable sources correlate significantly with infant growth.

3. Maternal RMR and available energy.

Average maternal RMR predicted growth in weight and length of infants at most ages including birth ($r = 0.51$, $p = 0.001$ for weight increase between 0 and 6 months; again this is an indicator of maternal size). Available energy (A.E.) was negatively associated with infant weight change in most intervals.

C. Maternal Characteristics During Lactation and Infant Size

Table 31.4 shows the correlations of maternal characteristics in lactation with infant weight and length during the first six postpartum months.

1. Maternal weight and weight change.

In general, maternal weight at 1, 3 and 6 months of lactation was strongly, positively associated with both infant weight and length at the same times. The correlation coefficients were even higher at 6 months of age than they were earlier in infancy.

Maternal postpartum weight change was not associated with infant size at any time.

Fatter women tended to have infants who were heavier from birth onwards and greater in length from one month onwards, with the association being especially strong when the infant is six months old. However, postpartum changes in maternal fatness were not strongly associated with infant size, except that women with more fat loss between 1 and 3 months had heavier infants at birth and 1 month.

TABLE 31.4
CORRELATIONS BETWEEN MATERNAL ANTHROPOMETRY AND RMR IN LACTATION AND INFANT SIZE

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
WEIGHT								
Day 30	0.211	0.208	0.302	0.406	0.200	0.137	0.283	0.317
	0.04*	0.03*	0.00*	0.00*	0.07*	0.17	0.00*	0.00*
	90	101	98	83	78	99	99	83
Day 90	0.189	0.257	0.232	0.428	0.252	0.206	0.313	0.349
	0.08*	0.01*	0.02*	0.00*	0.03*	0.05*	0.00*	0.00*
	84	91	99	84	72	90	100	84
Day 195	0.129	0.221	0.231	0.406	0.172	0.131	0.240	0.263
	0.23	0.03*	0.02*	0.00*	0.13	0.21	0.01*	0.01*
	85	93	95	90	75	92	96	89
WEIGHT CHANGE								
Day 30 to 90	0.094	-0.005	-.062	-0.045	0.094	-0.000	-0.068	-0.026
	0.39	0.95	0.55	0.69	0.43	0.99	0.50	0.81
	82	91	94	78	70	90	95	78
Day 90 to 195	0.118	-0.010	0.076	-0.136	0.267	0.035	0.042	-0.049
	0.29	0.92	0.47	0.21	0.02*	0.74	0.68	0.65
	80	87	91	83	70	86	92	83
Day 30 to 195	0.132	-0.009	0.058	-0.081	0.132	0.005	-0.020	-0.064
	0.23	0.92	0.58	0.46	0.26	0.95	0.84	0.56
	83	93	92	82	73	92	93	82
PERCENT FAT								
Day 30	0.289	0.218	0.175	0.344	0.091	0.171	0.177	0.292
	0.00*	0.03*	0.09*	0.00*	0.44	0.10*	0.08*	0.01*
	83	93	92	76	73	93	93	76
Day 90	0.181	0.089	0.123	0.342	0.088	0.067	0.161	0.329
	0.10*	0.40	0.24	0.00*	0.46	0.53	0.12	0.00*
	81	88	92	81	69	87	93	81
Day 95	0.078	0.097	0.153	0.220	0.146	0.152	0.185	0.186
	0.52	0.41	0.18	0.06*	0.26	0.19	0.10*	.12
	68	73	75	69	60	73	76	69

TABLE 31.4 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
FAT CHANGE								
Day 30 to 90	0.230	0.203	0.098	0.005	0.107	0.158	0.021	-0.074
	0.04*	0.06*	0.37	0.96	0.39	0.14	0.84	0.53
	76	84	85	70	66	84	86	70
Day 90 to 195	-0.032	-0.153	-0.096	-0.025	-0.141	-0.229	-0.058	0.008
	0.80	0.21	0.43	0.84	0.31	0.06*	0.63	0.94
	61	66	68	63	53	66	69	63
Day 0 to 195	0.180	-0.013	-0.075	-0.056	-0.030	-0.062	-0.046	-0.028
	0.15	0.91	0.53	0.65	0.82	0.60	0.69	0.82
	64	70	70	63	57	70	71	63
MEAN RMR	0.047	0.010	0.020	0.085	0.161	0.076	0.138	0.059
	0.66	0.91	0.84	0.44	0.17	0.47	0.17	0.59
	82	92	96	81	71	91	97	81

2. Maternal diet.

At no stage of lactation up to 6 months were the mean intake of kcal, kcal from vegetable sources, or % kcal from vegetable sources, correlated with infant size (Table 31.5). Interestingly, maternal consumption of energy and protein between 6 and 8 months were related to infant weight and length at 6 months - perhaps reflecting the higher energy requirements for milk to feed larger infants. In contrast, the intake of animal kcal between months 3 and 6, and the mean overall % kcal from animal sources, grams of animal protein, and % animal protein, were significantly correlated with infant weight at all times from the first month of age, and with infant length and weight at both one and six months.

3. Maternal RMR and available energy.

Neither mean RMR nor mean available energy in lactation were correlated with infant size at any time.

TABLE 31.5
CORRELATIONS BETWEEN MATERNAL DIET IN LACTATION AND INFANT SIZE

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
ENERGY INTAKE								
Day 0 to 90	-0.059	-0.011	-0.050	-0.031	-0.068	-0.036	-0.062	-0.067
	0.58	0.91	0.62	0.78	0.55	0.72	0.55	0.55
	86	93	94	78	75	92	94	78
Day 90 to 195	0.067	0.07[illegible]	-0.024	0.023	-0.046	0.023	0.057	0.035
	0.54	0.47	0.81	0.83	0.70	0.82	0.58	0.75
	82	90	93	81	71	89	94	781
Day 195 to 254	0.076	0.091	0.145	**0.253**	**-0.162**	**0.032**	**0.097**	**0.222**
	0.51	0.41	0.18	**0.02***	**0.20**	**0.77**	**0.36**	**0.05***
	74	81	85	77	63	80	86	77
Day 0 to 195	0.043	0.079	0.047	0.113	-0.057	0.033	0.084	0.102
	0.68	0.43	0.63	0.29	0.61	0.74	0.39	0.34
	89	98	101	86	77	97	102	86
ANIMAL KCAL								
Day 0 to 90	0.016	0.123	0.105	0.125	0.049	0.046	0.022	0.021
	0.88	0.23	0.31	0.27	0.67	0.65	0.82	0.85
	86	93	94	78	75	92	94	78
Day 90 to 195	0.188	**0.188**	**0.122**	**0.208**	0.136	0.114	0.108	0.196
	0.09*	**0.07***	0.24	**0.06***	**0.25**	**0.28**	**0.29**	**0.07**
	82	90	93	81	71	89	94	81
Day 195 to 254	0.155	**0.229**	**0.221**	**0.240**	0.027	0.061	0.086	0.181
	0.18	**0.03***	**0.04***	**0.03***	**0.83**	**0.59**	**0.43**	**0.11**
	74	81	85	77	63	80	86	77
Day 0 to 195	0.121	0.192	0.171	0.203	0.091	0.090	0.081	0.153
	0.25	**0.05***	**0.08***	**0.05***	**0.43**	**0.37**	**0.41**	**0.15**
	89	98	101	86	77	97	102	86
MEAN VEG KCAL								
	0.010	0.037	0.006	0.066	-0.087	0.013	0.066	0.068
	0.92	0.71	0.95	0.56	0.44	0.89	0.50	0.53
	89	98	101	86	77	97	102	86

TABLE 31.5 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
% ANIMAL KCAL								
Day 0 to 90	0.059	0.112	0.139	0.130	0.043	0.032	0.060	0.031
	0.58	0.28	0.17	0.25	0.71	0.75	0.56	0.78
	86	93	94	78	75	92	94	78
Day 90 to 195	0.195	0.158	0.104	**0.209**	**0.160**	**0.121**	**0.078**	**0.196**
	0.07*	**0.13**	0.31	**0.06***	0.18	0.25	0.45	**0.07***
	82	90	93	81	71	89	94	81
Day 195 to 254	0.153	**0.207**	**0.217**	**0.214**	0.087	**0.066**	**0.083**	**0.145**
	0.19	**0.06***	**0.04***	**0.06***	0.49	0.55	0.44	0.20
	74	81	85	77	63	80	86	77
Day 0 to 195	0.136	**0.165**	**0.170**	**0.191**	0.100	0.087	0.059	0.138
	0.20	**0.10***	**0.08***	**0.07***	0.38	0.39	0.55	0.20
	89	98	101	86	77	97	102	86
PROTEIN, grams								
Day 0 to 90	-0.045	0.057	0.031	0.058	-0.035	-0.001	-0.026	-0.012
	0.67	0.58	0.76	0.60	0.76	0.98	0.79	0.91
	86	93	94	78	75	92	94	78
Day 90 to 195	0.056	0.120	-0.022	0.067	-0.048	0.023	0.024	0.057
	0.61	0.25	0.82	0.54	0.68	0.82	0.81	0.61
	82	90	93	81	71	89	94	81
Day 195 to 254	0.047	0.153	**0.184**	**0.313**	**-0.172**	**0.060**	**0.097**	**0.213**
	0.68	0.17	**0.09***	**0.00***	0.17	0.59	0.37	**0.06***
	74	81	85	77	63	80	86	77
Day 0 to 195	0.031	0.141	0.090	0.165	-0.051	0.059	0.083	0.104
	0.76	0.16	0.37	0.12	0.65	0.56	0.40	0.33
	89	98	101	86	77	97	102	86

TABLE 31.5 continued

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
ANIMAL PROTEIN, grams								
Day 0 to 90	0.019	0.093	0.144	0.117	0.061	0.028	0.070	0.042
	0.85	0.37	0.16	0.30	0.60	0.78	0.49	0.71
	86	93	94	78	75	92	94	78
Day 90 to 195	**0.185**	0.155	0.090	**0.190**	0.168	0.096	0.091	**0.189**
	0.09*	**0.14**	0.38	**0.08***	0.16	0.37	0.38	**0.08***
	82	90	93	81	71	89	94	81
Day 195 to 254	0.163	0.233	0.244	**0.286**	0.028	0.087	0.094	0.181
	0.16	**0.03***	0.02*	**0.01***	0.82	0.44	0.38	0.11
	74	81	85	77	63	80	86	77
Day 0 to 195	0.120	**0.164**	**0.170**	**0.190**	0.116	0.084	0.097	0.150
	0.25	**0.10***	**0.08***	**0.07***	0.31	0.40	0.33	0.16
	89	98	101	86	77	97	102	86
% ANIMAL PROTEIN								
Day 0 to 90	0.084	0.073	**0.166**	0.120	0.075	0.001	0.091	0.052
	0.44	0.48	**0.10***	0.29	0.52	0.99	0.38	0.64
	86	93	94	78	75	92	94	78
Day 90 to 195	**0.222**	0.107	0.062	**0.187**	**0.216**	0.095	0.060	**0.189**
	0.04*	0.31	0.55*	**0.09***	**0.06***	0.37	0.55	**0.09***
	82	90	93	81	71	89	94	81
Day 195 to 254	0.170	0.179	0.214	0.203	0.098	0.075	0.053	0.123
	0.14	**0.10***	**0.04***	**0.07***	0.44	0.50	0.62	0.28
	74	81	85	77	63	80	86	77
Day 0 to 195	0.151	0.118	0.153	0.165	0.143	0.065	0.047	0.133
	0.15	0.24	0.12	0.12	0.21	0.52	0.63	0.22
	89	98	101	86	77	97	102	86

D. Maternal Variables During Lactation and Infant Growth

1. Maternal weight and weight change

Maternal weight throughout lactation was significantly and consistently correlated with infant growth in weight and length during the first six months of age ($r = 0.472$, $p = 0.001$ for mothers weight at 6 months and infant weight increase between birth and 6 months). Mother's height predicted weight and length change of the infant after months 3 and 1 respectively. Mothers who lost least weight and fat during months 3 through 6 of lactation, and who were fatter, had infants who gained more rapidly ($r = -0.31$, $p = 0.006$, for maternal weight change and infant weight gain from 3 to 6 months).

2. Maternal diet

The energy and protein intakes of the mother between 6 and 8 months postpartum were positively associated with the rate of increase in infant weight and length between 1 and 6 months (infant weight with kcal, $r = 0.30$, $p = 0.01$ and with protein, $r = 0.34$, $p = 0.006$). Maternal intake of kcal from animal sources showed no consistent pattern of associations with infant growth, and the correlation never exceeded 0.20.

E. Correlations with Infant Fatness

The sum of infant skinfolds was calculated at 1, 3 and 6 months, and this estimate of fatness was correlated with a number of maternal and environmental factors. A number of the explanatory variables described in Tables 31.2 and 31.3 showed significant correlations with infant skinfolds. Neither the weight nor the height of the pregnant mother, nor her weight gain in pregnancy, predicted infant fatness at any age. However, gain in fatness between months 1 to 6 was higher in infants whose mothers weighed more at 137 days ($r = 0.43$, $p = 0.02$) and 280 days ($r = 0.27$, $p = 0.05$) of pregnancy. Maternal weight changes during lactation were not correlated with the sum of infant skinfolds but did show a strong association with changes in infant skinfolds. Between 1 and 3, and 3 and 6 months of age, the increase in infant skinfolds was greater if the mother gained weight (or lost less) between months 1 and 6 of lactation ($r = -0.22$, $p = 0.05$ and $r = -0.41$, $p = 0.0002$ from 1 to 3 and 3 to 6 months of age respectively). There were also associations between: maternal percent fat at 30 days of lactation and infant skinfolds at 3 months ($r = 0.22$, $p = 0.05$); average maternal animal kcal intake during lactation (mostly explained by intake between months 6 and 8) and infant skinfolds at days 30 and 90 ($r = .20$, $p < .05$); maternal total kcal intake between 6 and 8 months of lactation and infant skinfolds at 6 months ($r = 0.23$, $p = 0.05$).

Thus it appears that fatter infants have mothers who are heavier and fatter, lose less weight during lactation, and consume more total kcal and animal kcal between 6 and 8 months postpartum.

Mothers who had a greater amount of illness during lactation had infants with larger skinfolds at 1 and 3 months ($r = 0.20$, $p < .05$), and a tendency toward larger skinfolds at 6 months ($p < 0.06$). There was no association between any of the infant morbidity variables and infant skinfolds.

Fatter children at 6 months also came from homes with higher (cleaner) external ($r = 0.27$, $p = 0.01$) and internal ($r = 0.26$, $p = 0.02$) sanitation scores, attributable to their faster rate of fat increase between months 1 and 6. Infants from larger households had smaller skinfolds at months 1 ($r = -0.27$, $p = 0.007$) and 3. The appearance of the mother, schooler and preschooler were positively associated with infant skinfold thickness at 3 and 6 months (cleaner appearance scored higher); the correlation was strongest at 6 months with the appearance of the preschooler ($r = 0.23$, $p = 0.03$). Mothers with higher socioeconomic status had a greater percent of body fat throughout lactation ($r = 0.29$, $p = 0.006$ at 6 months).

To summarize these simple associations, it appears that infants who have the greatest increase in fatness have fatter, heavier mothers who eat more. They also live in cleaner, smaller, and wealthier households. However, there were no detectable relationships between infants' skinfold measures or changes and either infant or maternal morbidity during lactation.

F. Correlations between Maternal Diet and Other Variables

Mean kcal from animal sources (but not total kcal) and the percent of kcal and protein from animal sources were significantly correlated with SES, external and internal sanitation, and the appearance of mothers, schoolers and preschoplers in the households. Total kcal intake in pregnancy and in lactation were significantly associated only with internal sanitation.

Maternal height is not significantly correlated with total kcal or protein intake at any time. However, taller women consumed more and a higher percentage of animal kcal in the second trimester, and a higher percentage of animal kcal throughout lactation. Why there should be significant associations between maternal height and animal product intake

is not clear. However, these associations between maternal intake--especially of animal products--and maternal height, as well as with a number of environmental variables, suggest that those between animal product intake and other variables must be interpreted with caution.

There were no consistent patterns of association between maternal weight or weight gain in pregnancy and any diet variables. At each stage of lactation, intriguing negative correlations (N subjects $\geq$ 69) were seen between the amount of kcal, vegetable kcal, and protein consumed during the second and third trimesters of pregnancy and maternal postpartum weight (for kcal, r = -0.20 to -0.31, p = .05). In other words, women who consumed more kcals during late pregnancy were smaller postpartum. They also lost consistently more weight throughout lactation (e.g. r = 0.31, p = 0.01 for intake average energy intake in pregnancy and maternal weight loss 1 to 6 months postpartum), had a lower percent fat at 3 and 6 months of lactation (r = -0.45, p = 0.0002 at 6 months), and lost more fat between 3 and 6 months (r = 0.41, p = 0.001). These same, if not stronger patterns were seen between protein intake in pregnancy and postpartum body composition changes (e.g. average protein intake in pregnancy and maternal percent fat at 6 months, r = -0.46, p = 0.0002).

In contrast, pregnancy intake of kcal and protein from animal sources was not correlated with postpartum weight, but predicted more weight increase (or less loss) between 1 and 6 months (r = -0.29, p = 0.01 for kcal).

No diet variables were significantly correlated with maternal lactation weight, weight change, fatness, or fat change at any time point.

The importance of these observations is that a higher energy intake in pregnancy may be related to postpartum infant growth through the amount of maternal energy stores that are available for (or used during) milk synthesis.

G. Maternal and Infant Morbidity

Women from larger households had more pregnancy complications (r = 0.25, p = .01). Postpartum weight loss was lower in those mothers who had more complications in pregnancy (r = -0.29, p = 0.05 for the period 3 to 6 months postpartum).

Maternal morbidity (total illness) during lactation was positively associated with infant size (especially weight) and fatness throughout infancy, e.g. with infant weight at 6 months the correlation was 0.23 (p = 0.03). Infant weight and skinfold changes, however, were unrelated to maternal morbidity. Reported maternal illness in lactation was highly related to reported infant illness (r = 0.40, p = 0.0001).

Morbidity variable constructs of (total days ill / observed) and (total days diarrhea / observed) were correlated with the variables measuring socioeconomic status, external sanitation, and internal sanitation. The results are as follows;

INFANTS TOTAL DAYS DIARRHEA/DAYS OBSERVED (p-values)

	N	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
External Sanit.	(71)	NS	.13	.08	.03	NS	NS	NS
Internal Sanit.	(71)	NS	NS	NS	.003	NS	NS	NS

INFANTS TOTAL DAYS DIARRHEA/DAYS OBSERVED (p-values)

	N	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
External Sanit.	(71)	NS	.004	.18	NS	NS	NS	NS
Internal Sanit.	(71)	NS	.03	NS	NS	NS	NS	NS

There are several possible explanations for this that need to be further explored. One potential explanation is that the morbidity measure is less reliable as an indicator of infant illness, and more reliable as a proxy for the mothers' ability to observe, and willingness to report, illness in her infant. The condition of sanitation was observed by the investigator, while the condition of the child's health was reported by the mother. Mothers in dirty houses may be less able to identify the symptoms of illness in their infant. The facts that i) mothers in cleaner houses tend to report more illness, ii) the frequency of maternal and infant illnesses is strongly associated, and iii) sicker mothers have fatter infants, supports this suggestion. This will be tested through similar situations in other data sets, and against other measures of maternal care-taking ability.

The seven month mean incidence rate of total illnesses of infants was not significantly correlated with: external sanitation, internal sanitation, socioeconomic status, and mother's average morbidity during pregnancy, (N=127). The mean days ill / days observed for diarrhea was not significantly correlated with socioeconomic status. The average days ill / days observed for the infant was not associated with infant size at any age included in these analyses. Infants born to women who ate more animal energy and protein during pregnancy had less morbidity during months 1 to 3 postpartum ($r = -0.30$, $p = 0.02$). Likewise, maternal intake of both total and animal energy and protein were associated with less infant illness between 3 and 6 months of age.

H. Socioeconomic Status Variables

Socioeconomic status was not related to the size or growth rate of the infant at any age (Table 31.6).

Women with poorer socioeconomic status weighed less at mid-pregnancy and the end of pregnancy ($r = 0.24$, $p < .05$), but were not different in weight at other times during pregnancy, nor did they differ in the amount of pregnancy weight gain. Higher SES women were taller ($r = 0.25$, $p = 0.004$), and had fewer complications during pregnancy ($r = 0.21$, $p = 0.03$).

Socioeconomic status was consistently positively related to the mother's weight ($r = 0.32$, $p = 0.0005$ at 6 months) and her fatness ($r = 0.29$, $p = 0.006$) throughout the first 6 months postpartum, and was consistently marginally ($p = 0.12$) associated with less weight and fatness loss during the same period.

I. Sanitation and Child Care Variables

Weight in pregnancy was not associated with sanitation or child care variables. In households which had better internal and external sanitation, and where the mother, schooler and youngest child had a cleaner appearance, mothers gained more weight during the last trimester of pregnancy (e.g. $r = 0.32$, $p = 0.02$ with external sanitation), and also gained more (or lost less) weight during lactation ($r = 0.19$ to 0.29, $p < 0.05$).

Several factors in the infant's environment correlate with its weight (but not length) during the first six months of age (Table 31.6). The strongest and most consistent of these were indicators of maternal "sanitary practices and child care". Specifically, the external and internal sanitation of the household, and the appearance of the mother and preschooler sibling, were positively associated with infant weight between 1 and 6 months and weight change during this period. More persons in the household predicted smaller infant weight (at 1 and 3 months) and length (at birth and 1 month). Since the effect of household size is more significant in the first 3 months, this may be operating through the parity of the mother rather than through household resources. Neither the number of females over 12 years of age, nor number of children less than 6 years of age, was related to infant size at any age.

In summary, infants increased faster in weight from birth onwards if the exterior and interior sanitatary conditions of their homes were better, and if the preschoolers and mothers in the household appeared cleaner, but they grew more slowly if the number of teenage women in the household was higher.

TABLE 31.6
CORRELATIONS BETWEEN SOCIAL AND ENVIRONMENTAL VARIABLES AND INFANT SIZE

MATERNAL VARIABLES	INFANT WEIGHT BIRTH	30 DAYS	90 DAYS	195 DAYS	INFANT LENGTH BIRTH	30 DAYS	90 DAYS	195 DAYS
SES	0.024	0.136	0.038	0.126	-0.078	0.015	0.058	0.019
	0.82	0.17	0.70	0.23	0.48	0.88	0.55	0.85
	92	101	103	90	80	99	104	89
EXT. SANITATION	-0.026	**0.271**	**0.223**	**0.288**	0.066	0.098	0.074	0.085
	0.80	**0.00***	**0.02***	**0.00***	**0.56**	**0.33**	**0.45**	**0.42**
	91	99	102	90	78	98	103	89
INT. SANITATION	0.028	**0.189**	**0.187**	**0.274**	0.056	0.092	0.091	0.114
	0.79	**0.06***	**0.05***	**0.00***	0.62	0.36	0.36	0.28
	91	99	102	90	78	98	103	89
MOTHER'S APPEAR.	0.007	**0.186**	**0.227**	**0.218**	0.082	0.118	0.147	0.138
	0.94	**0.06***	**0.02***	**0.03***	**0.47**	**0.24**	**0.13**	**0.19**
	91	99	102	90	78	98	103	89
SCHOOLER'S APPEAR.	-0.032	0.110	0.115	0.125	0.017	0.099	0.135	0.132
	0.76	0.29	0.26	0.25	0.88	0.34	0.18	0.22
	83	91	95	85	71	90	96	84
YOUNGEST'S APPEAR	-0.007	**0.225**	**0.225**	**0.251**	0.109	0.121	0.158	0.138
	0.94	**0.02***	**0.02***	**0.01***	0.33	0.23	0.11	0.19
	90	97	102	90	78	96	103	89
# IN HOUSEHOLD	-0.059	**-0.176**	**-0.210**	**-0.114**	**-0.234**	**-0.243**	-0.113	-0.152
	0.56	**0.07***	**0.03***	0.28	**0.03***	**0.01***	0.25	0.15
	94	102	103	91	81	100	104	90
# ADULT WOMEN	-0.002	-0.036	0.057	0.121	-0.095	-0.092	0.020	0.038
	0.97	0.71	0.56	0.25	0.39	0.35	0.83	0.71
	94	102	103	91	81	100	104	90
# WOMEN >12 YRS	0.069	0.102	0.076	-0.041	-0.023	0.027	0.085	0.037
	0.50	0.30	0.43	0.69	0.83	0.78	0.38	0.72
	94	102	103	91	81	100	104	90

V. MULTIVARIATE ANALYSES

A. Selection of Variables

From the above univariate analyses, patterns of relationships among variables were discerned. These patterns were entered into models using fewer, non-collinear variables. When members of a group of variables were highly correlated with each other, e.g. internal sanitation and child care, energy and protein intake, or maternal weight in trimesters 2 and 3 of pregnancy, only one of these variables was selected for the multivariate analyses. Variables were chosen for entry into each model based on their reasonableness from a biological perspective, and their lack of collinearity.

The SAS Stepwise Regression procedure was used by both the Mexico and Connecticut groups, except that Connecticut included the maximum R^2 improvement option. The maximum R^2 improvement method begins by finding the one-variable model producing the highest R^2. Then another variable, the one that produces the greatest increase in R^2, is added. At the point at which the two-variable model is obtained, each of the variables not in the model is compared to each variable in the model, and the procedure determines if removing one variable and replacing it with the other will increase the R^2. All possible switches are checked, with the one that is finally made producing the largest increase in R^2. The new comparisons start again and the procedure continues until no switches increase R^2. In the results presented here, variables were accepted as contributing significantly to the total variance explained if their F statistic reflecting its contribution to the model was $p < 0.10$. The maximum R^2 improvement option is considered superior to the regular Stepwise procedure because it checks whether the variables in the preceding step remain significant contributors to the total variance after comparing each variable in the model to each variable not in the model.

In the results presented below, associations are positive unless otherwise indicated. The hypotheses addressed here are those that the Principal Investigators of the CRSP agreed would be tested by all three projects.

B. Tests of Hypotheses Using Multivariate Models

1. Model # 1.

The general hypothesis tested was:

> Maternal energy intake during pregnancy affects maternal weight gain and body composition.

a) The Mexico model

The diet variable was mean energy intake for each month of pregnancy (two days per month).

Dependent (explained) variables were: weight in the last month of pregnancy, percent body fat in the last month of pregnancy (calculated using Durnin and Womersley's formula, although it is recognized that the values only approximate relative fatness in pregnant women), and the rate of weight gain between the 5th and 9th month of pregnancy.

Confounding explanatory variables were: monthly maternal weights; family composition (number of children <12 years of age, number 6 to 12 years of age, number of females >12 years and number of males >12 years of age); seasonality (three 4-month periods coded as dummy variables); socioeconomic status and sanitation variables; morbidity (days ill/days observed for gastrointestinal, respiratory {upper and lower combined}, fever, other); severity of these illnesses (% resulting in total or partial incapacity, or loss of appetite); presence or absence of appropriate treatment (treatment that would reduce the duration of an illness or reduce fever); number of abortions; parity (1 or ≥ 6 for high risk, 2 to 5 for low risk); interval since last pregnancy (a dummy variable of 1 if less than 12 months); pregnancy complications (excessive early vomiting, edema, vaginal bleeding).

Results of Stepwise Regression Analyses

i) Weight at the end of pregnancy.

Apart from weight at months 7 and 8, which predicted 56% of the variance in weight at month 9, other variables that reached the level of significance to stay in the model were kcal intake in the 6th month of pregnancy, percent fat of the mother at the 5th month (negative, $p = 0.09$), percent of respiratory episodes resulting in a mild incapacity (negative, $p = 0.06$), percent of gastrointestinal episodes resulting in a moderate incapacity (negative, $p = 0.06$), percent of gastrointestinal episodes that received adequate treatment (negative, $p = 0.06$), socioeconomic status ($p = 0.07$), and the occurrence of the birth during May to August ($p = 0.02$).

ii) Percent fat at the end of pregnancy.

Percent fat during the previous three months (6 to 8) explained 45% of the variability at 9 months. Other variables that entered the model were total kcal consumed in month 7 ($p = 0.01$) and month 9 ($p = 0.0001$), percent of gastrointestinal episodes that resulted in severe incapacity (negative, $p = 0.01$), percent of fever episodes that were treated ($p = 0.03$), parity ($p = 0.05$), socioeconomic status ($p = 0.08$) and number of males over 12 years of age (negative, $p = 0.003$).

iii) Slope of maternal weight gain, 5 to 9 months.

Only anthropometric and obstetric variables made a significant contribution. These were the weight of the mother at 8 months ($p = 0.004$), percent fat at 5 months ($p = 0.006$), excessive vomiting early in pregnancy (negative, $p = 0.01$), and percent of fever episodes treated ($p = 0.08$).

iv) Summary and discussion of the Mexico analyses.

The energy intake of the mother, especially in the second trimester, was positively related to mother's weight and fatness at the end of pregnancy. Women with a lower percent body fat at 5 months were heavier at the end of gestation and had the highest rates of weight gain between months 5 and 9. Further work is needed to explore the direction of causality here. "Treated fever episodes" had a positive association, and gastrointestinal illnesses a negative one, with both percent body fat and weight at the end of pregnancy. Excessive vomiting in early pregnancy had a negative association with weight gain. The effect of parity on percent fat is probably attributable to the higher percent body fat of older women (Chapter 22), but this possibility needs to be explored further. Socioeconomic status was related to both mother's weight and fatness in late pregnancy. There are a number of ways in which the presence of more males over 12 years of age could have negatively influenced maternal fatness, including a heavy work load on the mother and reduced food availability for the mother.

b) The Connecticut model

Diet variables were average energy intake in pregnancy, average animal kcal in pregnancy, and average % animal kcal in pregnancy.

Dependent (explained) variables were: sum of weight change in all trimesters, weight change mid-to-late pregnancy, weight change in the second trimester, and weight change during the last trimester.

Confounding explanatory variables included: mother's weight at day 0 to 93, mothers % fat at day 30, mother's height, socioeconomic status, pregnancy complications, appearance of mother, internal sanitation, and number in household.

Results of Stepwise Regression Analyses

i) Predictions of total weight change in pregnancy (0 to 280 days).

None of the explanatory variables entered significantly into the model.

ii) Predictions of maternal weight change, mid- to late pregnancy (137 to 280 days).

The best predictor was average intake of animal kcal during pregnancy, having a correlation coefficient of 0.46 with the weight gain variable. However, plots of average animal kcal intake in pregnancy and weight at 137 and 186 days of pregnancy revealed that the three smallest women in the sample had the highest animal kcal intakes in both periods and relatively large weight gains, thus greatly increasing the strength of the correlations. With this caution, the variables that entered significantly into the model were: average intake of animal kcal, maternal percent fat at 30 days postpartum (assumed here to be a reasonable proxy for relative maternal fatness at 137 days of pregnancy),

socioeconomic status, and total pregnancy complications (negative). The model explained 61% of the variance in weight gain during the last half of pregnancy.

iii) Predictions of maternal weight change, second trimester of pregnancy (93 to 186 days).

The variables that entered significantly into the final model were: average energy intake during pregnancy and total pregnancy complications (negative), together explaining 34% of the variance in second trimester weight gain.

iv) Predictions of maternal weight change, last trimester of pregnancy (186 to 280 days).

None of the explanatory variables entered significantly into the model.

v) Predictions of maternal fat at 30 days postpartum.

Since the Durnin and Womersley formula is not valid for calculating the percent fat of pregnant women, fatness at 30 days postpartum was used as the outcome. Changes in fatness may have occurred during the first 30 days postpartum, but these are not large in well-nourished women. No diet variables entered the model. Maternal weight at the end of pregnancy was the only variable to contribute significantly, explaining 37.1% of the variance in her fatness at 30 days postpartum.

2. Model #2.

The variables used were those described above for Connecticut's model #1. The hypothesis tested was:

> Maternal energy intake during pregnancy affects birth weight.

Only maternal weight at the end of pregnancy was significant in the model to predict birthweight, explaining only 7.0% of the variance. Average energy intake in pregnancy and socioeconomic status entered with a weak level of significance ($p < 0.10$) and the three variables explained 19.7% of the variance.

3. Model #3.

For this and subsequent models, the analysis variables were as follows.

Diet variables were maternal energy intake 6 - 8 months, and 0 - 8 months of lactation; animal kcal intake 6 - 8 months, and 0 to 8 months of lactation; and average percent kcal from animal sources in lactation.

Dependent (explained) variables were infant weight at 6 months, change in infant skinfolds 1 to 6 months, and infant weight change between 0 and 6 months and 1 and 6 months.

Confounding explanatory variables were maternal height, maternal weight at end of pregnancy, maternal % fat and weight at months 1, 3 and 6 of lactation, maternal weight change and fat change 1 to 6 months of lactation, number of persons in household, socioeconomic status, young child's appearance, internal sanitation, mothers and infants average % days ill in lactation, and birth weight.

The hypothesis in Model #3 was:

> Maternal intake during lactation affects infant size at 6 months.

i) Predictors of infant weight at 6 months

The infant's weight at 6 months was predicted by mother's weight at the end of pregnancy, internal sanitation of the household, and average maternal energy intake in lactation. Together they explained 38.8% of the variance in infant size.

ii) Predictors of infant weight change from 0 to 6 months.

Predictors of the increase in infant weight during the first six months were mother's weight at the end of pregnancy (40.8% of the variance), and internal sanitation of the household, which together explained 49.4% of the variance.

iii) Predictors of infant weight change from 1 to 6 months.

A total of 41.5% of the variance in the infant's weight change was explained by mother's weight at the end of pregnancy, external sanitation, and the percent of days the infant was ill with any illness. As discussed in the context of the simple correlations, heavier infants have more reported illness, which may be an artefact of better reporting by their mothers. No diet variables entered the model.

iv) Predictors of infant skinfold thickness at 6 months.

At 1 month of age, the only significant entry into the model to predict infant skinfolds was the number of persons in the household, with fatter infants coming from smaller households. This accounted for 8.1% of the variance. A total of 14.0% of the variance in the sum of infant skinfold thicknesses at 6 months was explained by internal sanitation of the household and the mother's percent body fat at 30 days postpartum. Maternal energy intake between 6 and 8 months was weakly correlated with the infant's skinfolds at 6 months suggesting a relationship between infant fatness and the amount of dietary energy consumed by the mother to support lactation.

Variables that entered significantly into the model to predict change in infant skinfolds between 1 and 6 months were maternal height and maternal weight change postpartum. The infants of mothers who lost less (or gained more) weight postpartum had larger increases in skinfolds.

4. Model #4.

The following hypothesis was tested:

> Maternal energy intake in lactation affects changes in maternal body composition between 1 and 6 months of lactation.

No variables entered significantly into the model to predict maternal weight change in lactation except for socioeconomic status which accounted for only 4.2% of the variance. Wealthier women lost less (or gained more) weight.

The only variable to enter significantly in the model to predict percent fat at 3 months postpartum was maternal weight at the end of pregnancy (explaining 41.7% of the variance in fatness). At 6 months postpartum, the situation was similar except that mother's height also entered into the model, with the two variables explaining 48.2% of the total variance. Of the variance in fatness change between 1 and 6 months, 14.4% was explained by maternal weight at the end of pregnancy and socioeconomic status, such that heavier, wealthier women gained more (or lost less) fat during lactation.

5) Model #5.

The hypothesis tested was:

Maternal energy intake in lactation affects maternal health.

No variables predicted maternal health except for socioeconomic status, which had a weak positive relationship with the total percent of days that the mother was ill with any illness. Only 5.7% of the variance in illness was explained.

VI. SUMMARY

A. Bivariate Analyses

The most important correlate of infant size is the weight of the mother during pregnancy, especially at the end of pregnancy. Maternal weight is strongly associated with the weight and length of her infant from birth until at least 6 months of age and with the increase in weight and length of the child during this time. Maternal height is correlated with infant length up to 6 months, more so than with infant weight. Maternal weight gain in pregnancy is less strongly associated with infant size, although gain in the last trimester was significantly correlated with infant weight change between birth and 6 months.

The amount of animal kcal and protein consumed during pregnancy was correlated with the size of the infant at 6 months and its weight change, especially between the third and sixth months.

The strongest relationship between maternal and infant variables during lactation was again between the weight of the mother and both the weight and length of her infant. Maternal weight also predicted the increase in infant weight and length over this period. Although maternal postpartum weight and fat changes were not correlated with infant size, the infants of fatter women were heavier and longer, and grew faster for the first six months of age. Paternal size will be examined in future analyses.

Maternal diet was only related to infant size for the period 6 to 8 months postpartum, with women who had heavier and fatter infants consuming more energy and protein. It is likely that the mothers of heavier infants consumed more food because of the higher milk production required, but more work is necessary before cause and effect can be determined.

The fatness of infants is not related to maternal height or weight gain in pregnancy, but fatter infants are born to mothers who weighed more in the last half of pregnancy. In lactation, the mothers of fatter infants lose less (or gained more) weight, consume more animal foods during pregnancy and more total kcal and animal kcal between 6 and 8 months postpartum. They also live in cleaner, smaller, and wealthier households although there were no detectable relationships between infants' skinfold measures or changes and either infant or maternal morbidity during lactation. In lactation, no diet variables were significantly correlated with maternal weight, weight change, fatness, or fat change at any time during lactation. However, those women who consumed more animal foods in late pregnancy had less weight loss during lactation.

Higher socioeconomic status was associated with a greater consumption of animal foods, cleaner households, and a cleaner appearance of the mother and her children. While status was not related to infant size or growth, the higher socioeconomic status mothers were heavier, taller, fatter, and lost less weight during lactation. In addition, women from households with better sanitation and cleaner children gained more weight in the last trimester of pregnancy, and lost less weight in lactation. Their children grew more during the first six months of life. Infants from larger households grew less in the early postpartum months, although growth was not associated with the number of children under six years of age, or the number of females over 12 years of age. The role of parity in infant growth has yet to be explored.

The average days ill / days observed for the infant was not associated with infant size at any age included in these analyses. Infants born to women who ate more animal energy and protein during pregnancy had less morbidity during months 1 to 3 postpartum. Maternal intake of both total and animal energy and protein were associated with less infant illness between 3 and 6 months of age.

B. Multivariate Analyses

In the Connecticut model, total maternal weight gain between conception and delivery was not predicted by any variables. Between mid-pregnancy and delivery, weight gain was positively associated with a higher intake of animal foods, maternal fatness, and higher socioeconomic status. Pregnancy complications affected weight gain adversely. In the second trimester, weight gain was related to total energy intake, and again pregnancy complications had a negative influence. The Mexican model used the slope of maternal weight gain between 5 and 8 months as the equivalent outcome. Similar to Connecticut's results, weight gain was adversely affected by pregnancy complications. Thinner women at 5 months gained more weight during the remainder of pregnancy, a pattern observed in Connecticut's bivariate analyses. Mexico found no relationship between maternal diet and weight gain between months 5 and 9, but weight at the end of pregnancy was higher in mothers with a higher intake of kcal in month 6, less body fat at 5 months, fewer gastrointestinal illnesses, and higher socioeconomic status.

The general picture that emerges from these analyses is that energy intake, low maternal fatness, and higher socioeconomic status have positive influences on maternal weight gain in the second and third trimesters, while pregnancy complications and maternal morbidity have a negative influence. Women from higher socioeconomic status families, as well as those who have less pregnancy morbidity, are fatter at the end of pregnancy.

The strongest predictor of birth weight was maternal weight in late pregnancy, with weak contributions from average energy intake in pregnancy and socioeconomic status. Only 20% of the variance in birthweight was explained by these variables. Future analyses will include paternal size and restrict birthweights to those measured in the first three days, but it may be difficult to improve the existing models due to the small amount of variance in birth weight.

In general, infant size (weight and length) and growth during the first six months of life were strongly predicted by maternal weight in late pregnancy and during lactation. Associations with maternal size were even stronger at six months than they were earlier in infancy. Infants also gained more weight and fat between 1 and 6 months if their mothers were fatter, lost less weight during lactation, and came from cleaner, wealthier households. Their mothers consumed significantly more energy and protein between 6 and 8 months of lactation.

C. General Comments

The pregnancy outcome analyses support several general themes and conclusions that are emerging from the Solis data. One of these is that early malnutrition has a permanent negative effect. If we assume that earlier malnutrition is to some extent responsible for small maternal size in pregnancy and lactation, then this has negative effects on infant growth up to at least 6 months of age. Since infant weights have already fallen to the 30th percentile by 6 months, and the situation is not only worse by 18 months but shows little sign of improvement thereafter, further attention should be paid to understanding the mechanism by which maternal size affects infant size. It is important to note that maternal weight and fatness seem to be stronger predictors of infant growth than maternal height, so that current nutrient intake may also have an influence. This is supported by the observation that heavier, taller, fatter women live in wealthier households. However, we cannot rule out the possibility that these women also lived in wealthier households and were well-nourished when they were children. It is not possible to explain the small sizes of the mothers and their infants simply on a genetic basis, since Mexican-American infants who are members of families that migrate to the United States on a seasonal basis are close to the 50th percentiles of the NCHS reference standards (31.3).

From these analyses, a weak influence of current maternal diet in pregnancy and lactation outcome is apparent. The data suggest a positive association between maternal energy intake and weight gain later in pregnancy, and maternal weight in late pregnancy is in turn associated with infant growth. However, in the models tested here maternal intake

in pregnancy did not affect birth weight. Larger babies at six months of age had mothers who were consuming more energy and protein between six and eight months, though this may be explained by a higher demand for milk by these infants. Further analyses are needed to explore causality. In contrast to the situation in preschoolers where the quantity of animal foods consumed seems to be the most important dietary variable for explaining growth, mental development, and activity (Chapters 28 - 30), these foods are not prominent in explaining maternal and infant weight change.

Morbidity of the mother during pregnancy has a negative relationship with maternal weight gain, but infant morbidity was not associated with infant size. The surprising lack of relationships with infant morbidity might be partly explained by the fact that over 80% of the infants had no reported diarrhea in the first six months. If diarrhea in this age group is of short duration, then some events will have been missed by the morbidity method used here (Chapter 22). An additional concern is a potential bias in mothers' reports about infant illnesses; more infant illness events were reported by mothers from cleaner homes, with cleaner children, and who reported that they themselves were sick more often. Thus, mothers who pay more attention to hygiene may be more likely to notice and report illness.

In future analyses it is important to include the role of weaning foods in explaining poor growth and morbidity of the Solis infants. Field workers report that a common practice is to give the infants supplements of weak, sugary tea starting around three months of age, a practice that may not only adversely affect dietary quality but introduce bacterial contamination. This is supported by the observation that 12% of the non-breast milk energy intake of infants is from sugar (Chapter 20). An additional concern that remains to be examined is the extent to which maternal consumption of pulque is related to the size and growth rate of the infants.

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PART IV

DISCUSSION

Chapter 32

SUMMARY AND CONCLUSIONS

This project was designed to measure the impact of marginal malnutrition on the function of households and specific (target) types of individuals in a rural region of Mexico. It was primarily a collaborative effort between investigators in the University of Connecticut's Department of Nutritional Sciences and the Instituto Nacional de la Nutricion in Mexico City. Additional collaborators included investigators from the Universities of Florida and Massachusetts, and Florida International University. Parallel projects were conducted in Egypt and Kenya, and the Managemnent Entity at the University of California, Berkeley coordinated the work of all three projects.

The valley of Solis was selected as the Mexico field site because it met the following criteria: the presence of a range of nutritional status with a substantial prevalence of marginal malnutrition; the communities were agricultural and typical of many in Mexico; it was rural yet a reasonable distance from Mexico City (three hours by car); and families were mostly nuclear. The valley of Solis lies at 2,300 m, and is an agricultural region ringed with a series of similar but distinct communities. The study recruited households from six of these communities.

Of the 290 households that were the final targets of study, about three quarters had access to agricultural land, most of which was ejido property. The average land holding was between one and two hectares, with about 25% of the households having less than one hectare (2.5 acres). Almost all households grow maize, which is the staple food, but few other foods or crops are grown and home gardens are rare. Most households have some chickens, turkeys and sheep that are used primarily for home consumption. The climate only supports one crop per year. Yields are relatively low due to the high cost of inputs such as seed, fertilizer, and herbicide. Irrigation from the Rio Lerma is only possible on some plots of land, and even then the cost of the pumps and fuel is often prohibitive. The economic situation in both Mexico and the Solis valley deteriorated markedly during the life of this project, with the result that the majority of households survived by sending members to work in Mexico City during the week, returning on weekends and when necessary to perform critical agricultural activities.

The communities were indeed marginally malnourished, based on the following evidence. Growth stunting of children starts around three months of age, becomes severe during the first six months of life, and persists so that by 18 months weight- and length-for-age deficits are greater than during infancy. On average, the rate of growth of the Solis preschoolers between 18 and 30 months of age parallels that of the standards for well-nourished children, but no signs of catch-up growth are evident for the group as a whole. Schoolers are the most growth-stunted group of all; they averaged between the 10th and 20th percentile for weight and the 12th percentile for height. Average weight-for-height was relatively normal in all groups. Cross-sectional anthropometric data that were collected once from all individuals in the target households revealed that growth percentiles remained very low throughout adolescence. It is impossible to attribute this growth stunting to "genetics"; Mexicans raised in the United States are close to average size based on international growth standards. It is also important to emphasize that there was a good deal of variability in socioeconomic and nutritional status among the Solis individuals, which will increase the likelihood of detecting significant associations between variables.

Some of the more in-depth statistical analyses in this report used the data from the preschoolers. A number of conclusions can be made about the relationships between food intake, nutritional status and function in this group. It is ap-

parent that most of the growth-stunting occurs before the age of 18 months and that the majority of the children do not shift their weight or length percentiles substantially between 18 and 30 months of age. Nevertheless, there is considerable variability among the children in their weight and length growth rates during this period.

Several analytical strategies were used to determine the role of nutrient intake in the growth of these children. Total energy intake is not related to growth rate, but the degree of consumption of animal foods is a significant predictor of the average increase in weight and length between 18 and 30 months of age. Diarrhea, measured either as the percent of days observed that diarrhea was recorded or as the presence or absence of diarrhea between the ages of 18 and 30 months, has a negative effect on weight and length increase during this period. An autoregression method was used so that we could test whether food intake or morbidity in the preceding period predicted weight or length in the subsequent period. The method demonstrates that the amount or percentage of animal foods consumed in the previous three months predicts length in the subsequent three months, and that morbidity in the preceding month predicts a smaller weight in the subsequent month. The weight and length adequacy of children at 30 months was related to the intake of animal foods during the preceding 12 months, but not to the amount of diarrhea recorded during this period. The most likely explanation is that size at 30 months reflects the cumulative experience of the child from birth and that illness events after 18 months do not have a detectable effect on the size attained at 30 months.

We conclude that animal foods are more limiting to the growth of Solis preschoolers than is total energy intake. The reasons for this are unknown but some possible explanations are suggested. The staple food of the Solis communities is maize, contributing on average about 60% of the dietary energy of adults, and 50 - 65% for weaned children. The other main energy sources are beans (5%), oil (5%), bread (3-5%), meat and fish (3%), dairy products (2%), eggs (2%) and pasta (1-2%). It is evident that the intake of foods of animal origin is low, especially in low socioeconomic status households. The preschoolers receive only 9% of their energy from animal products, mostly from milk. While food intake was not measured before the age of 18 months in the Solis preschooler sample, it is reasonable to assume that those children who were consuming a greater proportion of animal foods during the 18 to 30 month age period were also doing so from the time they were introduced to weaning foods or at least from the time at which they were weaned completely. Thus, relationships between diet patterns and functional outcomes between 18 and 30 months could in fact have been established at a much earlier age.

One possible explanation for the apparent importance of animal foods in preschooler diets, (rather than total energy intake, as hypothesized for the CRSP design), is that energy intake may not be limiting. Households always seemed to have some tortillas available - albeit not much else to eat. Nevertheless, some individuals - including preschoolers - did have energy intakes that averaged far below recommended levels. (Intakes of available energy are likely to be substantially overestimated in this report because the absorbable energy in maize is lower than that assumed in the nutrient data base). Another explanation could be that the quality of maize protein is inadequate to support maximal growth of children, especially during periods of catch-up growth after illness events. An additional concern is that a low intake of meat and eggs may have resulted in iron and zinc deficiency and that these nutrients are limiting both physical growth and mental development. Iron deficiency, assessed by serum ferritin and other hematological measures, was diagnosed in one-third of the preschoolers. Another possible explanation is that the intake of animal foods may be easier to measure accurately than that of total energy. Finally, the possibility exists that the physical development of the child is linked to animal food intake through a third variable that is common to both and actually responsible for the poor growth (such as some aspect of socioeconomic status, parental size, or household sanitation). Preliminary multivariate analyses do not support this explanation.

The length (and probably weight) of the child at 30 months of age, and the amount and percent of kcal and protein consumed in animal sources, are significantly associated with another functional outcome--the child's score on the Bayley mental performance test. Although socioeconomic status and the mother's child care score also correlated with the Bayley mental performance score at 30 months, the variance explained by dietary animal products remains significant when these social measures are statistically controlled. Analysis of the extent to which the cognitive and behavioral performance of children is influenced by their iron status will receive a high priority.

In a subsample of 41 mother-preschooler pairs, frequent observations were made of the activities of both individuals and of the interaction between the mother and her child. The preliminary analyses presented in this report again indicate that the average amount or percent of kcal or protein from animal sources are important, in this case significant positive correlates of the percent of time that the child plays and interacts verbally, and negative correlates of the time the child spends "doing nothing" or being changed or cleaned. The average weight and length Z scores of the child during the 18-to-30 month period--anthropometric variables that we know are associated with the consumption of animal foods--show similar associations with the child's activity patterns to those seen with animal food consumption. For example, taller, heavier children spend more time in play and verbal interaction, and less time doing nothing. These preliminary analyses suggest that the marginally malnourished preschooler who is shorter, lighter, and consumes less animal products, is an apathetic, less active child eliciting less interaction with his/her caretaker. It remains to be determined whether iron status of the children explains some of these behavioral differences.

It is also apparent that the mothers who consumed fewer foods from animal sources spend more time "doing nothing" and less time in child care. Further analyses are needed to clarify whether these maternal behavioral differences are explained by the mother's nutritional status (especially anthropometry and iron status) and/or the child's nutritional status. In general mothers from lower socioeconomic households do not keep either their homes, themselves or their children, as clean as those from wealthier households.

Fewer analyses have been performed on schooler and adult data, but there are some important results. The prevalence of iron deficiency anemia is high in schoolers and adult women, approximately 33 and 20 percent respectively as assessed by ferritin levels. In contrast, adult males rarely exhibit iron deficiency anemia as judged from ferritin, hemoglobin and hematocrit values. Rather there is a high prevalence of low red blood cell counts (41%) and high mean cell volumes (27%) in the adult male group, a picture suggestive of folic acid and/or vitamin B_{12} deficiency anemia. There were significant correlations between the amount of pulque (the local alcoholic beverage) usually consumed by both men and women and mean cell volume, so that it is probable that the consumption of this drink induces a folate-deficiency anemia.

There were no biochemical tests of other micronutrient deficiencies. Average intakes of vitamins A and C, niacin and riboflavin are substantially below recommended levels. A probability assessment analysis of the nutrient intake data confirmed that there is a high probability of inadequate intakes of iron and vitamins A and C.

The data concerning pregnancy, pregnancy outcome and infant growth during the first six months of life were analyzed in some depth. The energy and protein intake of the pregnant woman bear little relationship to her size or the birth weight of her infant. There is a weak positive association between maternal energy intake and weight gain in late pregnancy, and the latter is in turn associated with more infant growth. Women do not increase their energy intake significantly during pregnancy, an observation that agrees with data from many other population groups including those that are well-nourished. Of interest is the fact that resting metabolic rate (RMR) rises much less in the Mexican women than it does in well-nourished women studied in other countries. In a subset of 35 women followed from before pregnancy through lactation, the only significant increase was in RMR per cm height in the third trimester. In contrast to pregnancy, energy intake during lactation increases quite dramatically. An association was seen between maternal energy intake between six and eight months of lactation and the size of her infant at six months. RMR is not significantly different at any point in lactation from non-pregnant, non-lactating values.

One of the most striking relationships is between the size (especially weight and fatness) of the mother in late pregnancy and the weight and length of her infant at six months. Fatter mothers have babies who grow faster for the first six months, an important observation in a group where growth stunting starts to occur at three months of age. Maternal size is at least in part attributable to her nutritional history, and it is evident that in Solis this is a stronger predictor of infant size and growth than current maternal nutritional status. Maternal morbidity during pregnancy was negatively related to pregnancy weight gain, but neither maternal nor infant morbidity during lactation was related to infant growth.

EPILOGUE

This project was a remarkable experience for each of the thousands of persons who were involved. To a greater or lesser extent, each and every one of them--including the study households--contributed a part of their life, but all learned from the experience. Many were the occasions when the work appeared to be impossible. Almost all of the research protocols were innovative and developed specifically for this project. It was surprisingly difficult to predict those that would be difficult to administer or interpret. Collecting and updating census data and the continual monitoring of the physiological status of women are examples of two of the unexpectedly difficult tasks. The change to professional diet interviewers part way through the study was deemed to be necessary for community relationships but resulted in an unanticipated increase in nutrient intake estimates. For the preliminary analyses presented in this report, we have used diet data collected only after the interviewer change, and further work is needed to understand the nature of this change and the extent to which earlier data can be used. The morbidity data are weaker than they should be because the field method used underestimates the proportion of illnesses of short duration, and because a decision was made not to capture the dates of interviews for these preliminary analyses.

An excellent working relationship was established between the Mexican and American personnel. The Mexico team is in possession of clean data and has staff and facilities capable of further analysis, although the amount that can be done is severely constrained by lack of funds for personnel. The same situation exists at Connecticut. Many years of analysis and publication remain before the project is truly ended. Meanwhile, we all regard the highest priority to be the analysis of data and publication of results that will surely further substantiate the evidence in this report that marginal malnutrition impairs the function and quality of life of human beings.