Understanding the Health and Nutritional Status of the Children of Rwanda

Randall D. Schnepf

CORNELL FOOD AND NUTRITION POLICY PROGRAM

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The Cornell Food and Nutrition Policy Program (CFNPP) was created in 1988 within the Division of Nutritional Sciences, College of Human Ecology, Cornell University, to undertake research, training, and technical assistance in food and nutrition policy with emphasis on developing countries.

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Abbreviations

CDC	Centers for Disease Control
ENA	Enquête nationale agricole (National Agricultural Survey)
IAMSEA	Institut africain et mauricien de statistique et d'economique appliquée
IFPRI	International Food Policy Research Institute
MINAGRI	Ministry of Agriculture
MINISANTE	Ministry of Health
MINISAPASO	Ministry of Public Health and Social Affairs
MUAC	Mid-upper Arm Circumference
NBCS	National Budget and Consumption Survey
NCHS	National Center for Health Statistics
NNS	National Nutrition Survey
NS	Nutritional Status
ONAPO	Office national de la population (National Population Office)
RAP	Rapid assessment procedure
WAZ	Weight-for-age Z-score
WFS	Weaning Foods Survey

Preface

CFNPP conducts research to generate information about the impact of government action on poverty, food security, and human nutrition. As part of this effort, CFNPP began collaborative work with UNICEF/Kigali in early 1989 to improve upon existing knowledge concerning the prevalence and etiology of malnutrition in Rwanda.

Rwanda is the most densely populated country in Africa. It has the world's highest fertility rate and one of the highest population growth rates. This tremendous population dynamic, coupled with limited land expansion, has propelled Rwanda to the forefront of nutrition and health related problems in Africa.

Although Rwanda's endemic poverty and food insecurity are well-recognized, little attention has been given to understanding the nature of malnutrition. Instead, policymakers have relied principally on aggregate calorie production levels as the sole indicators of nutritional well-being, ignoring the implications of household food security, health, and fertility behavior.

CFNPP, in collaboration with UNICEF/Kigali, has worked at overcoming this dearth of knowledge concerning the intricate relationship between individual nutrition and the household's socioeconomic, demographic, and health environment.

This monograph provides new information on the structure underlying Rwandan household decisionmaking in the form of results from a statistical analysis based on a 1987 UNICEF/Kigali household nutrition survey. Using the survey data, this study focuses on the interconnections between household fertility and nutrition, while considering the important roles of the household's health, mortality risk, and socioeconomic environment.

Although data shortcomings prevent a complete and thorough investigation of the structural relationships governing nutrition and fertility in Rwanda, this

study provides a useful benchmark for future work in this area in Rwanda. In addition, it is hoped that the results of this study will shed light upon what has otherwise been murky ground for Rwanda's policymakers.

Financial support from UNICEF/Kigali for this study is gratefully acknowledged.

Ithaca, New York
December 1991

Per Pinstrup-Andersen
Director

Executive Summary

INTRODUCTION

This report presents the results from a UNICEF/Kigali cross-sectional nutrition survey of 1,847 children between 6 and 36 months of age conducted from August 1987 to September 1987. The survey was drawn from eight communes (Gafunzo, Kanama, Mbazi, Muhazi, Muhura, Nyamagabe, Nyarugenge, and Rubungo) situated in 7 of Rwanda's 10 prefectures. The aim of the survey was to collect relevant information concerning the food and nutritional habits of Rwandan households, vis-à-vis their young children, with an emphasis on household behavior during the child's weaning period.

The study does not contain information on either calorie consumption or calorie availability at the household level, but instead focuses on household health, weaning, and fertility behavior and their various relationships with child nutritional status.

Two common anthropometric measures were recorded for each child: weight-for-age and the left mid-upper arm circumference (MUAC). MUAC (an indicator of acute malnutrition or wasting) is used to measure near-term or current nutritional status; whereas weight-for-age reflects elements of both current and cumulative nutritional status.

The weight-for-age results as a percentage of National Center for Health Statistics/Centers for Disease Control (NCHS/CDC) reference medians show that a total of 24 percent of the sample children are underweight. This total includes the 4 percent of the sample children who are severely underweight (less than 65 percent of the reference median) and the 20 percent who are moderately underweight (between 65 and 80 percent of the reference median).

The MUAC index was calculated first as a percentage of WHO African reference medians and second under the assumption of constancy over the ages of 13 to 60 months. Each method produces slightly different results.

The MUAC-for-age results as a percentage of reference median show that over 27 percent of sample children are acutely malnourished: 4 percent severely (below 75 percent of the reference median), and 23 percent moderately (between 75 and 85 percent of the reference median).

The MUAC results under the assumption of constancy over the 13 to 60 month age period indicate that 21 percent of the sample children are acutely malnourished. Out of this total, 6 percent are severely malnourished (MUAC less than 12.5 centimeters) and 15 percent are moderately malnourished (MUAC between 12.5 and 13.5 centimeters).

Recall for the incidence of fever, diarrhea, bad cough, and worms was recorded for the two weeks preceding the survey. The results showed that 53 percent of the sample children suffered from at least one of the four ailments during this period. Furthermore, almost 28 percent of the sample children had multiple illnesses; of these, 11 percent experienced at least three of the four afflictions for which information was obtained. Not surprisingly, higher levels of malnutrition are also associated with higher levels of disease frequency. The prevalence of malnutrition for children experiencing 0, 1, 2, 3, and 4 of the afflictions during the two week period were 17, 24, 31, 38, and 50 percent, respectively.

These data are suggestive of the influence of child disease on nutritional status. In order to better understand the structure of this association, an econometric model emphasizing the potential trade-off between family size and child nutritional status is used to estimate the structural relationships governing both the nutritional status of sample children and their mothers' total fertility (the sum of all children living and deceased born to the sample child's mother).

The model focuses on the importance of maternal education and household income (or food availability), while controlling for head of household gender and household life cycle effects. Reduced-form estimating equations for child nutritional status and total fertility are estimated under both continuous and discrete specifications using a reduced data set with 1,328 observations on weight-for-age, and an extended data set with 1,847 observations on MUAC.

Child nutritional status and total fertility are functions of prices, income, head of household gender, the regional sanitary environment, and health infrastructure. Expected and experienced mortality rates based on the sample data are incorporated into the fertility equation, while child specific characteristics, experienced illnesses, and household child feeding behavior are incorporated into the nutritional status estimating equation.

FERTILITY RESULTS

The model suggests that three factors dominate household fertility decisions: maternal education, household income, and the household's child mortality experience.

Maternal education is associated with substitution of families with fewer and healthier children for larger families with less healthy children. Health is measured by near-term nutritional status. Primary school must be completed for maternal education to have this effect. No association was found between maternal education and the cumulative nutritional status indicator (weight-for-age).

Meanwhile, increased household food availability (a proxy for household income) produces both higher fertility levels and improved child nutritional status for both indicators. Thus, both maternal education and household food availability are important for near-term nutritional status, while household food availability appears more important for the longer term.

Households that experience the death of a child respond by having more children in order to maintain their desired fertility level. Furthermore, households appear to maintain overall high child mortality expectations regardless of mortality experience. This tendency helps to explain the prevailing pronatalist sentiment of Rwanda.

NUTRITIONAL STATUS RESULTS

Certain "key" tendencies emerge for the nutritional status equations. First, the age of the child is important for nutritional status. The nutritional status tends to decline starting at 6 months, continuing in a downward trend until the age of 16 to 18 months when some recovery is made.

The increased vulnerability of Rwandan children's nutritional status during the early months of life is probably related to household weaning activities. This hypothesis is supported by the poorer MUAC levels of children already receiving foods supplementary to maternal breast milk. This could reflect both the quantity and the quality of the weaning foods used, as well as the sanitary environment in which they are prepared.

As concerns the household's preference of weaning foods, sorghum porridge (70 percent) and powdered milk (10 percent) represented 80 percent of sample households' first choice. The preparation of both sorghum porridge and powdered milk require water. Bad water and improper food preparation methods increase the chance of exposure of weaning-age children to foreign bacteria and other contaminants.

Household responses to questions concerning restrictions on certain foods used for weaning infants suggest that poor nutritional knowledge prevails in Rwandan households. There appears to be much potential for improvement in this area whether via nutrition extension activities or a general social mobilization program.

Second, household wealth and food availability have important positive influences on child nutritional status. However, this cannot be said for regional food availability, as local agricultural surplus production appears to have no impact on household-level nutritional status.

Third, child health status and the general health and sanitary environment are closely related to child nutritional status. The incidence of diarrhea and fever show strong negative influences on child nutritional status, while an improved sanitary environment and health infrastructure (measured by the reciprocal of the regional child mortality rate) are associated with improved child weight-for-age levels.

Fourth, maternal education has a positive effect on near-term nutritional status, but it shows no influence over the cumulative nutritional status indicator (weight-for-age).

Inconclusive evidence is found with respect to parental preferences based on child sex because the continuous and discrete estimating frameworks provide contradictory results. The results do suggest that a simple bivariate statistical framework is insufficient for evaluating the association between a child's sex and nutritional status.

Finally, children from male-headed households are better off nutritionally than are those children from female-headed households. This may reflect the higher social status given to males by Rwandan society, as well as the greater labor power available to male-headed households.

CONCLUSION

Rwandan policymakers are confronted with a dilemma. Increasing rural incomes and food availability can positively affect nutrition and health but simultaneously produce more mouths to feed by stimulating fertility. However, if income increases are accompanied by more educational opportunities for women, improvements in the quality of the local sanitary environment, and better access to basic health services (thereby reducing child mortality rates), the fertility increases may be partially mitigated while generating positive nutritional consequences.

Female-headed households merit special attention as a target group for nutrition intervention programs. The disparity between male and female educational levels is tremendous. Over 42 percent of the sample mothers are illiterate, compared with only 22 percent of sample fathers. Furthermore, functional literacy is low; nearly 77 percent of mothers either never attended or never completed primary school.

Unfortunately, the benefits to women of adult literacy and nutritional education programs assume a "zero-sum" nature (McGuire and Popkin 1988). Time must be taken away from childcare, food production, etc., to devote more time to personal education. Focusing effort and resources on improved access to primary education for girls and incorporating basic nutrition information and materials into the curriculum may be a preferable, long-term solution with obvious nutritional benefits.

Increasing income and female educational levels while improving the regional sanitary environment and basic health infrastructure are difficult undertakings for a poor country such as Rwanda, which has limited resources for developing its health and educational sectors. This is particularly true in light of Rwanda's dispersed, rapidly growing population, its landlocked geographic position, its lack of natural resources, and its growing inability to produce or procure sufficient calories for its population.

Yet the results described in this monograph improve our understanding of the underlying structure of nutrition and health in Rwanda. Such knowledge must necessarily precede appropriate policy changes on new program initiatives. Finally, these results are encouraging due to the viability of MUAC as a nutritional status indicator for Rwanda. MUAC is a cost-effective and accessible data source. The collection of MUAC measures can be easily incorporated into ongoing survey activities with only a minimum of materials and interviewer training. In addition, the success of the MUAC data in this study suggests that better use of existing Rwandan data sets containing MUAC data can be made. All of these add up to potential improvements in both the level of nutritional status monitoring and the immediacy and precision of subsequent intervention activities.

1. Introduction

Nutritional surveillance and food security are vital to many developing countries. Rwanda is no exception. Judged to be among the poorest countries in the world (World Bank 1989), Rwanda still suffers from widespread malnutrition and the effects of debilitating tropical illnesses, including malaria and various diarrheal diseases. Rwanda's rampant population growth of nearly 3.8 percent annually (ONAPO 1983) adds to the vulnerability of the country's food security situation.

Against this background, the general focus of most nutritional work in Rwanda has been directed toward counting calories, to the neglect of the health side of the ledger. This is unfortunate since the health side offers many potentially cost-effective avenues for intervention into the domain of household nutrition.

On the other hand, interventions in the health sector have focused narrowly on combating individual diseases, ignoring the role of nutrition in maintaining the body's immune system and its physiological response mechanisms to diseases. This is evident from the concentrated investment of funds and personnel dedicated to the highly successful infant vaccination program in Rwanda. Vaccinating an unhealthy child may prolong his life but it does not necessarily improve its quality.

Since 1989 UNICEF and the Ministry of Health, in collaboration with other organizations interested in the health sector, have been setting in place a primary health care program entitled the "Bamako Initiative." The goal is to build up and reinforce Rwanda's primary health care structure.

In the end, however, Rwanda's economic and political future (and consequently its health and nutritional future) hinges on its ability to control the rapid demographic expansion that has occurred since the mid-1970s.

Government policymakers urgently need new information concerning the nature of household fertility choices in order to better address this problem.

Unfortunately, developing countries such as Rwanda are constrained in their intervention activities by very limited budgets and a shortage of trained personnel. As a result, studies that produce information leading to an improved return on Rwanda's limited resources are highly valued.

This report hopes to provide new information in the form of results from a statistical analysis of a cross-sectional survey of child feeding behavior of Rwandan households undertaken by UNICEF/Kigali during August and September of 1987. More specifically, this study will address the following points:

- Are household total fertility, health status, and nutritional status related? If so, how?
- How important are maternal education and household income in influencing the household's total fertility and child nutritional status?
- How important are diarrhea and other diseases in contributing to child malnutrition in Rwanda?
- Do parents exhibit child preferences based on the age, birth order, or sex of their children?
- What is the household's fertility response to expected and experienced mortality rates?
- Is the gender of the head of household critical to child nutritional status?
- What age-related nutritional status trends are observable from the survey data?
- To what extent are mid-upper arm circumference (MUAC) measures useful as indicators of child nutritional status in Rwanda?

It is hoped that the information addressing the above questions will assist the Government of Rwanda and the donor community in planning and evaluating their intervention activities in the domain of health and nutrition.

The study does not contain information on either calorie consumption or calorie availability at the household level. It focuses instead on socioeconomic and demographic variables, as well as household health, weaning, and fertility behavior and their various statistical relationships with child nutritional status. As such, the study provides important "pieces" of anthropometric and

household behavioral information that help in constructing the "puzzle" of Rwanda's nutritional reality.

This study comprises seven chapters, an appendix, and a bibliography. The first chapter includes the introduction, a background summary of Rwanda, a review of recent literature on the health and nutritional situation in Rwanda, a brief description of the methodological framework used to examine the available data, and a short discussion of the anthropometric and nutrition status indicator terminology used in the text.

The second chapter begins with a discussion of the characteristics of the samples. This is followed by a presentation of basic anthropometric results for both weight-for-age and MUAC with comparisons of the results based on age, sex, and location.

The third chapter considers the statistical relationships governing the household-level child nutritional status and certain household characteristics: child ordering; parental education and marital status, and the father's living circumstances; parental occupations; and household eating habits.

The fourth chapter deals with weaning behavior, including a discussion of the mother's field work schedule and the household's taboos or restrictions on the use of particular weaning foods.

The fifth chapter covers child morbidity. The incidence and frequency of disease are evaluated in light of their effect on the child's nutritional status. A final section deals with feeding habits during periods of child illness, particularly diarrhea.

The sixth chapter presents an econometric model of household total fertility and child nutritional status within a framework emphasizing the quality versus quantity trade-off hypothesized to prevail for Rwandan households. The theoretical underpinnings of the model are briefly introduced, and the statistical estimates are presented under both continuous and discrete modeling frameworks.

A summary of the survey results and tentative policy implications are presented in the executive summary.

COUNTRY BACKGROUND

Rwanda is a small, densely populated country in central Africa. Surrounded by Uganda to the north, Burundi to the south, Tanzania to the east, and Zaire to the west, it lies on the high central African plateau at an average altitude of 1,500 meters.

Rwanda is unique in that, despite its small size, it encompasses a tremendous diversity of geoclimatic zones. Each zone has a range of soil types, altitudes, precipitation levels, and crops, each with its particular cropping pattern. Delpierre (1975) has identified 12 distinct agricultural regions. Within most of these 12 zones a person could probably distinguish still further localized regional differences due to the mountain-valley contrasts, where high altitude, low-rainfall marginal soil areas overlook more fertile, low-lying bottom lands with higher soil moisture contents. However, for simplicity and ease of understanding, the country can be roughly divided into three geographical zones: the semiarid eastern savannah lying at an altitude of 1,000 to 1,500 meters, the densely populated central plateau of 1,500 to 2,000 meters, and the western volcanic and Zaire-Nile Divide region lying above 2,000 meters. The annual temperature correlates with the altitude, but in general it is mild, ranging between 18 to 24°C in regions lying between 900 to 1,800 meters (Gasana 1983). The annual rainfall in the eastern savannah region ranges between 700 to 1,000 millimeters versus 1,500 to 2,000 millimeters in the central plateau.

The country is divided into 10 prefectures; however, parallel to the prefectures the country is divided into 143 "communes" each of which is governed by a *bourgmestre*. Most rural development projects occur at the commune level. The communes are divided into varying numbers of sectors, which are further divided into base units called "cells." Theoretically each cell represents approximately 50 households.

Rwanda is predominantly Catholic. Religious restrictions and strong pronatalist tendencies restrict the acceptance and use of modern contraceptives. Only 3 percent of Rwanda's women of child-bearing age were using modern contraceptives in 1983 (ONAPO 1983). The population was estimated in January 1990 at approximately 7.2 million people and growing from 3.5 to 3.8 percent per annum (ONAPO 1985).

The acute demographic pressure is exerted on an estimated potential available agricultural land surface of only approximately 16,000 kilometers out of a total surface area of 26,338 kilometers (Delpierre 1985). With increasing population and a system of hereditary division and transfer of land to sons, the average size of landholdings estimated at 1.2 hectares for landowning households (MINAGRI 1985) is constantly decreasing. As each household owns smaller parcels, land tends to be more intensively cultivated with fallow periods decreasing in both duration and frequency. This is combined with low usage rates of chemical fertilizers estimated at 2 to 3 percent in 1984 (MINAGRI 1985). This situation is further combined with poor soil conservation practices

on the widely farmed, steep hillsides. The consequent soil erosion and lack of soil replenishment have become more noticeable as Rwanda has been experiencing a rapid deterioration in soil fertility since the mid-1980s.

Rwanda's two main ethnic groups, *Hutu* and *Tutsi*, share a common language, *Kinyarwanda*, and a common culture. The preferred food is beans eaten with cooking bananas, potatoes, sweet potatoes, or cassava. These five crops together with corn, sorghum, and soybeans comprise over 94 percent of all calorie food production (including livestock) in Rwanda (Ngarambe et al. 1989). The commercial crops of coffee and tea are grown extensively in Rwanda. Coffee and tea exports produce nearly 90 percent of Rwanda's foreign exchange.

Approximately 90 percent of Rwandans live in rural areas. From among the rural population aged seven and above, an estimated 97.9 percent of women and 87.6 percent of men depend on agriculture as a livelihood (UNICEF 1988).

A unique feature of Rwanda's rural structure is the absence of villages. Instead, households are dispersed over the countryside. Unfortunately, the lack of rural villages increases the difficulty in providing rural infrastructure and services, particularly with respect to health and sanitation.

The social, cultural, and legal environment of Rwanda greatly favors Rwandan men. Women are not part of the inheritance system and are thus excluded from land ownership. Lack of asset ownership denies women access to what credit markets may exist. Until recently women could not open a bank account without their husbands' signature. Husbands make all economic resource allocation decisions within the household. On the other hand, in addition to their traditional household duties of giving birth to and caring for children, cleaning house, preparing meals, doing laundry, and collecting water and firewood, women also grow all food crops for the household, and decide which food crops to grow and their subsequent disposal (Bucyedusenge et al. 1990). Given the low level of agricultural technology (most field work is done by hand or with a hoe), this work puts a tremendous demand on the energy and time of rural women.

Despite Rwanda's favorable agroclimate of mild temperatures and ample precipitation, food is frequently in short supply. The rural food security situation is very fragile; even minor perturbations from the norm can spur food crises. However, the crop year of 1986, which preceded the survey period of August to September 1987, saw normal to above average harvests throughout the country.

More recently, a severe food shortage occurred in 1989 in a belt running from southern Gikongoro prefecture to Kibuye, touching parts of Cyangugu, Butare, and Gitarama prefectures. The shortage resulted in several deaths and the

migration of as many as 5,000 households from the affected regions (Desmoulins 1990). An inflow of food assistance from the international donor community and a return to near normal growing conditions mitigated the famine's severity.

As evident from this background, producing sufficient food for all is a problem of major proportions in Rwanda. One easily understands the tendency to focus on "counting calories" to the detriment of fully exploiting potentially "cost- effective" avenues for intervention into the domain of household nutrition via the health sector.

REVIEW OF THE HEALTH AND NUTRITION SITUATION

A number of regional studies exist, but few attempts have been made to evaluate the general health and nutritional situation in Rwanda on a national scale in recent times. Furthermore, the few studies that have attempted a national focus have encountered the high cost of randomly surveying the households dispersed throughout the hilly countryside. The trade-off of cost versus sample size has been traditionally sidestepped by forsaking the randomness of proper survey methodology.

Most studies to date have focused on agricultural food crop production, and calorie availability and intake. The relationship of child health and nutritional status with disease prevalence, sanitary environment and hygiene, breast-feeding and weaning behavior, and other socioeconomic characteristics of the household has been neglected. For many of these relationships very few hard data exist.

This section briefly reviews some recent studies deemed useful in shedding light on the nutrition and health situation in Rwanda.

Counting Calories

Vis, Yourassowsky, and van der Borght (1975) studied the nutritional situation in 10 rural communes, 2 urban communes, and 3 *paysannats* (commercial crop promotion projects) across Rwanda from late 1966 until mid-1972. However, their sample size was small (100 households), and the study focused more on the nutrient content of foods consumed than on the actual health and nutritional status of the sample households.

The authors found that in nine out of the ten rural communes the annual energy consumption levels were below the theoretical needs.[1] In seven of the communes the calorie availability ranged from 64 to 83 percent of theoretical needs. In all three of the *paysannats* calorie consumption levels were below the theoretical needs level. Finally, of the two cities examined, in Kigali the calorie consumption levels were below theoretical needs (93.3 percent) while in Butare the calorie consumption levels just met the theoretical needs (100.5 percent).

The Ministry of Agriculture in Rwanda, particularly the Division of Agricultural Statistics, has undertaken a number of food security studies. These studies have measured calorie production per capita (with subsequent nutrient breakdowns) against theoretical calorie needs to evaluate the nutritional status of Rwanda's population.

Of particular interest is a 1989 report by the Ministry of Agriculture (MINAGRI 1989) that summarizes at a communal level for all 143 of the communes in Rwanda the production of all major agricultural crops in terms of harvested acreage, annual production in kilos, and annual production in terms of calories, protein, and lipids. These calorie and nutrient figures are converted into per capita figures, which are then compared against theoretical needs, all based on communal population figures extrapolated from the 1978 national census.

This study suggests that 62 communes (43 percent) meet all of their theoretical caloric needs, while 111 communes (78 percent) meet at least 80 percent of their theoretical caloric needs. However, the data were from the 1986 National Agricultural Survey; in 1986 agricultural production was normal to above average. Thus, even during a year of "normal" agricultural output, the crop production in 22 percent of Rwanda's communes failed to meet at least 80 percent of theoretically perceived needs. No account was made for interregional or international food movements and household-level purchases of food. It is widely accepted that significant amounts of food enter Rwanda from Uganda and Zaire due to stable markets and more favorable prices. Furthermore, Loveridge (1989) has shown that household marketing behavior is crucial to food security, as over 70 percent of rural households are net buyers of Rwanda's preferred food, beans.

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1 Based on WHO and FAO recommendations.

A more localized study was undertaken by Laure (1982), in collaboration with the Institut Africain et Mauricien de Statistique et d'Economie Appliquée (IAMSEA), during 1980 and 1981. Their study focused on the economic and nutritional status of 40 rural households comprising 176 persons in the cell of Nyabishongo. Nyabishongo is in the sector of Nyabirasi, Kanama commune, Gisenyi prefecture.

The height and weight information was not measured against international standards; however, Laure used the MUAC measures for children between the ages of 1 through 5 years to assess their nutritional status. He found that 30 percent (9 out of 30) of the children had MUAC smaller than 135 centimeters, the threshold below which children in the 1-to-5 year age group are classified as malnourished (Velzeboer et al. 1983; Ross et al. 1990). Meanwhile, a survey related medical examination discovered six cases (17 percent) of kwashiorkor from among 36 children examined clinically.

With respect to the food consumption data, Laure found that 40 percent of the households failed to consume as much as 80 percent of their annual theoretical calorie needs.

Seasonality of Malnutrition

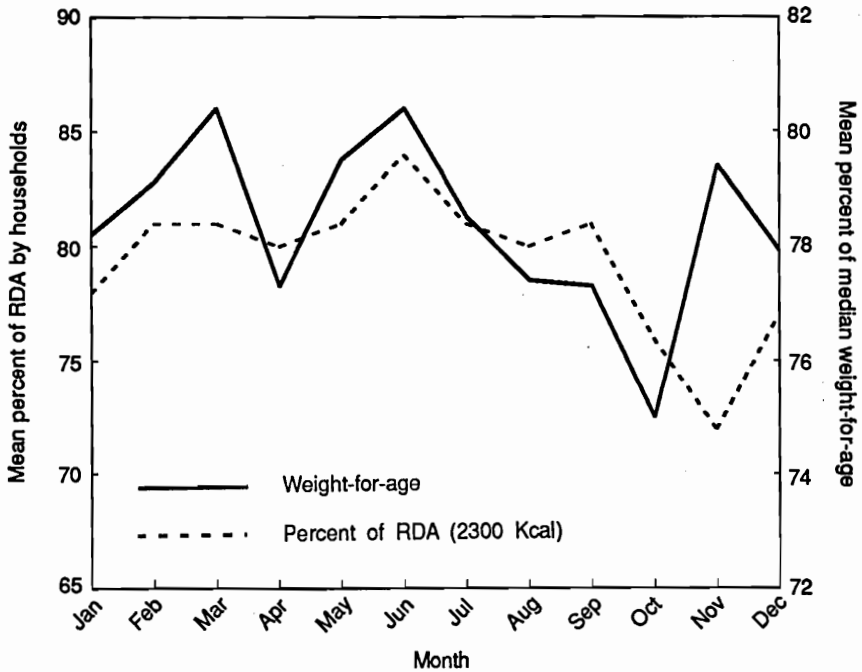
The major rainy season in Rwanda lasts from March until June, and the short rainy season runs from September until December. Crop seasons generally coincide with these two periods (planting at the start of the rains and harvesting afterwards), depending, of course, on the crop and its agroclimatic zone.

Laure's study (1982) found that the percentage of households failing to cover their theoretical calorie needs varied greatly from a low of 35 percent in the first quarter to a high of 70 percent during the third quarter. The third quarter falls in the "long dry season," a period generally associated with lower agricultural production and higher consumer food prices.

In another study, Hitchings (1979) looked at the initial registration weight-for-age data of 1,254 preschoolers registered in 9 health centers over five years (1970 to 1975). These 9 health centers were drawn from a total of 50 such centers that were participating in a national preschool food supplement program in Rwanda.

Hitchings found that childhood malnutrition, as measured by the average percentage of median of international standards, corresponded closely to fluctuations in the actual level of monthly calorie intake from the study by Vis et al. (1975), as seen in Figure 1 opposite.

Figure 1 — Rwanda: Seasonal Household Calorie Intake as a Percent of the Recommended Daily Allowance and Mean Weight-for-Age



Source: *Hitchings (1979).*

The seasonal pattern showed a decline in nutritional status beginning from the annual high point in June and falling to an annual low point in the preharvest month of October, while the lowest levels of calorie need satisfaction occurred from October to December (with a low point of 72 percent in November), and highest levels appeared between May and July (with a high point of 84 percent in June).

However, Hitchings does offer another hypothesis to explain this seasonal pattern: some synchronous, possibly weather dependent health factor could affect nutrient demand or absorption.

Unfortunately, Hitchings's data were limited to the data available from health and nutrition centers. The percentage of Rwandan children that frequent these centers ranges from only 6 to 13 percent of the entire population in any given year (Pagliarin 1989b). It is not clear if these children are representative of the general population.

Prevalence of Malnutrition

Five major studies of the overall prevalence of malnutrition in Rwanda are available. These include (1) the national nutrition survey of children under six of 1976 (Meheus et al. 1977); (2) the national budget and consumption survey (NBCS) for rural areas (1982 to 1983) and for urban areas (1983 to 1985) (MINIPLAN 1990; Schnepf forthcoming b); (3) the national nutrition survey (NNS) of 1985-1986 (MINISAPASO 1987); (4) the UNICEF/Kigali weaning foods survey (WFS) of 1987 (Schnepf 1990b); and (5) the UNICEF/Kigali famine rapid assessment procedure (RAP) of 1989 (Desmoulins 1990).

The general anthropometric results from these five surveys are presented in Table 1 and are discussed below.

In 1976, Meheus et al. (1977) undertook a nutrition survey of children between the ages of 0 and 5 years. A total of 3,029 children were chosen from 12 communes, one each from the 12 agricultural zones as defined by Delpierre (1975). Meheus's study indicated that 39 percent of the sample children were underweight (less than 80 percent of weight-for-age reference medians), 33 percent were stunted (less than 90 percent of height-for-age reference medians), and 6 percent were wasted (less than 80 percent of weight-for-height reference medians). Following the Waterlow classification, 2.6 percent of children were both stunted and wasted—i.e., less than both 90 percent of reference height-for-age and 80 percent of weight-for-height.

In November 1982 the Ministry of Plan of the Government of Rwanda began a highly detailed National Budget and Consumption Survey (NBCS). The

Table 1 – Rwanda: Available Anthropometric Data

Indicator	Meheus[a] 1976	NBCS[b] 1982-83	NBCS[c] 1984-86	NNS[d] 1985-86	WFS[e] 1987	RAP[f] 1989
Sample size	3,029	276	276	2,995	1,328	812
Prefectures surveyed	10	10	10	10	7	4
Weight-for-age						
65 < 80%	—	29.4	23.8	21.3	20.3	—
< 65%	—	4.0	2.8	6.2	3.6	—
Cum. < 80%	39	33.4	26.6	27.5	23.9	—
Height-for-age						
80 < 90%	—	33.7	22.6	—	—	—
< 80%	—	4.0	1.4	—	—	—
Cum. < 90%	33	37.7	24.0	—	—	—
Weight-for-height						
60 < 80%	—	2.8	0.0	—	—	—
< 60%	—	0.2	3.9	—	—	—
Cum. < 80%	6	3.0	3.9	—	—	—
MUAC (1-5 years):						
12.5 < 13.5 cm	—	—	—	—	15.4	—
< 12.5 cm	—	—	—	—	8.8	—
Cum. < 13.5 cm	—	—	—	—	24.2	—
MUAC (1-5 years): 4 Famine-affected Prefectures[g]						
12.5 < 13.5 cm	—	7.6	—	—	15.0[h]	30.3
< 12.5 cm	—	4.8	—	—	13.1[h]	17.5
Cum. < 13.5 cm	—	12.4	—	—	28.1[h]	47.8

Source: *UNICEF/Kigali (n.d.).*

[a] *Meheus et al. (1977).*

[b] *MINIPLAN (1990); rural households only.*

[c] *Schnepf (forthcoming[b]); urban households only.*

[d] *MINISAPASO (1987).*

[e] *Schnepf (1990b).*

[f] *Desmoulins (1990).*

[g] *Gikongoro, Butare, Gitarama, and Kibuye.*

[h] *Gikongoro and Butare.*

NBCS covered 270 households in the rural areas of Rwanda from November 1982 to December 1983, and an additional 300 households in the urban areas from October 1984 to January 1986. The anthropometric measures of height, weight, and arm circumference were collected for most of the children in the sample households. Unfortunately, the nationwide sample was limited to 552 children younger than six years with data for both height and weight; 276 in each of the rural and urban surveys (Schnepf forthcoming b). The percentage of malnourished children was found to be higher in rural areas than in urban areas with respect to both weight-for-age (33.4 percent versus 26.6 percent below 80 percent of reference medians) and height-for-age (37.7 percent versus 24.0 percent below 90 percent of reference medians). No real difference emerged in terms of weight-for-height (3.0 percent versus 3.9 percent below 80 percent of reference medians).

The most recent national-level nutrition survey was undertaken by the Ministry of Health and Social Affairs[2] from December 1985 to January 1986 (MINISAPASO 1987). The national nutrition survey (NNS) included 2,995 children drawn from 20 administrative sectors, each from a different commune, within each of Rwanda's 10 prefectures. The communes and sectors were not selected randomly, but were chosen with the intent of evaluating the usefulness of clinic-based data.

The survey found 27.6 percent of the sample children below 80 percent of the National Center for Health Statistics/Centers for Disease Control (NCHS/CDC) reference medians, of which 6.2 percent were below 66 percent of the reference medians. These figures varied over the 10 prefectures ranging from a low value of 21.7 percent below 80 percent of the reference median in Gitarama to 33.8 percent in Kibungo.

Unfortunately, the survey restricted itself to measuring a child's weight-for-age as the sole indicator of nutritional status. Weight-for-age is a difficult indicator to interpret since it captures elements of both near-term and cumulative nutritional status. Height-for-age or a combination of height-for-age, weight-for-age, and weight-for-height are preferred over weight-for-age alone. However, a high level of cultural sensitivity is attached to the measurement of height in Rwanda due to perceived differences in stature between the

2 In 1989 the Ministry of Health and Social Affairs (MINISAPASO) became the Ministry of Health (MINISANTE).

two main ethnic groups. As a result, height measurements have often been excluded from anthropometric survey work in Rwanda and undue emphasis has been placed on weight-for-age to moderate nutritional status.

In December 1989, a team funded by UNICEF undertook a rapid assessment procedure (RAP) in four famine stricken prefectures of Rwanda. In order to expedite the survey findings, data collection was restricted to the MUACs of children between the ages of one and five years. Comparing the RAP results with similar results for the four famine affected prefectures from the Ministry of Plan's rural NBCS and the UNICEF/Kigali WFS of 1987, a pattern of worsening nutritional status emerges. The overall percentage of malnourished children is estimated first at 12.4 percent, then at 28.1 percent, and finally at an extremely high 47.8 percent.

The UNICEF weaning foods survey results are discussed in this present report. They are included in Table 1 for purposes of comparison.

Mortality, Morbidity, and Health Factors

In 1983 the National Population Office (ONAPO) undertook a national fertility survey. The survey provided estimates of infant and child mortality rates. Infant mortality (0 to 1 year) was estimated at 127 per thousand, while mortality of children under five was estimated at 214 per thousand.

ONAPO also compared the birth spacing results with the child mortality rates. The average duration between pregnancies for nonsingle women of child bearing age was 31.3 months. The infant mortality rate for children born within 24 months of their preceding sibling was estimated at 18 percent. For children born within 24 to 47 months of their predecessor, the infant mortality rate estimate was only 9.2 percent. And for children born later than 47 months after their previous sibling, the rate fell to 5.5 percent.

Thus, the ONAPO data suggest that factors other than calorie intake could be significant in the nutritional status and mortality rates of Rwandan children.

In 1987 an important study was conducted in Giciye commune by von Braun, de Haen, and Blanken (1988) of the International Food Policy Research Institute (IFPRI). Although the study focused on the economic and nutritional effects of agricultural commercialization of tea and potatoes, the survey also included the heights and weights of all children under seven years in the 213 sample households.

The authors found that malnutrition in their study area was largely a health problem requiring improvements in the health and sanitation dimensions of rural services. The authors examined two morbidity variables: (1) "sickness,"

which they found to be negatively related to both child weight-for-age and child weight-for-height status, and (2) "worm infestations," which showed a strong negative relationship with child height-for-age. The sanitary environment (measured by the "cleanliness of the household toilet") revealed an important positive association with both the height-for-age and the weight-for-age measures of sample children.

Food consumption was statistically important in determining the nutritional status of children, but von Braun et al. found that its absolute impact was far weaker than any of the health and sanitation variables examined. On the other hand, income was linked to nutritional status via both household food consumption, as well as the household's health and sanitation environment through household investments.

Von Braun et al. conclude that a narrow focus on food production would be entirely insufficient in improving household nutritional status, but rather that improvements in rural health and sanitation services or income growth leading to such improvements would have to be an essential part of any program oriented toward improving household nutrition.

Finally, UNICEF/Kigali (1988) brings together a variety of data to present a general picture of the incidence and leading causes of childhood disease and mortality. The evidence suggests that diarrheal diseases, malaria, respiratory problems, and malnutrition are key causes of infant and child mortality and child morbidity.

UNICEF/Kigali cites infectious diseases, malnutrition, prenatal complications, and the direct and indirect effects of overpopulation as acting in synergy to create morbidity and mortality in Rwandan children. However, UNICEF clearly states that proper understanding of the biological and social factors that affect the health of children in Rwanda is hindered by the paucity of available and accurate population health and nutritional status information (UNICEF/Kigali 1988).

Summary

Existing studies suggest that Rwanda suffers from high levels of undernutrition; however, information is still inadequate for a complete understanding of the nature of malnutrition in Rwanda. Many pieces of the puzzle remain to be fitted to fully understand the complex interactions among the health, nutritional, and socioeconomic environments found in Rwanda.

Several essential points can be drawn from the previous studies on Rwanda's health and nutrition situation:

- Many Rwandan households suffer from chronic calorie deficits.
- Rwanda suffers from a high prevalence of malnutrition and disease-related morbidity.
- Rwanda suffers from high levels of infant and maternal mortality most predominantly attributable to illness and malnutrition.
- Calorie availability, illness, and malnutrition vary greatly over geographic and agroclimatic localities within Rwanda.
- Seasonal aspects appear to be very important. Significant shortfalls in calorie availability occur during the third and fourth quarters of the year.
- Rwandan households exhibit great diversity in their breast-feeding and child weaning habits, but their specific relationship with child nutritional status is still unclear. However, evidence suggests that the "weaning period" represents a nutritionally dangerous period in Rwandan children's lives.
- Household hygiene habits and the sanitary environment are important determinants of the health and nutritional status of Rwandan children.

To date, the debate on nutrition in Rwanda has focused principally on regional crop production levels (i.e., counting aggregate calorie production levels). This debate needs to be extended to include the health side of the ledger, particularly with respect to the role of child illness and morbidity, the regional sanitary environment and health infrastructure, and the household's sanitary environment and hygiene practices. Better information is needed on the importance of maternal breast-feeding and child weaning behavior, as well as on the nutritional consequences of household fertility decisions.

In short, information concerning the underlying structure of malnutrition in Rwanda is still needed. In addition, Rwanda's rapid demographic expansion suggests that a clearer understanding of household fertility and its relation to malnutrition would aid in the struggle to ensure the opportunity for full physical and mental growth and development for all Rwandan children.

The 1987 UNICEF/Kigali survey of child weaning foods with components on health and nutrition represents a step toward filling this informational deficit while heightening the nature of the general debate on nutrition.

METHODOLOGY OVERVIEW

This study will use household-level data to examine the nutritional status of Rwandan children with an emphasis on the role of child health status and household total fertility.

Nutritional status results from a combination of nutrient intake, physical output, and disease. A graphic model (Figure 2) is developed to aid in appreciating the many factors and interactions involved at the household level in determining nutritional status of the individual household members. The model is designed to show the entry point for observable influences on the nutritional production process.

In general, the household operates within an environment of regional food availability. The household decisionmaker uses his available revenue and own production opportunities to acquire food resources for the household, which are subsequently distributed to members of the household for their own consumption.

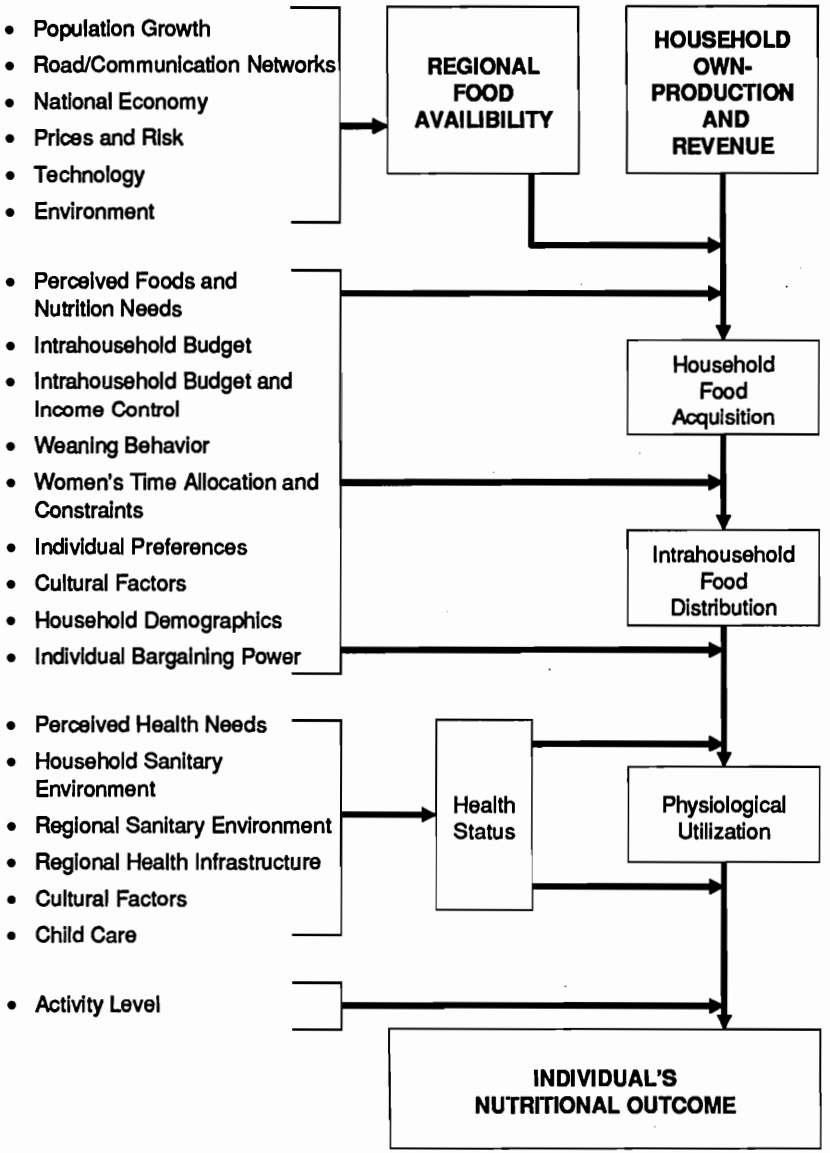
The regional food availability and the household's revenue sources are each subject to a range of external influences outside of the scope of this study. These include Rwanda's rapid population growth, new technological developments, environmental degradation, national economic health, and the efficiency and availability of markets and supporting infrastructure. These last three factors (national economy, markets, and infrastructure) determine the prices, wages, and risks faced by the household.

Several factors influence household food acquisition and distribution: the household's perceived food and nutritional needs, intrahousehold budget and income control, women's time allocation and constraints, weaning behavior, individual preferences, cultural factors, household demographics, and individual bargaining power.

The role of Rwandan women is crucial in producing positive nutritional outcomes. Women perform a number of household nonrevenue generating activities that are vital to the household's proper functioning and require investments of both time and materials. These activities include preparing meals, caring for children, breast-feeding, gathering water and fuel, and performing hygienic activities such as house cleaning, laundry, bathing, and waste removal. Their child-care behavior during periods of illness is another factor. In addition, the females are responsible for the production of the household's food crops.

An individual's health outcome directly affects his or her nutritional status. Illness often reduces an individual's appetite and, along with infections and

Figure 2 – Household Nutrition Model



internal parasites, may impair the body's ability to absorb nutrients from ingested foods. Diarrhea can also produce dehydration. Severe illness may even result in death in malnourished children.

Certain observable factors that directly influence child health status indirectly influence child nutritional status. These include the household's perceived health needs, the household and regional sanitary environment, the regional health infrastructure, household cultural factors, and child-care activities.

The household's daily hygiene behavior and sanitary environment indirectly affect the nutritional status of the household's children since these factors control the level of exposure to disease vectors. Thus, they have a strong relationship with household morbidity and mortality, otherwise referred to as the household's "health status."

Furthermore, the distance to the nearest health center or medical facility, as well as the quality and cost of services, has a strong influence on household health outcomes. This also holds true for access to health and nutrition educational information, clean water, and immunization of children.

Finally, the child's unobserved level of activity influences overall energy needs and the body's physiological utilization of calories consumed.

The household's total fertility acts upon child nutritional status by increasing the total cost of the household's nutritional inputs needed to maintain a given level of nutritional status for all of the household's children.

Figure 2 serves as a guide in tracing the causal relationships between different socioeconomic variables and the nutritional status of the household's children. Furthermore, it will be used in Chapter 6 to develop a multivariate model of the household's nutritional outcome.

ANTHROPOMETRIC INDICATORS

Since it is not possible to measure an individual's "nutrition" per se, certain physical measurements are used as "indicators" of nutritional well-being. With respect to the available survey data, two common anthropometric measures – weight-for-age and MUAC – were recorded for the sample children.

These anthropometric measurements were then used to produce three nutritional status indicators – weight-for-age, MUAC, and MUAC-for-age. The weight-for-age indicator is based on the NCHS/CDC references while the MUAC-for-age indicator is based on WHO/Brazzaville African standards. These two anthropometric measures – weight-for-age and MUAC – represent different types of nutritional status (Table 2).

Table 2 – Rwanda: Nutritional Status Indicators

Indicator	Interpretation	
Weight-for-age	Underweight. Combines elements of cumulative and current nutritional status.	
	Total malnutrition	<80%
	Moderate malnutrition	65% ≤ * < 80%
	Severe malnutrition	≤ 65%
MUAC-for-age	Acute malnutrition (wasting). Used as an indicator of near-term nutritional status.	
	Total malnutrition	<85%
	Moderate malnutrition	75% ≤ * < 85%
	Severe malnutrition	≤ 75%
MUAC	Total malnutrition	<13.5 cm.
	Moderate malnutrition	12.5 cm. ≤ * < 13.5 cm.
	Severe malnutrition	≤ 12.5 cm.

Sources: *Zerfas (1986); Ross et al. (1990); Velzeboer et al. (1983).*

MUAC is an objective counterpart to the clinical sign of thinness (Zerfas 1986). Ross et al. (1990) suggest that MUAC is particularly useful during emergency situations since (a) it is relatively age independent between the first and fifth birthdays and thus does not require accurate assessment of age, and (b) it is thought to be sensitive to acute malnutrition or wasting, which is usually measured by the weight-for-height index. Thus, MUAC and MUAC-for-age indicate near-term nutritional status.

In evaluating a child's arm circumference the data may be interpreted in two possible ways.

First, assuming that the MUAC for all children between the ages of 1 through 5 years remains reasonably constant in measure, a child is judged "severely malnourished" if her MUAC is less than 12.5 centimeters, "moderately malnourished" if her MUAC is equal to or more than 12.5 centimeters but below 13.5 centimeters, and "normal" if her MUAC is equal to or more than 13.5 centimeters. This method is frequently used in evaluating nutritional status

during famine or near-famine situations; furthermore, it lends itself easily to intuitive interpretation. Unfortunately, this approach is susceptible to bias should the underlying assumption of MUAC constancy over the 1-to-5 year age range fail to hold (Ross et al. 1990).

The second approach is to compare the MUAC data to international reference standards. In this study, reference medians are used to produce percentage of reference median statistics. Although this approach avoids the potential bias that results from MUAC growth between 1 and 5 years, it is not intuitively apparent which percentage cutoff levels should be used in assessing a child's nutritional status. Velzeboer et al. (1983) have shown the practicality of adopting 85 percent and 75 percent as the cutoff points for moderate and severe malnutrition, respectively. These thresholds are used in this study.

A serious deficiency of the MUAC indicator is that it may produce a normal classification of nutritional status for a stunted child (i.e., a child with low height-for-age).

Weight-for-age is more difficult to interpret intuitively since it represents a combination of both cumulative nutritional background as well as near-term nutritional status (WHO Working Group 1986). Thus, weight-for-age includes elements of cumulative nutritional status to the extent that a taller skeletal structure (which is clearly associated with long-term nutritional status) will tend to support greater weight and show a diminished tendency to change in accordance with temporary perturbations in its outside stimuli. On the other hand, weight-for-age captures elements of near-term nutritional status since body weight can change rapidly following bouts of illness or insufficient food intake.

A better measure of nutritional status is a child's height-for-age since it reflects the history of dietary deficiency and recurrent illness. As mentioned earlier, cultural sensitivity to perceived height differences between ethnic groups prevented the collection of data on child height.

In addition, a child's birthweight is an important determinant of current weight-for-age status and should be controlled for. Unfortunately, birthweight data are scarce in Rwanda, where 80 percent of births take place in the home (UNICEF/Kigali 1988).

The weight-for-age measurement of each child yielded two anthropometric statistics: the child's weight as a percentage of the international median for the relevant age/sex grouping, and the Z-score of weight-for-age based on the international mean and standard deviation per relevant age and sex grouping. These two statistics provide a means both for assessing the child's nutritional

status and for evaluating relationships between the child's nutritional status and certain key socioeconomic variables.

Nutritional status as classified by weight-for-age is categorized as "severe" if the observed weight-for-age value is below 65 percent of the international reference median. It is "moderate" if the observed weight-for-age is greater than or equal to 65 percent and below 80 percent of the reference median. Finally, summing "severe" and "moderate" malnutrition produces cumulative "malnutrition."

MUAC-for-age information is available for a total sample size of 1,847 children. The MUAC indicator independent of age is only relevant for children aged 13 months or older, thus, children aged 6 to 12 months are excluded from the sample based on the simple MUAC indicator, leaving a total of 1,127 children. Finally, only 1,328 children (aged 6 to 36 months) were observed for weight.

Thus, three different subsamples are used throughout this study. The maximum sample size available is used whenever possible. However, because weight-for-age is so important as an indicator in previous nutritional studies conducted in Rwanda, it is the focal point for examining child nutritional status.

Few socioeconomic studies include MUAC data, probably because of a lack of obvious intuitive socioeconomic interpretation with respect to nutritional status threshold points, but certainly also because of the preferred status of the weight-for-height, weight-for-age, and height-for-age indicators in the literature. However, MUAC is included in this study for several reasons.

First, the MUAC survey data permit two additional nutritional status indicators, which should enhance the analysis of associations between socioeconomic factors and child nutritional status.

Second, although several surveys in Rwanda include MUAC measures, this information has not been fully exploited. This study may provide the impetus for a better use of existing information, as well as for permitting comparisons across surveys to indicate both the direction and degree of nutritional status change in Rwanda.

Third, the MUAC measure can be incorporated into ongoing or future household surveys in a "cost-effective" manner; thus potentially increasing the level of information available for household nutrition surveillance activities in Rwanda.

Finally, with MUAC the sample size may be expanded to incorporate survey children with records of their MUAC but with no observation on weight. The larger sample may serve as a check on the robustness of estimation results under the reduced sample that is limited by the weight-for-age variable.

2. Anthropometric Results

SAMPLE CHARACTERISTICS

The sample is drawn from 7 of Rwanda's 10 prefectures and covers 1,847 children between the ages of 6 and 36 months. Budget and time limitations restricted the survey to only 7 prefectures. The selected areas were felt to represent the country's diversity; however, the sample was not drawn to reflect regional population differences, nor were weighting factors ever included in the sample design.

In each of the seven prefectures a commune was randomly chosen (except for Kigali prefecture, where the commune Nyarugenge, which includes the capital city of Kigali, was selected in addition to the randomly drawn commune of Rubungo), then four sectors were randomly chosen from each of the selected communes. Within each sector households with children between the ages of 6 and 36 months were drawn from communal registries. The number of households varied across sectors based on the availability of households with qualifying children and the level of assistance from local authorities. The sample distribution over political divisions is presented in Appendix Table A.1.

The selected communes are presented according to the agroclimatic zone classifications of Delpierre (1985) (see Table 3 and Figure 3). The data are presented in terms of the sex and age composition given in Table 4. The age categories were chosen from the sample data in a manner so as to permit a relatively even distribution of the children over the sample size. These same age categories are used in the subsequent chapters, which examine child weaning habits and nutritional status across age groups.

Table 3 – Rwanda: Agroclimatic Zone Classifications, by Selected Communes

Agroclimatic Zone	Altitude	Precipitation	Survey Communes	Major Crops
Impala	1,400-1,900	1,300-2,000	Gafunzo	Beans, corn, sweet potatoes, bananas, cassava, potatoes, sorghum, peas, peanuts, soybeans
Crête-Zaire Nile	1,900-2,500	1,400-1,800	Nyamagabe, Kanama	Sorghum, peas, corn, potatoes, wheat, eleusine
Eastern Plateau	1,400-1,800	900-1,000	Muhura, Muhazi, Nyarugenge, Rubungo	Bananas, beans, sorghum, sweet potatoes, corn, cassava, peanuts, peas
Central Plateau	1,500-1,900	1,100-1,300	Mbazi	Bananas, sorghum, sweet potatoes, cassava, corn

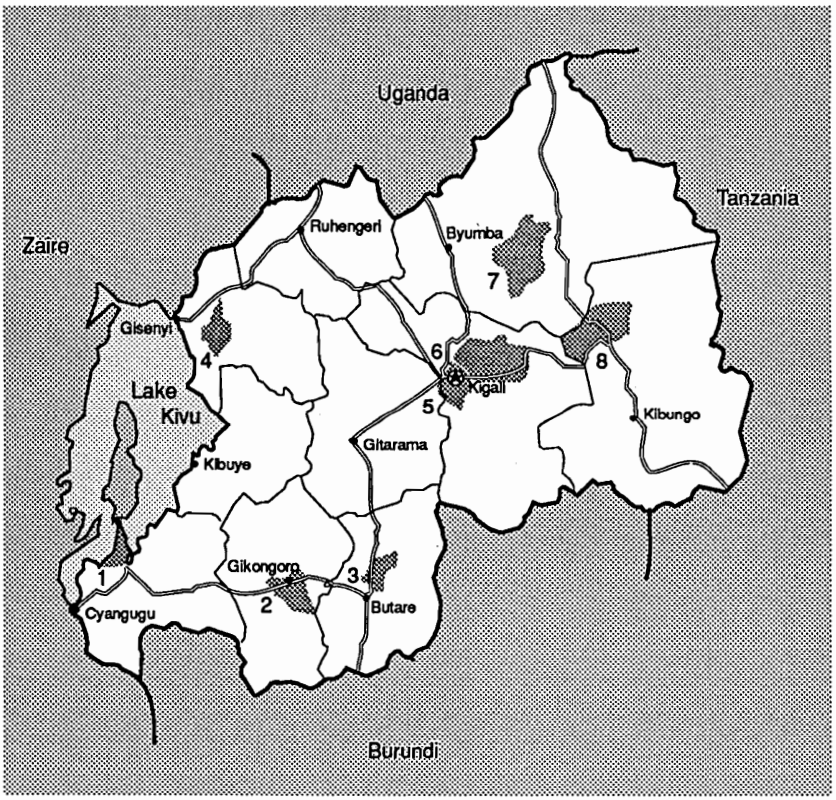
Source: *Delpierre (1985).*

Table 4 – Rwanda: Sample Distribution, by Age and Sex

Months	Male	Female	Total	Percent
6 ≤ 7	89	66	**155**	11.7
8 ≤ 9	91	82	**173**	13.0
10 ≤ 12	101	96	**197**	14.8
13 ≤ 15	107	96	**203**	15.3
16 ≤ 18	89	90	**179**	13.5
19 ≤ 23	115	83	**198**	14.9
24 ≤ 36	111	112	**223**	16.8
Total	**703**	**625**	**1,328**	
Percent	**52.9**	**47.1**	**100.0**	**100.0**

Source: *UNICEF/Kigali (n.d.).*

Figure 3 – Map of Rwanda and Survey Communes



Commune	Préfecture
1 - Gafunzo	Cyangugu
2 - Nyamagabe	Gikongoro
3 - Mbazi	Butare
4 - Kanama	Gisenyi
5 - Nyarugenge	Kigali
6 - Rubungo	Kigali
7 - Muhura	Byumba
8 - Muhazi	Kibungo

- Commune
- Kigali
- Major road
- Préfecture border
- Préfecture capital

INDEX-SPECIFIC RESULTS

Weight-for-Age

The weight-for-age results (Table 5) suggest that a total of 23.9 percent of the sample children are underweight. Out of this total 3.6 percent are severely underweight and 20.3 percent are moderately underweight. These results compare favorably with anthropometric data from previous surveys (refer to Table 1).

MUAC

The MUAC-for-age results as a percentage of reference median show that over 27.2 percent of sample children are acutely malnourished: 4.0 percent severely and 23.2 percent moderately so.

The MUAC results, assuming constancy over the 13-to-60 month age period, indicate that a total of 21.3 percent of the sample children are malnourished. Out of this total 6.5 percent are severely malnourished and 14.8 percent are moderately malnourished. Thus, the MUAC-for-age indicator produces a higher overall level of acute malnutrition than does the simple MUAC indicator. However, MUAC alone shows a greater incidence of severe acute malnutrition (6.5 percent versus 4.0 percent) than does MUAC-for-age. This discrepancy could be the result of the inherent age bias contained in the simple MUAC indicator.

Table 5 – Rwanda: Nutritional Status, by Anthropometric Indicator

Nutritional Status	Weight-for-Age[a]	MUAC-for-Age[b]	MUAC[c]
		Percent	
Severe malnutrition	3.6	4.0	6.5
Moderate malnutrition	20.3	23.2	14.8
Total malnutrition	**23.9**	**27.2**	**21.3**
No. of observations	**1,328**	**1,847**	**1,127**

Source: *UNICEF/Kigali (n.d.).*

[a] *Based on sample of children with weight-for-age observations.*

[b] *Based on the entire sample of children aged 6 to 36 months.*

[c] *Based on the sample of children aged 13 to 36 months.*

DIFFERENCES AMONG AGE GROUPS

Generally, between the 6th and 12th months of a child's life, mother's breast milk is supplemented with weaning foods to meet the child's increased demand for vitamins and nutrients not found in maternal milk. Children are nutritionally vulnerable in this period. Their intake of new foods and their increasing mobility increase their exposure to bacteria and foreign matter. It is not uncommon for nutritional status indicators to reflect this heightened vulnerability, particularly for children from poorer countries where an unsanitary environment and inadequate weaning foods predominate.

Weight-for-Age

The hypothesis of heightened vulnerability during the weaning period is supported by the increased malnutrition in children during the second year of life as revealed by the weight-for-age results of Table 6.

Table 6 – Rwanda: Levels of Weight-for-Age Malnutrition, by Age Group

Age (Months)	Sample Percent	Percent of Median[b]			Z-Score[c]
		<65%	65 ≤ < 80%	Cum. < 80%	Average
6 - 7	11.7	1.9	11.6	13.5	-0.13
8 - 9	13.0	2.9	19.7	22.6	-0.96
10 - 12	14.8	5.1	22.8	27.9	-0.99
13 - 15	15.3	3.4	25.1	28.5	-1.16
16 - 18	13.5	5.0	26.8	31.8	-1.26
19 - 23	14.9	4.5	23.7	28.2	-1.25
24 - 36	16.8	2.2	11.7	13.9	-0.85
Total[a]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,328.*

[b] χ^2 *= 35.3; probability = 0.000.*

[c] *F = 14.7; probability = 0.000.*

The percentage of children who weigh less than 80 percent of the reference median rises from 13.5 percent during the 6-to-7 month age group to 31.8 percent in the 16-to-18 month age group. During the third year the prevalence of underweight children returns to 13.9 percent. Several factors can explain this return to lower levels of malnutrition. From a negative perspective, a high rate of infant mortality – 12.3 percent for 0 to 1 year and 21.4 percent for 0 to 5 years of age (ONAPO 1983) – decimates the ranks of the poorly nourished children. From a positive point of view the child is better able to physically adjust to eating solid foods.

The Z-score results concur with the percentage of median results by gradually increasing in absolute magnitude until the midpoint of the second year. However, the mean Z-score of -0.85 for the 24-to-36 month age group suggests that the nutritional level has not returned completely to the same healthier status that the children enjoy during the 6-to-7 month period (-0.13) when they still depend almost entirely on the mother's breast milk for sustenance.

The statistical significance of the Chi-squared statistic (F-statistic) indicates that the level of malnutrition as measured by the percentage of reference medians (mean Z-scores) varies in a statistically significant manner across age categories.

These results agree with previous findings. Both the rural children and the urban children (aged 0 to 60 months) studied in the Ministry of Plan's NBCS and the children studied in the Ministry of Health's NNS survey (of children aged 0 to 60 months) showed a marked downturn in their weight-for-age after the first year of life. Meheus et al. (1977) found that 5 percent of their sample children between the age of 12 to 23 months were both stunted and wasted according to the Waterlow classification, compared with a sample average of only 2.6 percent in their 1976 Rwandan nutritional survey.

Cant et al. (1982) found that the proportion of stunted children from their sample data of 414 children at Gahini and 386 children at Cyanyabugayi increased markedly from the ages of 6 months to two years, i.e., the weaning period. Furthermore their data showed that the increase in stunting coincided with a decline in breast-feeding. In addition, their results showed statistically less stunting in children in the 1-to-2 year age group receiving specially prepared food supplements than in children from the same age group eating out of the family pot, which inevitably yields lower nutritional value.

MUAC

The MUAC-for-age results based on a larger sample (Table 7) echo the age related tendency of the weight-for-age results. Again, child nutritional status worsens dramatically between the sixth and ninth months. High levels of malnutrition continue through the second year before decreasing.

The MUAC results, assuming constancy in arm circumference between the ages of 13 to 60 months, suggest that malnutrition occurs earlier in the weaning period rather than later. However, the child's age strongly influences the percentages, which suggests that the assumption of constancy is weaker for older children.

The MUAC of over 26 percent of 13-to-18 month old children measures less than 13.5 centimeters. The percentage of malnourished children older than 18 months decreases gradually in each age group until only 12.1 percent of children two years or older are affected. The age bias inherent in this MUAC measure probably produces an understatement of the level of acute malnutrition during the third year, compared with earlier months. The age bias is partially revealed by the average age of a severely malnourished child, 17.6 months versus 19.6 months for a child of "normal" nutritional status.

In general, both the weight-for-age and the MUAC results support the conclusion that, on average, the nutritional status of rural Rwandan children deteriorates during the weaning period, from 8 to 24 months of age.

Figure 4 shows the percentages of malnourished children, as measured by the three nutritional indicators. The three indicators show nearly identical patterns of malnutrition, with the rate of malnutrition increasing once the child enters the weaning period some time after his/her sixth month.

DIFFERENCES BY SEX

Weight-for-Age

Table 8 presents the levels of weight-for-age malnutrition by sex. The percentage of median results shows only a small difference between the two sexes, with the males having a slightly higher level of malnutrition of 25.6 percent versus 21.9 percent for the females. The mean Z-scores show that the males have a statistically significant higher level of malnutrition with a mean Z-score of -1.06 versus -0.86 for the females.

These results contradict findings from the Ministry of Plan's rural 1982 to 1983 NBCS, which showed remarkably higher percentages of malnutrition for female children than their male counterparts for all three nutritional status

Table 7 – Rwanda: Nutritional Status Based on MUAC Indicators, by Age

Age (Months)	Sample Percent	Severe Malnutrition <75%	Moderate Malnutrition 75-85%	Cumulative[b] <85%
	MUAC as a Percent of Reference Medians			
6 - 7	12.4	1.7	14.8	16.6
8 - 9	12.4	3.5	26.6	30.6
10 - 12	14.2	5.7	31.7	37.4
13 - 15	15.3	6.0	21.9	27.9
16 - 18	12.5	6.5	25.5	32.0
19 - 23	15.3	3.5	26.1	29.7
24 - 36	17.9	1.2	17.0	18.2
Total[a]	**100.0**	**4.0**	**23.2**	**27.2**
Age (Months)	Sample Percent	Severe Malnutrition <12.5	Moderate Malnutrition 12.5-13.5	Cumulative[e] ≤13.5
	MUAC Based on Constancy of Arm Circumference Between 13 to 36 Months			
13 - 15	25.1	9.5	16.6	26.1
16 - 18	20.5	9.1	17.7	26.8
19 - 23	25.1	6.0	16.6	24.6
24 - 36	29.3	2.4	9.7	12.1
Total[c,d]	**100.0**	**6.5**	**14.8**	**23.3**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,847.*

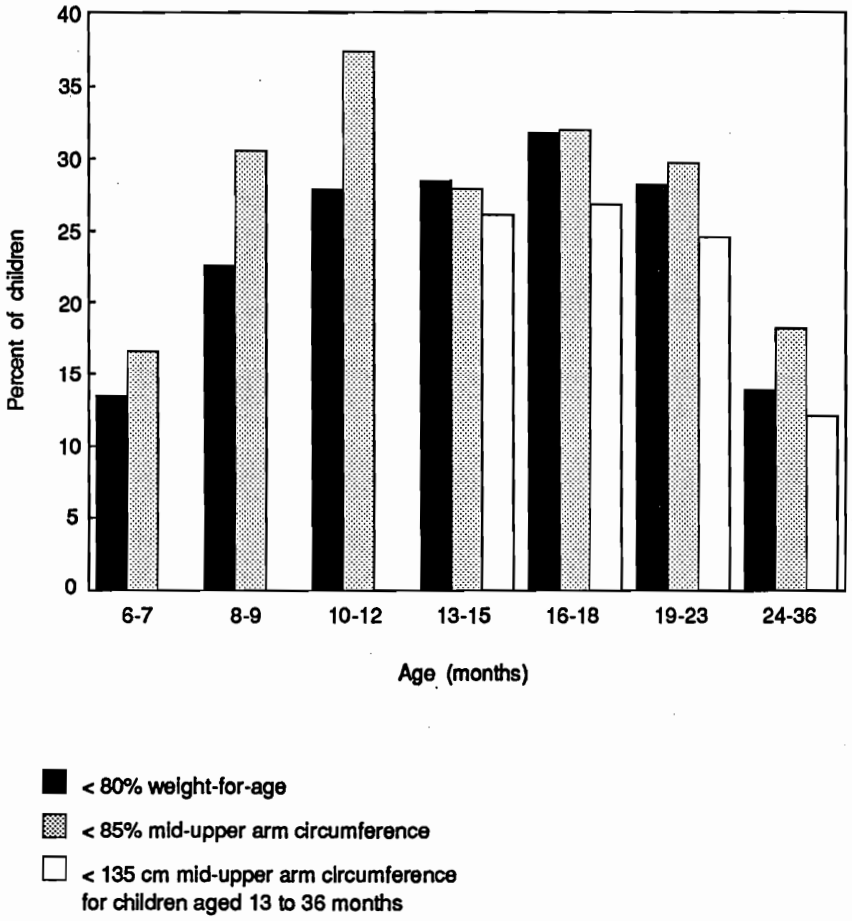
[b] *χ^2 = 56.9; probability = 0.000.*

[c] *N = 1,127.*

[d] *Only contains children between 12 and 36 months of age.*

[e] *χ^2 = 28.8; probability = 0.000.*

Figure 4 — Rwanda: Percentage of Malnourished Children in Terms of Weight-for-Age and Mid-upper Arm Circumference, by Age Group



Note: *Age categories are of unequal lengths.*

Table 8 – Rwanda: Levels of Weight-for-Age Malnutrition, by Sex

Sex	Sample Percent	Percent of Median[b]			Z-Score[c]
		< 65%	65 ≤ 80%	Cum. < 80%	Average
Male	53.0	4.0	21.6	25.6	-1.06
Female	47.0	3.2	18.7	21.9	-0.86
Total[a]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,328.*

[b] *Statistical sign:* $\chi^2 = 2.59$*; probability = 0.289.*

[c] *F = 7.24; probability = 0.005.*

indicators: weight-for-age (40.5 percent versus 28.5 percent), height-for-age (46.0 percent versus 32.0 percent), and weight-for-height (4.2 percent versus 2.1 percent). However, it should be noted that none of these differences appeared statistically significant in a multivariate setting that controlled for the child's age (Schnepf forthcoming b). No difference based on sex was found for urban children in the 1984-1985 urban NBCS.

The Ministry of Health's NNS (1986 to 1987) results agreed with the NBCS rural bivariate results. Girls were found to be more malnourished, with 32.1 percent weighing less than 80 percent of the reference median versus only 23.5 percent of the boys.

MUAC

Table 9 presents a comparison of MUAC-based malnutrition levels for the two sexes. The MUAC results contradict the weight-for-age findings in that the level of malnutrition is significantly larger for the females for both MUAC indicators (29.8 percent versus 24.9 percent as a percentage of median, and 23.5 percent versus 19.2 percent, assuming constancy over the 13-to-60 month age range).

Table 9 – Rwanda: Nutritional Status Based on MUAC Indicators, by Sex

Sex	Percent	Severe Malnutrition <75%	Moderate Malnutrition 75-85%	Cumulative[b] <85%
	MUAC as a Percent of Reference Medians			
Male	51.8	4.4	20.5	24.9
Female	48.2	3.6	26.2	29.8
Total[a]	**100.0**	**4.0**	**23.2**	**27.2**
Sex	Percent	Severe Malnutrition <12.5	Moderate Malnutrition 12.5-13.5	Cumulative[e] ≤13.5
	MUAC Based on Constancy of Arm Circumference Between 13 to 60 Months			
Male	51.4	6.9	12.3	19.2
Female	48.6	6.0	17.5	23.5
Total[c,d]	**100.0**	**6.5**	**14.8**	**14.8**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,847.*

[b] χ^2 *= 8.6; probability = 0.014.*

[c] *N = 1,127.*

[d] *Only contains children between 12 and 36 months of age.*

[e] χ^2 *= 6.28; probability = 0.049.*

DIFFERENCES BY COMMUNE

Weight-for-Age

The two statistical tests of Table 10 suggest significant differences in malnutrition levels over communes, ranging from a high of 38.0 percent in Nyamagabe (Gikongoro prefecture) to a low of 10.4 percent in Nyarugenge (urban Kigali). Surprisingly, Muhazi (Kibungo prefecture), a region of surplus agricultural production, shows a high level of malnutrition, with nearly 34 percent of its sample children weighing less than 80 percent of median

Table 10 – Rwanda: Levels of Weight-for-Age Malnutrition, by Commune

Commune	Sample Percent	Percent of Median[b]			Z-Score[c]
		< 65%	65 ≤ 80%	Cum. < 80%	Mean
Mbazi	9.3	0.8	13.7	14.5	-0.60
Muhura	11.1	1.4	21.8	23.2	-0.97
Gafunzo	15.0	3.5	28.6	32.1	-1.32
Nyamagabe	10.3	6.6	31.4	38.0	-1.41
Kanama	22.7	5.6	23.2	28.8	-1.29
Muhazi	4.0	11.3	22.6	33.9	-1.49
Nyarugenge	10.9	1.4	9.0	10.4	-0.35
Rubungo	16.6	1.8	11.3	13.1	-0.39
Total[a]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*
[a] *N = 1,328.*
[b] *χ^2 = 76.9; probability = 0.000.*
[c] *F = 21.6; probability = 0.000.*

weight-for-age. In addition, 11.3 percent of its children are severely malnourished. In 1986 Muhazi commune produced nearly 2,800 calories per day per capita.

The weight-for-age indicators produce two major groupings of survey communes. The sample children from Gafunzo, Nyamagabe, Kanama, and Muhazi communes have markedly poorer nutritional status than do children from Mbazi, Muhura, Nyarugenge, and Rubungo communes.

MUAC

The two MUAC indicators show the same two distinct divisions for the survey communes. However, under the larger sample permitted by the MUAC percentage of median indicator, Rubungo commune appears to have much higher levels of acute malnutrition (26.5 percent) than the malnutrition (13.1 percent) measured by weight-for-age. In addition, the two urban communes of Mbazi (Butare) and Nyarugenge (Kigali) show dramatically lower levels of acute malnutrition than the remaining six survey communes (Table 11).

Table 11 – Rwanda: Nutritional Levels Based on MUAC Indicators, by Commune

Commune	Percent	Severe Malnutrition <75%	Moderate Malnutrition 75-85%	Cumulative[b] <85%
	MUAC as a Percent of Reference Medians			
Mbazi	10.4	2.6	14.1	16.7
Muhura	12.4	0.4	21.0	21.4
Gafunzo	14.5	4.1	29.9	34.0
Nyamagabe	14.8	7.3	30.0	37.3
Kanama	17.2	3.5	22.7	26.2
Muhazi	10.9	6.4	27.2	33.6
Nyarugenge	8.0	1.4	12.2	13.6
Rubungo	11.9	5.0	21.5	26.5
Total[a]	**100.0**	**4.0**	**23.2**	**27.2**

Commune	Percent	Severe Malnutrition <12.5	Moderate Malnutrition 12.5-13.5	Cumulative[d] <13.5
	MUAC Based on Constancy of Arm Circumference Between 13 to 60 Months			
Mbazi	11.8	2.3	5.3	7.6
Muhura	12.2	2.2	15.2	18.0
Gafunzo	14.0	7.6	19.6	36.0
Nyamagabe	15.3	11.6	20.3	41.4
Kanama	14.9	10.1	23.2	28.9
Muhazi	11.5	6.9	17.7	31.6
Nyarugenge	8.2	1.1	3.3	7.9
Rubungo	12.1	5.9	5.9	16.8
Total[c]	**100.0**	**6.5**	**14.8**	**21.3**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,847.*

[b] χ^2 *= 69.9; probability = 0.000.*

[c] *N = 1,127.*

[d] χ^2 *= 76.1; probability = 0.000.*

Both the study by Meheus et al. (1977) and the Ministry of Health's NNS revealed large regional variations in nutritional status. Interestingly, the Ministry of Health's NNS also found the highest prevalence of weight-for-age malnutrition in Kibungo prefecture,[3] thus showing the inadequacy of aggregate regional calorie availability figures to assess household or individual nutritional status.

It is important that policymakers consider interregional differences when thinking of ways to combat malnutrition. However, the apparent poor correlation between agricultural production data and nutritional status for the survey communes suggests that nutrition and food security are household-level problems. Consequently, there is an element of danger in relying too heavily on aggregate regional production figures to indicate the prevalence of malnutrition for a given region.

3 In 1986 Kibungo prefecture produced an average of 3,350 kilocalories per day per capita.

3. Household Characteristics

This chapter presents data on several characteristics of the child and his or her household environment. The anthropometric weight-for-age indicators' percentage of median and Z-scores are studied as they relate to varying levels of household socioeconomic characteristics. This bivariate statistical analysis serves to introduce the multivariate analysis of Chapter 6.

CHILD BIRTH ORDER/TOTAL FERTILITY

No information was gathered on total household size, but the number of older brothers and sisters, both living and deceased, of each sample child was recorded.

Each sample child's birth order was based on both living and deceased siblings. Since the children included in the survey were always the youngest living family member, the household's current total fertility equals the child's birth order.

The results (Table 12) indicate that 37 percent of all sample children have at least one deceased sibling, while 92 percent have at least one living sibling. The average sample child had 0.7 deceased siblings and 2.5 living siblings.

Only 16 percent of the sample children (Table 13) have no siblings living or dead. This indicates the tremendous emphasis on child birth in Rwandan society. The fertility rate is estimated at 8.6 live births per woman of childbearing age (ONAPO 1983), while the annual rate of population growth is estimated at 3.5 to 3.8 percent (ONAPO 1985).

The statistical tests for both indicators suggest that a birth order (total fertility) of three or higher is associated with higher percentages of malnourished children than are birth orders of only one or two. This relationship shows the lesser bargaining power of young, "economically unproductive" children within

Table 12 – Rwanda: Number of Siblings in Household per Sample Child

Deceased			Living		
Number	Percent	Cumulative	Number	Percent	Cumulative
0	63.0	63.0	0	18.1	18.1
1	20.3	83.4	1	20.1	38.2
2	9.6	92.9	2	18.2	56.4
≥3	7.1	100.0	3	14.0	70.4
			4	12.2	82.6
			5	8.1	90.7
			6	4.7	95.5
			≥7	4.5	100.0
Total[a]		**100.0**			**100.0**
Average		**0.7**			**2.5**
Standard Deviation		**1.2**			**2.1**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,328.*

Table 13 – Rwanda: Level of Weight-for-Age Malnutrition, by Birth Order

Birth Order	Sample Percent	Percent of Median[b]			Z-Score[c]
		<65%	65-80%	Cum. <80%	Mean
1	15.8	2.9	19.0	21.9	-0.90
2	16.1	1.4	14.0	15.4	-0.71
3	15.4	5.9	21.1	27.0	-1.05
4-5	25.2	3.0	24.2	27.2	-1.04
≥ 6	27.5	4.7	20.5	25.2	-1.03
Total[a]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,328.*

[b] $\chi^2 = 17.4$; *probability = 0.026.*

[c] *F = 2.7; probability = 0.091.*

the household. In addition it suggests the increased strain placed on the household's limited resources by a large family. Thus, decreasing the number of children per family via family planning could positively influence the nutritional status of Rwandan children.

PARENTS' EDUCATIONAL LEVELS, MARITAL STATUS, AND THE FATHER'S LIVING CIRCUMSTANCES

Maternal educational levels show a positive relationship with child nutritional status (Table 14). Nearly 28 percent of the children of illiterate mothers are malnourished in terms of weight-for-age. This compares with fewer than 9 percent of children whose mothers have obtained at least some secondary education. Furthermore, the sample mothers have attained strikingly low educational levels. Only 34 percent of the mothers report having finished primary school. A total of 42 percent are fully illiterate.

The nutritional status of the child also has a strong positive relationship with the father's educational level; higher educational levels are associated with better child nutritional status.

Over 30 percent of the sample children of illiterate fathers were malnourished in terms of weight-for-age versus fewer than 15 percent of children whose fathers have at least some secondary education.

It deserves mentioning that the overall educational levels of the fathers are dramatically higher than those of the mothers. Only 22 percent of fathers are illiterate versus 42 percent of the mothers. Over 45 percent of fathers have completed primary school versus 34 percent of the mothers in the sample. Such dramatic differences will have similarly dramatic repercussions on any literacy-dependent rural extension program oriented toward females that is designed to improve child weaning methods and health practices, or to improve agricultural practices for that matter.

These results indicate a strong positive relationship between parents' educational levels and children's nutritional status. However, bivariate statistical methods fail to control for household income and wealth, which are generally correlated with household educational levels. Such a positive correlation would overemphasize the importance of education in a bivariate framework. This relationship is examined in a multivariate framework in Chapter 6.

The survey households were asked whether the child's father lived with the household full time. Over 85 percent of the households responded affirmatively.

Table 14 – Rwanda: Levels of Weight-for-Age Malnutrition, by Education Level of the Child's Parents

Parent/Education	Sample Percent	Percent of Median[a,b]			Z-Score[c,d]
		<65%	65-80%	Cum. <80%	Mean
Mother					
Illiterate	42.2	5.6	21.9	27.9	-1.16
Primary incomplete	24.2	3.1	22.3	25.4	-1.01
Primary completed	27.1	2.0	19.6	21.6	-0.82
Secondary incomplete	4.7	0.0	6.5	6.5	-0.32
Secondary completed	1.8	0.0	8.3	8.3	-0.13
Total[e]	**100.0**	**3.6**	**20.4**	**24.0**	**-0.97**
Father					
Illiterate	22.2	7.4	23.0	30.4	-1.18
Primary incomplete	32.7	4.5	22.4	26.9	-1.18
Primary completed	34.8	1.9	20.1	22.0	-0.89
Secondary incomplete	5.6	0.0	14.7	14.7	-0.58
Secondary completed	3.7	0.0	8.9	8.9	-0.26
Total[f]	**100.0**	**3.8**	**20.6**	**24.4**	**-0.99**

Source: *UNICEF/Kigali (n.d.).*

[a] *Mother:* $\chi^2 = 25.4$; *probability = 0.001.*

[b] *Father:* $\chi^2 = 91.5$; *probability = 0.001.*

[c] *Mother:* $\chi^2 = 12.1$; *probability = 0.000.*

[d] *Father:* $\chi^2 = 12.8$; *probability = 0.000.*

[e] *N = 1,319.*

[f] *N = 1,214.*

This information represents the "effective" gender of the head of the household. Households where the male declares himself the head of the household but does not live in the household are effectively headed by a female. The lack of a male counterpart greatly reduces the manpower available to the household, thus increasing the work load placed upon the mother.

It is becoming more and more common for husbands to leave their families in the countryside to seek employment in an urban center (most likely Kigali). It is not clear whether this absence is actually temporary or permanent (i.e., abandonment).

With respect to the mother's marital status, the vast majority of the sample mothers (77 percent) are married. However, the 23 percent of single, widowed, or separated mothers is not an insignificant figure, particularly considering the fact that most women make a livelihood by farming.

Cohabitation outside of marriage is common in rural areas, as the data suggest. The 23 percent of sample women who declared themselves to be unmarried, widowed, separated, or divorced is significantly higher than the 14 percent of households stating that the child's father does not live with the household. This difference reflects the complicated nature of the household composition.

PARENTS' OCCUPATIONAL STATUS

The survey data revealed statistically significant differences in the levels of child malnutrition based on both parents' occupation. A significantly higher percentage of malnourished children is associated with agriculturally oriented parents than with nonagricultural professionals. Nearly three in every four Rwandans claim agriculture as their principal profession (Table 15).

Although information for Rwanda is limited, nonagricultural professionals probably earn higher income because of better education, greater initial wealth, etc. The relationship between child nutritional status and parental occupation is examined further in Chapter 6.

HOUSEHOLD EATING HABITS

Two questions were posed concerning household eating habits. The first question asked how many times meals were cooked each day, while the second question asked how many times the household ate meals in a day.

A slight inconsistency in responses (i.e., 271 households claim to cook hot meals three times in a day, but only 187 households eat three or more meals in

Table 15 – Rwanda: Level of Weight-for-Age Malnutrition, by Occupation of the Child's Parents

Parent/Occupation	Sample Percent	Percent of Median[a,b]			Z-Score[c,d]
		<65%	65-80%	Cum. <80%	Mean
Mother					
Nonagriculture	23.6	1.7	10.3	12.0	-0.39
Agriculture	76.4	4.4	23.9	28.3	-1.16
Total[e]	**100.0**	**3.8**	**20.7**	**24.5**	**-0.98**
Father					
Nonagriculture	29.4	1.7	11.7	13.4	-0.53
Agriculture	70.6	4.5	24.2	28.7	-1.17
Total[f]	**100.0**	**3.7**	**20.6**	**24.3**	**-0.98**

Source: *UNICEF/Kigali (n.d.).*
[a] *Mother:* $\chi^2 = 99.6$; *probability = 0.000.*
[b] *Father:* $\chi^2 = 92.9$; *probability = 0.000.*
[c] *Mother:* $\chi^2 = 81.8$; *probability = 0.000.*
[d] *Father:* $\chi^2 = 61.5$; *probability = 0.000.*
[e] *N = 1,277.*
[f] *N = 1,221.*

a day) suggests that not all family members eat at the same time. The mother (or the women of the household) may prepare separate meals for the children and the adults; thus explaining the higher number of meals cooked than meals eaten.

It appears (Table 16) that meal frequency is positively associated with better child nutritional status.

Households eating only one meal per day experience high levels of malnutrition. Almost 37 percent of children in these households weigh less than 80 percent of the reference median. On the other hand, only about 12 percent of the children from households eating three meals per day suffer from an inadequate nutritional status.

Table 16 – Rwanda: Nutritional Status per Number of Meals Eaten and Number of Meals Cooked During a Day

Number	Percent	Percent of Median[a,b]			Z-Score[c,d]
		<65%	65-80%	Cum. <80%	Mean
Number of Family Meals Eaten During a Day					
1	6.4	1.2	35.7	36.9	-1.41
2	79.5	4.4	20.6	25.0	-1.02
3	13.9	0.5	11.4	11.9	-0.46
4	0.2	0.0	0.0	0.0	-0.46
Total[e]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.97**
Number of Meals Cooked During a Day					
1	19.6	3.9	30.5	34.4	-1.35
2	59.9	4.2	19.9	24.1	-1.01
3	20.5	1.8	11.4	13.2	-0.46
Total[e]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.97**

Source: *UNICEF/Kigali (n.d.).*

[a] *Eaten:* $\chi^2 = 91.9$; *probability = 0.000.*

[b] *Cooked:* $\chi^2 = 94.6$; *probability = 0.000.*

[c] *Eaten:* $F = 12.9$; *probability = 0.000.*

[d] *Cooked:* $F = 91.7$; *probability = 0.000.*

[e] *N = 1,322.*

What does this table actually say? It could possibly be the manifestation of three underlying causes. First, a higher meal frequency could represent greater food availability in the household; second, it could represent greater amounts of time dedicated by the female to household activities (due possibly to a combination of less field work, abundant household labor, or adequate revenue sources); and third, it could simply represent a conscious effort on the part of the household to ensure proper eating habits by its members. But whatever the underlying reason, its effect is clearly positive.

Similarly, better nutritional status is strongly associated with more frequent meal preparations. More than one-third (34 percent) of the sample children living in households that prepare meals once per day were malnourished, whereas slightly more than one-eighth (13 percent) of the children from households preparing meals three times per day were malnourished. In addition to the reasons cited above, this relationship may in part be attributable to the fact that heating food before serving kills many of the weaker bacteria that otherwise might attack the child's digestive tract.

4. Child Weaning Behavior

Previous studies in Rwanda (MINISAPASO 1987; MINIPLAN 1990) have hinted that much of Rwanda's child malnutrition is either directly or indirectly attributable to the mother's health during pregnancy and to her breast-feeding and weaning behavior.

Unfortunately, this survey was not able to obtain any information concerning the mother's health status during the child's gestation period. Nor was accurate information on maternal breast-feeding activities available. Instead, certain pieces of information were gathered with respect to child feeding behavior including a description of the foods most frequently used during the child's weaning period. This is particularly important since the weaning period is considered the most physically vulnerable period of a child's life outside of the mother's womb (Scheider 1983). Results from Chapter 2 have already shown that the weaning period (6 to 24 months) is associated with higher levels of weight-for-age malnutrition among infants under 3 years than during the preceding and following periods.

WEANING FOODS

The survey participants were asked to name the weaning foods used for their child's diet. This information is presented in an aggregated form by major food group (Table 17).

Nearly 70 percent of the households use some form of cereal (principally sorghum porridge) as a first weaning food.

Meanwhile another 16.4 percent of the sample uses dairy products as a first weaning food (10.2 percent uses powdered milk and 4.3 percent uses cow milk). The other category of importance was the fruit category, which 8.4 percent of

Table 17 – Rwanda: List of Preferred Weaning Foods

Category	First Choice[b]		Second Choice[c]	
Cereal	**69.3**		**16.9**	
Sorghum porridge		68.8		14.7
Other		0.6		2.2
Root crop	**3.1**		**6.4**	
Cooking bananas		1.9		3.0
Potatoes		0.9		1.9
Other		0.5		1.5
Legumes[a]	**0.9**		**6.8**	
Meat and dairy	**16.4**		**20.7**	
Powdered milk		10.2		6.8
Cow milk		4.3		2.3
Eggs		1.1		7.9
Other		0.7		38
Vegetables and leaves	**1.3**		**5.6**	
Fruit	**8.6**		**43.2**	
Avocados		0.9		6.4
Bananas		5.7		8.3
Other		2.0		28.7
Drinks	**0.5**		**0.4**	
Total sample	**100.0**		**100.0**	

Source: *UNICEF/Kigali (n.d.).*

[a] *Exclusively beans.*

[b] *N = 1,289.*

[c] *N = 266.*

the households used as a first weaning food. Most of this comes from bananas (5.7 percent).

Although the use of sorghum porridge as a weaning food is fairly widespread, the use of germinated sorghum is not. Only a single household reported using germinated sorghum as a first weaning food. Germinated sorghum has been shown to be a weaning food of high nutritive value exceeding that of ungerminated sorghum by 20 to 30 percent (Ramakavelo 1987).

A combined total of 80 percent of sample households choose either some form of sorghum porridge or powdered milk as their first choice of weaning food. The preparation of both sorghum porridge and powdered milk require water, which increases the exposure of weaning-age children to foreign bacteria and other contaminants through the use of contaminated water and/or improper water preparation methods.

As for the use of a second weaning food, only 266 households responded. Of these, 42.5 percent declared some type of fruit as their second weaning food, 20.7 percent used meat or dairy products (principally powdered milk, cow's milk, and eggs), and 16.9 percent used cereals (usually sorghum porridge again).

PERSONS ASSISTING IN CHILD FEEDING

The sample households were asked to identify the extent of child feeding undertaken by each household member, as well as by hired help and neighbors (Table 18). Clearly the child's mother is the primary feeder of the child. Only 21.4 percent of the sample households said that the child's father performed the task occasionally. Persons outside of the direct family rarely assisted in child feeding. This implies that information on proper weaning food habits should be directed principally to the child's mother.

Table 18 – Rwanda: Who Ordinarily Feeds the Child?

	Generally	Sometimes	Rarely	Never	**Total[a]**
	Percent				
Mother	98.4	1.1	0.1	0.5	**1,289**
Father	0.4	21.4	12.8	65.4	**1,233**
Grandparents	1.2	19.2	7.9	71.7	**1,227**
Older brother	0.6	14.6	6.9	77.9	**1,213**
Older sister	3.8	21.6	4.4	69.8	**1,223**
Neighbor	0.4	4.9	7.5	87.2	**1,229**
Domestic	3.0	3.9	1.2	91.9	**1,204**
Other	0.4	1.3	0.3	96.8	**681**

Source: *UNICEF/Kigali (n.d.).*

[a] *The difference from 1,328 represents missing data.*

MOTHER'S FIELD WORK HABITS

Regional specialization in crop production activities based on agroclimatic comparative advantages has yet to develop in Rwanda. The dispersion and self-sufficiency orientation of rural households have inhibited the growth of rural market centers, thus further retarding the development of regional crop specialization.

Instead, the concept of food self-sufficiency prevails, even at the household level. In the absence of villages, rural households have adopted a "family centric" attitude that appears to strengthen during difficult times. This motivation compels the households to vary their own production activities in terms of both source of calories as well as seasonality of calories production. Unfortunately, most households do not actually produce enough calories to meet 100 percent of FAO/WHO recommended levels.[4]

The 1984 National Agricultural Survey (MINAGRI 1985) found an average landholding of only 1.2 hectares per household. This 1.2 hectares is broken up into an average of 4.7 small parcels or garden plots situated within approximately one hour's walk of each other. These plots are used to produce a variety of crops that help hedge against risk attributable to seasonal factors and market inadequacies. This production strategy places an added burden on the labor demands of the household's females, who are expected to produce the food crops necessary for the household's existence.

Given this background, an attempt was made to ascertain the amount of field work undertaken by the mothers of the sample children. The amount and intensity of the mother's field work will reflect directly upon the amount of time available to her for childcare and household tasks such as meal preparation, and indirectly upon her ability to produce milk by its influence on her own nutritional status and the regularity of nursing sessions.

Three general questions were asked regarding the mother's field work:

1. How many days per week does the mother spend in the field?
2. What is the time she leaves and returns from the field (or how many hours per day does she spend in the field)?
3. Does she take her infant with her?

The responses to the above questions reflect the mother's perception of her average field work activities.The survey was undertaken during the months of

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4 The 1986 national crop production estimates (MINAGRI 1988) indicate that only 43 percent of Rwanda's 143 communes produced more than 2,100 kilocalories per day per capita.

August and September, which fall toward the latter part of the major dry season in Rwanda. Mid-September rains initiate the major soil preparation and planting activities for leguminous crops and cereals. However, sweet potatoes and some cassava cultivation occurs continuously in the more moist, low-lying areas.

With respect to the first question, nearly three-fourths of the women go to their fields at least four days per week. Survey results indicate a very distinct, negative relationship between the number of days the child's mother spends in the field per week and the nutritional status of the child. Nearly 35 percent of the children of mother's spending six out of every seven days doing field work are malnourished in terms of weight-for-age, whereas less than 10 percent of the children of mothers spending no time doing field work are malnourished (Table 19).

This phenomenon could reflect household labor shortages and subsequent excess demands on female labor time. But to the extent that the average number of field days reflects the household's food availability or the means to procure food in relation to its perceived food needs, the problem is one of poverty and limited economic opportunities rather than labor shortage or crop choice. Poorer households feel compelled to spend more time in the field in order to meet their perceived food needs.

Table 19 – Rwanda: The Number of Days per Week the Mother Spends in the Field

Days	Sample Percent	Percent of Median[a]			Z-Score[b]
		<65%	65-80%	Cum. <80%	Mean
0	15.0	0.6	8.7	9.3	-0.44
1-3	11.6	5.3	18.0	23.3	-1,07
4	17.3	5.0	20.1	25.1	-1.10
5	39.2	3.5	25.5	29.0	-1.16
6	16.9	5.6	29.2	34.8	-1.33
Total[c]	**100.0**	**3.7**	**20.2**	**23.9**	**-1.06**

Source: *UNICEF/Kigali (n.d.).*

[a] $\chi^2 = 40.8$; *probability = 0.000.*

[b] $F = 19.1$; *probability = 0.000.*

[c] $N = 1,151$.

The average number of hours per day per week was calculated from the answers to questions 1 and 2. However, the resulting hours per day per week data failed to show any relationship to child nutritional status. The actual number of hours spent in the field probably depends on the field size, the crop choice, and the growing season, with too much variation throughout the year to be properly represented by a subjectively estimated mean level.

When asked whether or not the child accompanies the mother to the field, almost three-fourths of sample mothers responded affirmatively; however, no statistical relationship was found with respect to the child's nutritional status.

TABOOS AND RESTRICTIONS ON WEANING FOOD USAGE

Household respondents were asked to indicate whether their household had any taboos or restrictions on some foods for weaning purposes.

In addition to the general question of taboos or restrictions for any food, a list of several common commodities was provided to each household. These include corn, uncrushed vegetables, cassava, beer, and colocasse (Table 20).

In response, 58 percent of the sample households responded affirmatively. The statistical tests show a significant difference in the levels of weight-for-age malnutrition between those households with restrictions and those households without restrictions. This probably reflects, at least in part, the possibility that a discriminating household would take more care in its child rearing habits than a less discriminating household. Only 21 percent of children from households with food taboos or restrictions were malnourished compared with 27 percent of the sample children coming from households with no restrictions.

With respect to the responses for restrictions placed on specific commodities, beer and corn are the two most restricted commodities among the sample households that entertain taboos or restrictions. Beer ranked most important, as more than one-half (53 percent) of the sample households restricted the use of beer for the child during its weaning period.

The issue of beer usage as a weaning food in Rwanda is of some concern because of the widespread consumption of sorghum beer. Sorghum beer is not always recognized as an alcohol, despite its alcoholic potency. Many females who declare to never drink alcohol will respond affirmatively when asked if they consume sorghum beer. Furthermore, the process used to prepare sorghum beer is not far removed from the process used in preparing germinated sorghum porridge. Not surprisingly, the difference of 5 percent fewer malnourished children for households restricting the use of beer was statistically significant.

Table 20 – Rwanda: Does the Household Have Taboos or Restrictions on Any Foods for Child Weaning?

Item	Sample Percent	Percent of Median			Z-Score
		<65%	65-80%	Cum. <80%	Mean
Any Food					
Yes	58.2	2.8	18.6	21.4	-0.85
No	41.8	4.7	22.5	27.2[a]	-1.12[b]
Total[c]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**
Corn					
Yes	40.3	2.3	17.9	20.2	-0.78
No	59.7	4.4	21.9	26.3	-1.08[b]
Total[d]	**100.0**	**3.7**	**20.2**	**23.9**	**-0.96**
Uncrushed Vegetables					
Yes	6.3	2.4	23.2	25.6	-0.83
No	93.7	3.6	20.1	23.7	-0.97
Total[e]	**100.0**	**3.5**	**20.3**	**23.8**	**-0.96**
Cassava					
Yes	15.8	1.8	16.8	18.6	-0.58
No	84.2	3.3	20.8	24.1	-0.98[b]
Total[f]	**100.0**	**3.0**	**20.2**	**23.2**	**-0.92**
Beer					
Yes	53.2	2.5	19.0	21.5	-0.86
No	46.8	4.8	21.7	26.5[a]	-1.08[b]
Total[e]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**
Colocasse					
Yes	9.6	2.4	21.4	23.8	-0.64
No	90.4	3.6	20.2	23.8	-0.99[b]
Total[g]	**100.0**	**3.5**	**20.3**	**23.8**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] *Significance level of 0.05 on the Chi-square test.*

[b] *Significance level of 0.01 on the F-test.*

[c] *N = 1,328.*

[d] *N = 1,319.*

[e] *N = 1,297.*

[f] *N = 1,056.*

[g] *N = 1,306.*

Most sample respondents had no restrictions on uncrushed vegetables, cassava, or colocasse as weaning foods. This suggests that the concept of weaning is not well-understood from a nutritional point of view in Rwandan households. Changing an infant's calorie source from breast milk to the family platter can cause nutritional harm. There appears to be much potential room for improvement in this area whether via nutrition extension activities or a general social mobilization program.

5. Child Morbidity Factors

CHILD ILLNESSES

The subjective appraisal of the sample mothers was used as an indicator of the incidence of child illness during the two weeks before the interview. The illnesses included fever, diarrhea, bad cough, or worms.

The reported high prevalence of illness (Table 21) is shocking. Over 50 percent of the sample children suffered from at least one physical affliction from among the four listed during the two weeks preceding the survey. Almost 30 percent of all sample children suffered from at least one bout of diarrhea, almost one-fourth had a fever, slightly more than one-fourth suffered from a bad cough, while 10 percent of the children emitted worms.

Furthermore, the results show a high correlation between the incidence of disease and the frequency of malnutrition. The statistical tests show a significantly higher percentage of children experiencing illness (30 percent) who are malnourished than the percentage of children not experiencing any illness during the same period (17 percent).

The level of malnutrition, as measured by weight-for-age Z-scores, is significantly higher for "yes" responses than for the "no" responses concerning the incidence of every affliction. This result is supported by the percentages of the reference median with fever, diarrhea, bad cough, and worms, which are all statistically associated with higher percentages of children weighing less than 80 percent of the weight-for-age reference median.

One is led to conclude that higher levels of malnutrition are associated more with the presence of illness and parasites than with their absence. This supports the concept of a vicious cycle between poor health and poor nutrition where one reinforces the other to the detriment of the child. Once the child has one illness, his or her body is often so weakened that it succumbs easily to other diseases with often devastating nutritional consequences. To examine the nature of this

Table 21 – Rwanda: Incidence of Affliction Over Two Weeks and the Statistical Association with the Level of Malnutrition

	Sample Percent	Percent of Median[d]			Z-Score[e]
		<65%	65-80%	Cum. <80%	Mean
Illness?					
Yes	51.7	4.4	25.5	29.9[c]	-1.20[c]
No	48.3	2.8	14.6	17.4	-0.71
Fever					
Yes	24.9	6.6	29.9	36.5[c]	-1.36[c]
No	75.1	2.6	17.1	19.7	-0.83
Diarrhea					
Yes	29.7	4.6	29.4	34.0[c]	-1.29[c]
No	70.3	3.2	16.4	19.6	-0.83
Cough					
Yes	26.7	3.7	24.6	28.3[a]	-1.17[c]
No	73.3	3.6	18.7	22.3	-0.89
Worms					
Yes	10.6	5.0	29.1	34.1[b]	-1.44[c]
No	89.4	3.5	19.2	22.7	-0.91
Total[f]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] *Significance level of 0.10.*

[b] *Significance level of 0.05.*

[c] *Significance level of 0.01.*

[d] *A Chi-square test is used to test for significant differences in responses.*

[e] *An F-test is used to test for significant differences in responses.*

[f] *N = 1,928.*

problem in Rwanda, the number of different maladies among the sample children during the two weeks immediately preceding the survey was calculated (Table 22).

Over half of all the sample children suffered from at least one physical affliction during the two weeks, while almost 28 percent had multiple illnesses. Another 11 percent of the sample children experienced at least three of the four afflictions for which information was obtained.

One would immediately suspect that this group of 11 percent of the sample children represents the most vulnerable children in the sample. This hypothesis is supported by the statistical tests measuring the strength and degree of association between illness "frequency" and nutritional status.

The pattern of statistical evidence is very clear. Higher levels of malnutrition as measured by weight-for-age are significantly associated with higher incidence and frequency of diseases or afflictions.

Almost one-half of the children experiencing four of the afflictions were underweight, while 38 percent of the children suffering from three of the afflictions weighed less than the 80 percent level of weight-for-age. On the other hand, only 17 percent of the children not experiencing any illness over the two weeks were underweight.

An attempt is made to evaluate the distribution of incidence and frequency of illnesses by age group (Table 23). However, care must be taken in interpreting

Table 22 – Rwanda: Number of Different Afflictions in the Two Weeks

Number of Afflictions	Sample Percent	Percent of Median[a]			Z-Score[b]
		<65%	65-80%	Cum. <80%	Mean
4	1.9	0.0	48.0	48.0	-1.75
3	9.0	9.2	29.2	38.4	-1.48
2	16.6	3.6	28.2	31.8	-1.23
1	24.2	3.4	20.6	24.0	-1.02
0	48.3	2.8	14.6	17.4	-0.71
Total[c]	**100.0**	**3.6**	**20.3**	**23.9**	**-0.96**

Source: *UNICEF/Kigali (n.d.).*

[a] $\chi^2 = 55.1$; *probability = 0.00.*

[b] $F = 15.2$; *probability = 0.00.*

[c] $N = 1,328$.

Table 23 – Rwanda: Percent of Children Affected by Illness During Two Weeks, by Age Group

	Age						
	6-7	8-9	10-12	13-15	16-18	19-23	> 24
	Percent						
Illness	56	55	55	51	59	55	44
Fever	31	30	28	25	22	26	15
Diarrhea	26	35	34	34	32	28	20
Cough	35	25	25	24	26	33	20
Worms	2	4	8	8	18	16	16
Frequency per Age Group							
4	0	1	1	3	4	4	2
3	10	11	10	10	7	11	6
2	22	19	20	14	18	15	11
1	23	24	23	24	27	24	22
0	46	46	46	50	44	46	58
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
No. of Observations	**155**	**173**	**197**	**203**	**179**	**198**	**223**

Source: *UNICEF/Kigali (n.d.).*

these numbers since the survey's purpose was not to draw representative samples for each age group shown below, but rather to draw a sample for the single age group of children from 6 to 36 months of age. The percentages presented in Table 23 suggest, at a minimum, the nature of the distribution of disease incidence and frequency over the chosen age groups.

Worm infestations were found to increase gradually from a low of 2 percent during the sixth month to a peak of 18 percent during the 16-to-18 month age period, after which they level off at 16 percent through the third year. This reflects the child's mobility. During the first year of its life the child is relatively immobile, thus limiting its exposure to parasitic infestation. Gradually as the child first crawls, then begins to walk, it increases its exposure and the likelihood

of acquiring worms. Children in their first trimester of weaning (6 to 9 months) appear to have the highest incidence of fever (over 30 percent) and cough (35 percent). The data for incidence of the remaining three illnesses are less indicative of any pattern, although the children in their third year of life show a diminished tendency for overall illness.

No perceptible pattern emerges from the data for age related cumulative illness frequencies, as seen in the lower section of Table 23.

FEEDING HABITS DURING PERIODS OF CHILD ILLNESS

This section examines the responses of the children's mothers to questions regarding her child feeding behavior during periods of child illness. Two particular areas of concern were examined: changes in breast-feeding behavior, and maternal responses to her child's diarrhea.

First, the mother was asked if she felt that her breast-feeding activities should be modified when her child is ill. It is feared that withdrawing maternal milk during periods of illness could further heighten a child's nutritional vulnerability. Only 12 percent of the mothers thought that they should stop or reduce their nursing activities.

Those mothers who responded affirmatively to either "decreasing" or "stopping" her breast-feeding activities were then asked to identify their reason for altering their nursing behavior.

The most common response (54 percent) given for reducing breast-feeding activities was that the child refused further suckling when ill. Another 12 percent of the mothers from among those changing their breast-feeding activities claimed that it caused their child to suffer diarrhea. Other responses given included that the child loses his/her appetite and that breast milk results in vomiting. Not one mother believed that breast-feeding a sick child was bad for her own personal health.

Finally, mothers were asked to name the foods they give to their children when they have diarrhea. Cereals dominated the responses (Table 24), constituting 43 percent of the first choices, 38 percent of the second choices, and 41 percent of the third choices.

But for individual items there was more variety in the responses. Rice was the principal choice of all respondents: 34 percent selected rice or rice water as their first choice, 28 percent chose rice as their second choice, and 23 percent as their third choice. Sorghum porridge in any form, eggs, and cooking bananas were also important responses.

Table 24 – Rwanda: Foods Given as Treatment for Diarrhea

Choices	First	Second	Third
		Percent	
Cereal	42.8	37.5	41.0
Sorghum porridge	19.2	13.5	19.8
Rice	20.2	16.6	13.2
Bread/biscuit	1.6	4.1	3.2
Sorghum paste	1.7	3.4	4.9
Root crop	15.5	16.9	13.7
Cooking banana	9.5	8.7	8.1
Plantains	0.9	1.4	1.3
Coloccase	3.9	5.1	4.3
Other	1.1	1.8	0.0
Legumes	1.2	2.7	4.6
Haricots	1.2	2.7	3.2
Other[a]	0.0	0.0	1.4
Meat and dairy	12.8	15.0	13.7
Meat and fish	1.0	3.3	4.0
Milk (nonmaternal)	0.4	1.1	0.8
Eggs	11.4	10.6	8.9
Vegetables	3.9	9.0	9.7
Fruit	0.2	0.6	0.8
Drinks	23.0	18.3	16.2
Banana beer	0.1	0.1	0.0
Tea	1.7	2.0	2.2
Salt and sugar water	7.3	4.6	4.0
Rice water	13.5	11.5	10.0
Maternal milk	0.5	0.0	0.0
Total observations	**100.0**[b]	**100.0**[c]	**100.0**[d]

Source: *UNICEF/Kigali (n.d.).*

[a] *Includes beans, soybeans, peanuts, peas, and other high protein vegetables.*

[b] *N = 1,279.*

[c] *N = 887.*

[d] *N = 371.*

The national budget and consumption survey for rural areas (MINIPLAN 1988) found that cereals make up only 5.6 percent of rural households' annual calorie consumption, with rice representing less than 0.4 percent. Yet more than one-third of responding households choose rice as their response to questions concerning feeding habits during episodes of child diarrhea. Similarly, meat and dairy products comprise less than 2 percent of calories consumed nationally, but nearly 13 percent of responding households included them in the child's diet when the child was ill with diarrhea. On the other hand, tubers and legumes constitute 78 percent of all rural calories consumed, but together they represent the first choice in response to diarrhea of only 17 percent of survey households.

This indicates that households are interested in responding (within their means and knowledge) to child illness. Improvements in the rural health infrastructure could help ensure that each household's particular response is the appropriate one.

6. Model of Child Nutritional Status and Household Fertility

This chapter involves the modeling and estimation of the determinants of child nutritional status and household total fertility. A framework emphasizing the potential trade-off between family size and child nutritional status (Becker and Lewis 1974) is adopted for examining the Rwandan data set. This approach was chosen in order to account for the tremendous demographic pressure being placed on Rwanda's food security, nutrition, and health sectors.

In Rwanda a high prevalence of malnutrition exists alongside the world's highest fertility rate (8.6 live births per woman). Households with limited resources are seen as choosing between (1) investing in the quality of individual "surviving" children (measured by nutritional status) via improved intra-household food distribution, increased food acquisition, specialty foods, medicine, health care, education, family planning, etc., with subsequent longer birth spacings and smaller family size, or (2) investing in producing many children (measured by total fertility) in order to ensure a minimum acceptable number of surviving children at the expense of investments in the individual surviving children.

The cost of an additional child increases with the desired level of individual child quality, while the cost of improving the level of child quality increases with the number of desired children.

Horton (1986) used a quantity versus quality framework with Philippine data to show significant substitutions away from larger families toward higher quality children with higher maternal and paternal education. Horton also found

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similar, but less significant, substitutions occurring for higher maternal occupational status, and for lower child mortality in the locality.

This study also examines the role of parental education and household income while controlling for head of household gender and life cycle effects. Reduced form equations for child nutritional status and total fertility are specified and estimated under the assumption that the reduced form equations are derivable from the household's underlying constrained utility maximization problem.

Under this framework, child nutritional status and total fertility are functions of prices, income, head of household gender, the regional sanitary environment, and health infrastructure. Expected and experienced mortality rates based on the sample data are incorporated into the fertility equation, while child specific characteristics, experienced illnesses, and household child feeding behavior are incorporated into the nutritional status estimating equations.

The data are estimated under both continuous and discrete specifications using the original data set with 1,328 observations of weight-for-age data and an extended data set of 1,847 observations of MUAC data.

Explicit household-level price and income data are not available from the survey. Instead proxy variables that are correlated with prices and income are substituted into the estimating equations.

DEPENDENT VARIABLES

The child's weight-for-age Z-score (WAZ) and MUAC as a percent of reference median (MUAC_PM) are used to measure child nutritional status (NS). Each of these indicators represents a different form of nutritional status (refer to the section on Anthropometric Indicators in Chapter 1); therefore, the influences of the socioeconomic variables need not be the same for their estimating equations.

Child nutritional status is specified as a function of prices, income, head of household gender, parental preferences for children based on gender, household child care behavior and cultural practices, child specific characteristics, the regional sanitary environment and health infrastructure, and child health status.

The household's quantity choice is measured by total fertility (*FERT*), which includes the total number of births, that is, of both living and deceased children to the sample child's mother.

Total fertility is specified as a function of prices, income, head of household gender, household expected mortality, household experienced mortality, life

cycle stage, parental family planning and health knowledge, and the regional sanitary environment and health infrastructure.

The specifications for the child nutritional status and household total fertility estimating equations are given by equations (1) and (2) below.

$$NS = F(SEX, AGE, AGESQ, AGEMO, AGEMOSQ, AGEFA, AGEFASQ, EDUCMO, EDUCFA, GENDER, OCCUP, MEALS/DY, AGSURP, WEAN, TABOOS, NO_LIV, DIARRHEA, FEVER, WORMS, RESP_PROB, MORTAL) \quad (1)$$

$$FERT = F(AGEMO, AGEMOSQ, AGEFA, AGEFASQ, EDUCMO, EDUCFA, GENDER, OCCUP, MEALS/DY, AGSURP, MORTAL, DEC1, DEC2). \quad (2)$$

The nature and hypothesized relationship that each of these independent variables has with the nutritional status and fertility dependent variables are given below. They are defined and summarized in Table 25.

INDEPENDENT VARIABLES

A set of variables common to both the nutritional status and fertility equations are included to capture the essence of the quantity versus quality trade-off. These variables include parental age and education; head of household gender, household income and price proxy variables, and the regional sanitary environment and mortality equation rates.

The mother's and father's age and square of their ages (*AGEMO, AGEMOSQ, AGEFA, AGEFASQ*) are included to control for the household's life cycle (i.e., the developmental stage of the household with respect to demographic characteristics and asset structure), as well as acquired experiences with respect to child rearing efficiency.

The parent's age, particularly the mother's, is also needed to partially offset the absence of any information on the household's desired size (final fertility). Horton (1986) has pointed out that it may be misleading to compare the nutritional status of a child from a two-child family where the mother is only 26, with that of a child from a similar household where the mother is 56.

The squared parental age terms are included to account for any nonlinearities in household behavior toward its fertility and nutritional status outcomes.

Table 25 – Rwanda: Definition of Variables

Variables	Definition
Dependent Variables	
WEIGHT-FOR-AGE (NCHS/ CDC REFERENCES)	
WAZ	Z-score
MLN_01	1 if < 80% of reference median; 0 ≥ 80%.
MID UPPER-ARM CIRCUM-FERENCE (WHO AFRICAN REFERENCES)	
MUAC_PM	Percent of reference median.
MUAC_01	1 if < 85% of reference median; 0 ≥ 85%.
FERTILITY	Total fertility: births living and deceased.
Independent Variables	
SEX	Sex of child: 0 if female; 1 if male.
AGE	Age of child in months.
AGESQ	Age of child squared.
AGEMO	Age of mother in years.
AGEMOSQ	Age of mother squared.
AGEFA	Age of father in years.
AGEFASQ	Age of father squared.
EDUCMO1	Mother: some primary school but incomplete.
EDUCMO2	Mother: completed primary school.
EDUCMO3	Mother: secondary school or higher.
EDUCFA1	Father: some primary school but incomplete.
EDUCFA2	Father: completed primary school.
EDUCFA3	Father: secondary school or higher.
GENDER	Sex of household head: 0 if female; 1 if male.
OCCUP	1 if primarily agriculture; 0 otherwise.
MEALS/DY	Number of household meals per day.
AGSURP	Located in a commune with 1986 annual agricultural production greater than 2,100 calorie/day/capita: 1 = Muhazi, Muhura, Rubungo. 0 = Gafunzo, Kanama, Mbazi, Nyamagabe, Nyarugenge.

Table 25 (continued)

Variables	Definition
MORTAL	Commune-level child mortality rate based on sample data: total deceased/total fertility .
WEAN	1 if consuming supplementary weaning foods; 0 if exclusively breast-feeding.
TABOOS	Household restrictions on weaning foods: 1 if yes; 0 if no.
NO_LIV	Number of surviving siblings from the same mother.
ILLNESS EXPERIENCED DURING TWO-WEEK PERIOD	
DIARRHEA	Episode of diarrhea: 1 if yes; 0 if no.
FEVER	Episode of fever: 1 if yes; 0 if no.
WORMS	Episode of worms: 1 if yes; 0 if no.
RESP_PROB	Respiratory problems: 1 if yes; 0 if no.
HOUSEHOLD CHILD MORTALITY EXPERIENCE	
DEC1	1 if a single deceased child; 0 otherwise.
DEC2	1 if at least two deceased children; 0 otherwise.

Parental educational levels are included as separate variables to further capture household differences in child rearing efficiencies via parental ability to assimilate new information concerning health, nutrition, and family planning.

Parental educational levels, particularly the father's, may also contain information concerning wage rates, income levels, and household resource constraints since they are generally associated with an individual's earning potential. With only indirect information on household revenues or assets it is likely that the father's educational level will be biased upward as it partially picks up the effect of the missing "true" household endowments and income variables.

Wolfe and Behrman (1982) have estimated nutritional status equations for Nicaraguan data revealing the importance of maternal education levels on child nutritional status. Ainsworth (1987) has shown that parental education (particularly maternal) plays a strong role in lowering fertility levels, whereas household income has the opposite effect.

The gender of the head of the household (*GENDER*) attempts to capture the influence of both the preferred status of males in the Rwandan society with respect to most legal and social issues, as well as the generally higher labor supply available in male-headed households (MINIPLAN 1990). Three variables are designed to proxy for household income and the level of local prices faced by the household. These variables include two dichotomous variables reflecting (a) the occupational status of the household head and (b) the level of regional agricultural production. The third income proxy is a discrete variable representing household food consumption.

The occupational status of the head of the household (*OCCUP*) is included as a dichotomous variable in order to test the importance of agricultural versus nonagricultural occupations when controls for education and income are in place. However, income is not controlled for explicitly but indirectly via proxy. Furthermore, as mentioned earlier, occupational status in a poor country like Rwanda probably reflects the household's level of physical and human endowments. Consequently occupational status indirectly measures income or earning potential.

A commune-level variable, agricultural surplus production (*AGSURP*), indicates whether or not the household's commune of residence had an agricultural surplus (more than 2,100 calories per person per day) during 1986. Obviously, more abundant regional food availability is expected to reflect better crop conditions (e.g., soil fertility, weather, etc.) and more food availability at the household level, whether through own production or more opportunities for rural employment. Thus, the *AGSURP* variable should be correlated with the unavailable household income level.

In addition, as a regional location variable *AGSURP* should reflect regional differentials in prices associated with production surpluses and market efficiency.

A final income proxy variable is the number of household meals per day (*MEALS/DAY*). The hypothesis is that the more frequent the number of feedings, the higher the food availability. Thus, like the parental education variable, food availability indirectly reflects household income or wealth.

A final commune-level variable, the mortality rate (*MORTAL*), was calculated from the sample data to reflect household expectations of child mortality. Of course, household expectations of child survival rates will directly influence fertility levels and subsequently indirectly affect nutritional and health status.

MORTAL may also reflect the historical quality of the regional sanitary environment and health infrastructure. Bardhan (1984) has shown that the local health infrastructure is a key determinant of regional mortality rates using Indian data.

Initially an additional commune-level variable, urban infrastructure (*URBINF*), was added to reflect the commune's location with respect to its access or nearness to urban infrastructure. *URBINF* was expected to be a direct positive force on the child's health status, and an indirect force on the child's nutritional status to the extent that nearness to urban infrastructure reflects access to health facilities, medical prophylactics, and better information on hygiene, nutrition, family planning, etc. However, a very high level of correlation (-0.6) was found with *MORTAL*. In order to avoid multicollinearity problems, *URBINF* was dropped from the estimation process with only trivial changes in the remaining estimated coefficients. Meanwhile it is assumed that *MORTAL* captures the essential nature of Rwanda's health infrastructure.

Thus, as a regional location variable, *MORTAL* should reflect regional differentials in the general level of prices as well as the urban concentration in the distribution of public health related facilities.

A set of child specific and household behavioral variables are included in only the nutritional equations. These include variables for the child's sex, age, number of living siblings, weaning status, and recent illness experience, along with the household's weaning food restrictions.

Although the weight-for-age Z-score calculations already take sex and age into consideration, they are added as explanatory variables in the nutritional status equation.

The child's sex variable (*SEX*) examines parental preferences for their children based on the children's sex. The child's age (*AGE*) is included to examine health and nutritional status changes associated with age. The quadratic age term (*AGESQ*) is included to capture the effect of "catch up" growth that often occurs after the child has physically adjusted to his or her environment.

The number of living siblings (*NO_LIV*), rather than total fertility, is used as an independent regressor. *NO_LIV* can be expected to capture the impact of family size and child birth order, both of which reflect the competition within the household for food and health resources.

The dichotomous variable (*WEAN*), is included in the nutritional status equation in order to account for the weaning status of the child, i.e., already taking supplementary foods versus still exclusively breast-feeding. This follows

from previous studies (Cant et al. 1982; MINIPLAN 1990), suggesting that the weaning period represents a higher risk of malnutrition to Rwandan children. Increased mobility, a growing curiosity, the tendency to explore with the hands and mouth, and an increased exposure to foods other than the mother's breast milk may have negative health consequences in unhygienic settings.

The presence of an illness (whether diarrheal or otherwise) negatively influences a child's nutritional status. Morbidity is often associated with loss of appetite and the inability to fully absorb nutrients from those foods that are consumed; thus both the weight-for-age and MUAC nutritional status indicators should show sensitivity to severe near-term illnesses.

In order to quantify the incidence of disease, this study followed Heller and Drake's (1979) approach of using dichotomous variables to measure the incidence of diarrhea, fever, emission of worms, and respiratory problems (*DIARRHEA, FEVER, WORMS, RESP PROB*, respectively) during the two weeks preceding the survey interview.

It should be noted that these variables measure the mother's subjective assessment of her child's status with respect to the presence or absence of diarrhea, fever, worms, or respiratory problems and, as such, are subject to error in accordance with the mother's inability to correctly diagnose her child's health status.

The indirect health influences, regional sanitary environment and regional health infrastructure, are included directly into the nutritional status estimating equation in the guise of the variable *MORTAL*. This is legitimate because the observed illness variables reflect only the most recent two weeks of health history, whereas *MORTAL* captures long-term elements of the general health environment. Furthermore, the quality of the regional sanitary environment and health infrastructure reflect the cost of obtaining health services and improving hygiene.

An additional behavioral variable is included to reflect the household's response to the question of restrictions or taboos concerning certain supplementary weaning foods (*TABOOS*). Household-level taboos or restrictions on foods during the child's weaning period should reflect the concern exhibited by the mother (or household) for the infant's nutritional habits, as well as to childcare. Thus, they should positively influence both the child's health and nutritional status.

Finally, two additional household specific dichotomous variables (*DEC1, DEC2*) are included in the fertility estimating equation to capture the effect of deceased siblings within the sample household. *DEC1* reflects whether or not

the responding mother has experienced a single child fatality, while *DEC2* considers those women that experienced at least two child deaths. These variables work in combination with the commune-level mortality rate in producing the household's expected mortality rate.

Ben-Porath (1976) has pointed out the importance of the relationship between child mortality rates (both expected and experienced) and fertility levels. Ben-Porath has shown that learning is involved in the household's planning of its eventual size. A child's death will lead the household to reevaluate its child mortality expectations. This may result in simple "replacement" of a deceased child with a return to the planned birth schedule and family size; or it may provoke a "hoarding" response whereby the family overcompensates for a child's death by rapid near-term births in light of its revised "expected" child mortality rate.

Unfortunately, to the extent that experienced mortality is correlated with expected mortality via learning, it is difficult to separate the household fertility responses of hoarding and replacement with cross-sectional data. Instead the data can be used to indicate the existence and importance of replacement.

An additional consequence of a child's death is the removal of a temporary birth control device via breast-feeding (Labbock et al. n.d.). No control is made for contraceptive usage; however, low national usage rates of nearly 3 percent (ONAPO 1983) suggest that this may not be a serious omission.

Table 25 lists the dependent and independent variables used in the empirical work along with their definitions. Table 26 provides descriptive statistics for the variables listed in Table 25. The empirical results are reported in Tables 27 through 29 and are discussed in the following sections.

ESTIMATION RESULTS BASED ON THE INITIAL SAMPLE

The initial estimation results (Table 27) obtained by using ordinary least squares suggest that higher levels of maternal education are associated with substitution away from larger families and toward families with fewer, healthier children, as measured by the MUAC indicator of near-term nutritional status. However, maternal education failed to show any association with the weight-for-age nutritional status indicator, which combines the cumulative effect of past nutritional status with current status.

Meanwhile, increased household food availability (serving as a proxy for household income) produces both higher fertility levels and improved child nutritional status. Thus, maternal education and household food availability are important for near-term nutritional status, while household food availability

Table 26 – Rwanda: Descriptive Statistics for All Models

Variables	Original Sample		Extended Sample	
	Mean	Standard Deviation	Mean	Standard Deviation
WAZ	-0.99	1.31	—	—
MLN_01	0.24	0.43	—	—
MUAC_PM	89.54	8.72	89.57	8.50
MUAC_01	0.28	0.45	0.27	0.44
FERT	4.28	2.55	4.35	2.63
SEX	0.53	0.50	0.51	0.50
AGE	15.17	6.06	15.29	6.15
AGEMO	29.05	5.88	29.29	6.10
AGEFA	35.04	8.65	35.28	8.89
EDUCMO1	0.24	0.42	0.25	0.43
EDUCMO2	0.27	0.44	0.23	0.42
EDUCMO3	0.07	0.25	0.06	0.23
EDUCFA1	0.32	0.47	0.33	0.47
EDUCFA2	0.35	0.48	0.33	0.47
EDUCFA3	0.10	0.31	0.09	0.29
GENDER	0.91	0.28	0.91	0.29
OCCUP	0.71	0.45	0.76	0.43
MEALS/DY	2.08	0.45	2.05	0.43
AGSURP	0.26	0.44	0.32	0.47
MORTAL	0.16	0.06	0.16	0.05
WEAN	0.94	0.24	0.94	0.25
TABOOS	0.60	0.49	0.51	0.50
NO_LIV	2.58	2.08	2.63	2.10
DIARRHEA	0.30	0.46	0.30	0.46
FEVER	0.25	0.43	0.26	0.44
WORMS	0.10	0.30	0.11	0.31
RESP_PROB	0.27	0.44	0.29	0.45
DEC1	0.21	0.41	0.20	0.40
DEC2	0.17	0.38	0.18	0.39
N	**1,168**		**1,620**	

Source: *UNICEF/Kigali (n.d.).*

Table 27 – Rwanda: Initial Estimation Results for the Nutritional Status and Total Fertility Equations

Variables	Fertility		Weight-for-Age		MUAC_PM	
	Coeff.	(T-Stat.)	Coeff.	(T-Stat.)	Coeff.	(T-Stat.)
CONSTANT	-6.96	(-7.81)[c]	1.40	(1.67)	99.87	(17.23)[c]
SEX	—	—	-0.19	(-2.69)[c]	0.39	(0.80)
AGE	—	—	-0.25	(-6.60)[c]	-1.82	(-6.77)[c]
AGESQ	—	—	0.71[d]	(6.00)[c]	0.06	(6.72)[c]
AGEMO	0.32	(5.99)[c]	-0.20[d]	(-0.04)	-0.42	(-1.29)
AGEMOSQ	-0.97[e]	(-1.18)	-0.18[f]	(-0.03)	0.65[d]	(1.30)
AGEFA	0.07	(2.48)[b]	0.35[d]	(0.15)	0.11	(0.64)
AGEFASQ	-0.55[e]	(-1.63)[a]	0.23[f]	(0.07)	-0.63[e]	(-0.31)
EDUCMO1	-0.08	(-0.75)	0.08	(0.91)	1.08	(1.70)[a]
EDUCMO2	-0.49	(-4.25)[c]	-0.12	(-1.15)	-0.38	(-0.54)
EDUCMO3	-0.61	(-2.97)[c]	0.21	(1.16)	2.55	(2.05)[b]
EDUCFA1	0.09	(0.82)	-0.07	(-0.67)	-0.99	(-0.13)
EDUCFA2	0.13	(1.08)	-0.02	(-0.15)	0.77	(1.02)
EDUCFA3	0.25	(1.30)	0.21	(1.28)	0.94	(0.80)
GENDER	0.03	(0.19)	0.27	(2.15)[b]	1.49	(1.68)[a]
OCCUP	-0.12	(-1.97)	-0.18	(-1.67)[a]	-0.15	(-0.20)
MEALS/DY	0.34	(3.28)[c]	0.29	(3.06)[c]	2.95	(4.54)[c]
AGSURP	0.14	(1.38)	-0.13	(-1.39)	-1.33	(-1.97)[a]
MORTAL	-1.12	(-1.26)	-4.16	(-4.93)[c]	6.83	(1.17)
WEAN	—	—	-0.27	(-1.62)	-2.58	(-2.21)[b]
TABOOS	—	—	0.14	(1.60)	0.48	(0.82)
NO_LIV	—	—	-0.03	(-1.04)	-0.19	(-1.03)
DIARRHEA	—	—	-0.25	(-2.91)[c]	-1.24	(-2.11)[b]
FEVER	—	—	-0.20	(-2.04)[b]	-2.01	(-3.00)[c]
WORMS	—	—	-0.17	(-1.38)	-0.14	(-0.17)
RESP_PROB	—	—	-0.04	(-0.45)	0.51	(0.87)
DEC1	0.94	(8.89)[c]	—	—	—	—
DEC2	2.16	(17.58)[c]	—	—	—	—
Adjusted R^2	**0.72**		**0.17**		**0.10**	
N	**1,168**		**1,168**		**1,168**	

Source: *UNICEF/Kigali (n.d.).*

[a] *Significant at 10 percent level of probability.*

[b] *Significant at 5 percent level of probability.*

[c] *Significant at 1 percent level of probability.*

[d] $\chi\ 10^{-2}$.

[e] $\chi\ 10^{-3}$.

[f] $\chi\ 10^{-4}$.

Table 28 – Rwanda: Discrete Specification Results from Initial Sample

Variables	MLN_01		MUAC_01	
	Coefficient	(T-Statistic)	Coefficient	(T-Statistic)
CONSTANT	-3.99	(-2.33)[b]	-3.26	(-1.93)[a]
SEX	0.08	(0.54)	-0.36	(-2.59)[c]
AGE	0.34	(4.06)[c]	0.28	(3.53)[c]
AGESQ	-0.01	(-4.09)[a]	-0.91[d]	(-3.72)[c]
AGEMO	-0.07	(-0.71)	0.11	(1.17)
AGEMOSQ	0.14[d]	(0.95)	-0.15[d]	(-1.01)
AGEFA	0.07	(1.11)	0.03	(0.61)
AGEFASQ	-0.10[d]	(-1.46)	-0.48[e]	(-0.81)
EDUCMO1	-0.06	(-0.32)	-0.34	(-1.87)[a]
EDUCMO2	0.27	(1.29)	0.32	(1.67)[a]
EDUCMO3	-0.52	(-1.03)	-0.34	(-0.84)
EDUCFA1	-0.04	(-0.19)	0.10	(0.51)
EDUCFA2	-0.09	(-0.44)	-0.12	(-0.59)
EDUCFA3	-0.18	(-0.46)	-0.18	(-0.52)
GENDER	0.07	(0.29)	-0.19	(-0.80)
OCCUP	0.68	(2.75)[c]	0.38	(1.70)[a]
MEALS/DY	-0.63	(-3.08)[c]	-0.71	(-3.67)[c]
AGSURP	0.08	(0.37)	-0.29	(-1.46)
MORTAL	1.68	(0.95)	-3.76	(-2.27)[b]
WEAN	0.26	(0.66)	0.12	(0.32)
TABOOS	0.01	(0.01)	-0.02	(-0.10)
NO_LIV	0.02	(0.37)	-0.01	(-0.24)
DIARRHEA	0.50	(3.05)[c]	0.35	(2.22)[b]
FEVER	0.57	(3.12)[c]	0.49	(2.72)[c]
WORMS	0.10	(0.44)	0.08	(0.32)
RESP_PROB	-0.12	(-0.68)	-0.08	(-0.48)
χ^2 (df)	**167.5 (25)**		**160.4 (25)**	
Probability	**0.000**		**0.000**	
N	**1,168**		**1,168**	

Source: *UNICEF/Kigali (n.d.).*

[a] *Significant at 10 percent level of probability.*

[b] *Significant at 5 percent level of probability.*

[c] *Significant at 1 percent level of probability.*

[d] $\chi\ 10^{-2}$.

[e] $\chi\ 10^{-3}$.

Table 29 – Rwanda: Comparison of Observed and Estimated Cases of Malnutrition

	Estimated		Total
	Not Malnourished	Malnourished	
1 — MLN_01[a]			
Observed	**1,105**	**63**	**1,168**
Not malnourished	860	25	**885**
Malnourished	245	38	**283**
Correctly classified (percent)		76.9	
Sensitivity (38 out of 283) (percent)		13.4	
Specificity (860 out of 885) (percent)		97.2	
2 — MUAC_01[a]			
Observed	**1,090**	**78**	**1,168**
Not malnourished	811	32	**843**
Malnourished	279	46	**325**
Correctly classified (percent)		73.4	
Sensitivity (46 out of 325) (percent)		14.2	
Specificity (811 out of 843) (percent)		96.2	

Source: *UNICEF/Kigali (n.d.).*

[a] *N = 1,168.*

appears more important for the longer term. The equation-specific details are discussed below.

Total Fertility Equation

Three factors tend to dominate household fertility decisions when controlling for parental ages: maternal education, household income, and the household's child mortality experience.

The maternal education variables *EDUCMO2* and *EDUCMO3* both show strong negative influences on total fertility. This suggests that females who have

completed primary school or higher levels have lower fertility levels than either illiterate women or women who have failed to finish their primary schooling. The higher opportunity cost of time for better educated women raises the cost of having a larger family.

On the other hand, household food availability, as represented by household meal frequency, positively affects fertility. Other things being equal, greater household food availability (serving as a proxy for household income) translates into more births.

With respect to the influence of experienced mortality rates, the large and positive coefficients of 0.94 and 2.16 on the variables *DEC1* and *DEC2*, respectively, suggest that the death of a child produces an important replacement response whereby the household compensates for a child's death with a replacement birth in order to maintain its desired fertility outcome. These two variables, *DEC1* and *DEC2*, could also capture the effect of the removal of an important birth control mechanism, i.e., breast-feeding. Lack of modern contraceptives increases the importance of traditional methods. A recent study by May et al. (1990) indicated that limited availability of modern contraceptives may be the principal constraint to increased usage.

The variable *MORTAL*, which reflects regional child mortality rates, is not statistically significant. Ben-Porath (1976) has suggested that if families have learned to expect a high child mortality rate (as represented by local mortality rates) and respond to it by hoarding, then fertility should not respond strongly to actual mortality. In other words, households have already decided to produce a high final fertility outcome due to the high probability of incurring some child fatalities; therefore, small changes in the local mortality rate will not cause households to deviate from their planned high fertility outcome.

If this holds true for Rwanda, then major improvements in the regional health infrastructure and sanitary environment may be necessary before household fertility levels and child mortality rates decline.

Both mother's and father's age are statistically significant and are positively associated with higher total fertility as expected, thus highlighting the importance of controlling for household life cycle effects on family size.

Nutritional Status Equations

Readers are reminded of the different interpretations given to the two nutritional status indicators, weight-for-age and MUAC, as earlier discussed in the first chapter.

MUAC is generally considered a measure of "wasting" or acute malnutrition. As such, MUAC is often thought of as representing short- term nutritional status since it can change rapidly in response to temporary changes in its outside stimuli. On the other hand, weight-for-age contains aspects of both cumulative (longer term) and current nutritional status. As such, it is less sensitive to temporary external changes than is MUAC.

This difference is borne out by the maternal education variables. Maternal education has a positive association with near-term nutritional status as measured by MUAC_PM; whereas, none of the maternal education variables were significant with respect to the weight-for-age Z-scores.

On the other hand, household income as represented by household meal frequency has a positive impact on both the MUAC and weight-for-age nutritional status indicators. Furthermore, the meal frequency variables, *MEALS/DY*, appear to have a greater absolute impact on child nutritional status than maternal education in both of the nutritional status equations.

This result suggests that maternal (postprimary) education positively affects near-term child nutritional status, while household-level food availability plays a greater overall role, particularly for cumulative nutritional status.

The child's age shows a negative association with nutritional status for both WAZ and MUAC_PM as hypothesized. Some reduction occurs during the second and third years as the quadratic age terms suggest nutritional status low points of 17.8 months for WAZ and of 16.3 months for MUAC_PM. Two factors can explain this reduction. First, a child's body probably makes some physical adaptation to its environment and to the level of its nutrient intake. Second, the high infant mortality rates in Rwanda decimate the ranks of the poorly nourished children, thus lowering the percentage of children classified as malnourished.

With respect to the impact of child illnesses, the presence of both diarrhea and fever are strongly associated with lower levels of the two child nutritional status indicators. Fever appears to be a slightly stronger contributor than diarrhea to poorer near-term nutritional status; however, the true degree of influence attributable to diarrhea may be understated because mothers tend to overstate the prevalence of diarrhea.

Unfortunately, data on the child's birth weight, nutritional history, and the explicit household sanitary environment were lacking. As a consequence it is possible that the child's health status variables will capture some of the impact of the quality and availability of his or her calorie consumption since birth, as well as the historic quality of the household's sanitary environment. Thus, the

actual influence of present health variables as explanatory variables may be overstated.[5]

Concerning the head of household's gender, children from male-headed households are better off nutritionally than those from female-headed households, as hypothesized.

With respect to parental preferences based on the the sex of their child, the weight-for-age of male children are significantly lower than those of their female counterparts. This concurs with the results shown in Table 8; however, it contradicts the findings of previous studies (MINISAPASO 1987, MINIPLAN 1990). No statistical difference appears for the sexes with respect to the MUAC indicator, unlike the bivariate result of Table 9, which suggests that females were worse off. Thus, the differences in MUAC between sexes disappear when controls for age and other relevant socioeconomic variables are included.

The child's weaning status appears to have important influences on his or her near-term nutritional status. Children that have already received food supplementary to maternal breast milk have lower average percentage of median values by nearly three percentage points than those children still relying totally on maternal breast milk.

The location variable, *AGSURP*, is not statistically significant for the weight-for-age equation, whereas it is significant but negative for the MUAC equation (contradicting expectations). This points to the idea that child nutritional status is a household-level problem. Consequently a too heavy reliance on aggregate regional production figures to indicate the prevalence of malnutrition for a given area contains an element of danger. This entire issue of interregional differences in crop production and food availability certainly merits further study and attention, particularly in Rwanda, where regional crop production has often been the sole indicator used to assess household food security. The alleged link between *regional* production and *household* nutritional status has yet to be shown in Rwanda.

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5 Child illness may be endogenous to the household, but is not treated as such here. See Appendix C for elaboration.

A poor regional health and sanitary environment, as represented by the commune mortality rates (*MORTAL*), shows a strong negative association with child weight-for-age Z-scores. In other words, the lower the quality of the regional sanitary environment and health infrastructure (i.e., the higher the calculated child mortality rate), the lower the child's weight-for-age nutritional status.

Finally, the data provide no evidence for systematic parental preferences in favor of earlier children as no statistical association was found between the number of living siblings (*NO_LIV*) and the child's nutritional status.[6]

ESTIMATION OF NUTRITIONAL STATUS BASED ON A DISCRETE SPECIFICATION

Under the continuous specification used earlier, the estimation procedure evaluates the degree and direction of association for changes in the level of the nutritional status indicators with changes in the independent variables. An additional approach, adopted here, examines how the independent variables influence the "probability" of being malnourished (i.e., above or below a threshold level) rather than the specific level itself. Thus, the orientation is different from the earlier estimation procedure. It is not unexpected, therefore, to find some interesting differences between the two model estimation results.

The two nutritional status indicators, weight-for-age and MUAC, are transformed from continuous to discrete dichotomous variables according to selected percentage of reference median cutoff points, below which a child is classified as malnourished.

The discrete weight-for-age variable, MLN_01, is defined as 0 (not malnourished) if the child's weight-for-age as a percentage of the NCHS/CDC reference medians is greater than or equal to 80 percent and 1 (malnourished) if less than 80 percent. Likewise, 85 percent is used as the cutoff point for the MUAC percentage of reference median data used to define the discrete MUAC variable, MUAC_01.

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6 Predicted fertility was substituted in the estimation process in order to account for the potential simultaneity bias introduced by using the observed number of living siblings in the estimation. No significant changes ensued; therefore, the original specification was retained. Also, the estimations were run with NO_LIV omitted as a check for potential multicolinearity with the mother's age variables. Again, no significant changes resulted.

Again, the interpretation of these two variables is different. A value of one for MLN_01 indicates inadequate weight-for-age, whereas a value of one for MUAC_01 represents a state of "wasting" or acute malnutrition. The specification of the independent variables for the two models of nutritional status (NS) used in this section remains the same as in equation (1). The equations are estimated using simple logit estimation of the dichotomous dependent variables. The results for the discrete models of nutritional status are presented in Table 28. The discrete results tend to echo the earlier continuous estimation results, although overall fewer independent variables are important.

Under the discrete framework, the role of maternal education is reduced, while household income and endowments are more important. Only the *EDUCMO1* (i.e., mothers with some primary education) variable is associated with a lower probability of acute malnutrition, while none of the education variables appear to influence the probability of a low weight-for-age.

The income proxy variables are associated with changes in the probability of malnutrition. Higher income levels (or greater food availability), as represented by household meal frequency, reduces both the probability of acute malnutrition and the probability of being underweight. Similarly, children from households with nonagricultural heads have a lower probability of malnutrition. As mentioned earlier, it is assumed that a nonagricultural occupation indicates greater household wealth and education levels.

As under the continuous specification, the child age variables suggest a quadratic relationship with the probability of being malnourished. The probability of being underweight is highest in sample children at the age of 16 months, while the probability of acute malnutrition is highest at 15 months of age.

With respect to morbidity factors, the presence of both diarrhea and fever increases the probability of malnutrition. As before, fever is a slightly stronger contributor than diarrhea to a higher probability of malnutrition, particularly acute malnutrition.

Oddly enough, the discrete results concerning parental preferences vis-à-vis their child's sex contradict the results found under the continuous framework. Under the discrete specification male children have a significantly lower probability of acute malnutrition than do female children. Sex does not appear to affect the probability of being underweight.

Neither the mortality, weaning, nor head of household gender variables were significant determinants of the probability of being classified as malnourished under the discrete estimating framework.

In addition, the discrete framework produced incorrect signs for the *MORTAL* and *EDUCMO2* variables. This may be attributable to poor overall "fit" for the discrete estimating equations compared with the continuous framework.

Table 29 presents information on the "goodness of fit" for the discrete estimating equations. Although both the weight-for-age and MUAC logit estimating equations correctly classify approximately three-fourths of the observations and show high levels of specificity, they have poor sensitivity levels (13.4 percent and 14.2 percent, respectively). In other words, these discrete models have poor track records at correctly identifying children below the nutritional status threshold levels.

The poor "fit" may be attributable to two underlying causes. First, the model may be insensitive to moderate levels of malnutrition, i.e., the threshold levels may be too high for the model to perform properly. Second, several important explanatory factors may be excluded from the estimation process such as specific household-level variables for sanitary environment, calorie intake, child nutrition and health history, women's time constraints, and seasonal influences.

The discrete specification was also estimated under a modified ordered probit framework where nutritional status was classified into normal (0), moderate malnutrition (1), and severe malnutrition (2), with no improvement in the results.[7]

ESTIMATION OF FERTILITY AND NUTRITIONAL STATUS BASED ON AN EXTENDED DATA SET

The limiting factor for the sample size used in the initial estimations in this chapter was information on child weight-for-age where only 1,328 observations were available. However, the original survey data include 1,847 households with information on MUAC, fertility, and the remaining socioeconomic variables. This section uses this extended data set to examine the quality versus quantity trade-off based on total fertility and MUAC nutritional status. These results are reported in Table 30.

7 These results are not reported here but are available from the author upon request.

Table 30 – Rwanda: Results from Extended Sample

Variables	Fertility		MUAC_PM	
	Coefficient	(T-Statistic)	Coefficient	(T-Statistic)
CONSTANT	-6.15	(-8.28)[c]	107.47	(22.83)[c]
SEX	—	—	0.19	(0.46)
AGE	—	—	-1.81	(-8.20)[c]
AGESQ	—	—	0.05	(8.08)[c]
AGEMO	0.25	(5.67)[c]	-0.64	(-2.44)[b]
AGEMOSQ	-0.04[e]	(0.01)	0.01	(2.56)[b]
AGEFA	0.10	(3.94)[c]	0.02	(0.14)
AGEFASQ	-0.94[d]	(-3.13)[c]	-0.32[d]	(-0.18)
EDUCMO1	-0.14	(-1.55)	1.10	(2.12)[b]
EDUCMO2	-0.44	(-4.39)[c]	0.32	(0.53)
EDUCMO3	-0.64	(-3.49)[c]	2.29	(2.09)[b]
EDUCFA1	0.04	(0.44)	-0.23	(-0.42)
EDUCFA2	0.06	(0.62)	0.09	(0.14)
EDUCFA3	0.26	(1.54)	0.54	(0.54)
GENDER	-0.01	(-0.09)	1.37	(1.90)[a]
OCCUP	-0.20	(-1.83)[a]	-0.90	(-1.34)
MEALS/DY	0.26	(2.89)[c]	2.11	(3.83)[c]
AGSURP	0.13	(1.62)	-0.83	(-1.64)[a]
MORTAL	-0.82	(-1.01)	4.52	(0.89)
WEAN	—	—	-1.43	(-1.53)
TABOOS	—	—	-0.05	(-0.10)
NO_LIV	—	—	-0.04	(-0.28)
DIARRHEA	—	—	-0.61	(-1.26)
FEVER	—	—	-1.51	(-2.77)[c]
WORMS	—	—	-0.14	(-0.21)
RESP_PROB	—	—	0.96	(1.95)[b]
DEC1	0.97	(10.61)[c]	—	—
DEC2	2.20	(21.15)[c]	—	—
Adjusted R^2	**0.724**		**0.083**	
N	**1,620**		**1,620**	

Source: *UNICEF/Kigali (n.d.).*

[a] *Significant at 10 percent level of probability.*

[b] *Significant at 5 percent level of probability.*

[c] *Significant at 1 percent level of probability.*

[d] $\chi X 10^{-2}$.

[e] $\chi 10^{-3}; \chi 10^{-4}$.

The advantage of examining multiple estimation procedures and an extended data set is to be able to examine the robustness of individual variables; thus reinforcing or questioning potential policy implications.

The estimation results obtained by using the extended sample show a good deal of similarity to the previous estimation procedures. All of the signs are the same, while the estimated coefficients varied only slightly in magnitude. However, some of the independent variables changed with respect to statistical importance under the larger sample.

As before, household income and maternal education are the principal determinants of total fertility. Both of the income proxy variables, the occupational status of the head of the household and the household meal frequency, retained their statistical importance under the larger sample size, thus reinforcing the importance of household income in promoting a higher fertility outcome. The maternal education variables all gained in importance although their magnitudes were nearly unchanged for MUAC as a percentage of reference median.

Results for the nutritional status equations found the mother's age variables gaining statistical importance. Their implied quadratic relationship with child nutritional status suggests that child nutritional status as measured by MUAC is lowest for mothers aged thirty-one years and improves with increasing maternal age. This reflects the household's life cycle status.

The incidence of child fever dominates the health and nutritional status relationship under the extended sample size. Diarrhea is no longer found to influence child nutritional status, whereas the incidence of respiratory problems shows an unexpected positive association.

The incorrect sign on the respiratory problems variable is unexpected and probably reflects an inadequate maternal judgment as to what constitutes a respiratory problem. Normal coughs and throat irritations could easily be misinterpreted as problematic.

The discrete estimating framework was also used with the extended sample; however, no major changes were found.[8]

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8 These results are not reported here but are available from the author upon request.

7. Summary and Conclusions

This report adds new information about the underlying structural relationships between health, fertility, and child nutritional status in Rwanda while demonstrating the usefulness of existing, albeit deficient, data sets. It is hoped that the results have shown the importance of child health status and household fertility issues in any analysis of nutritional status in Rwanda.

To date the health and nutrition surveys undertaken in Rwanda have focused on either nutrition and calorie consumption aspects or health and illness aspects of nutrition with no single survey combining aspects of both. This survey falls victim to this weakness in that it focuses on the health side of the nutrition ledger. Consequently, it lacks several of the essential ingredients necessary for undertaking a thorough analysis of the relationships between morbidity or health status and nutritional status at the household level (Schiff and Valdés 1990).

Some of the more crucial variables missing from the survey data are (1) household agricultural production activities, (2) household wealth, income, and expenditure patterns, (3) household and individual calorie consumption information, (4) household demographic composition, (5) child birth weight, (6) household birth spacing intervals between children, (7) household birth control and family planning activities, (8) maternal breast-feeding behavior, and (9) child and maternal health and nutritional history, particularly the mother's health status during pregnancy.

In addition, better information is still needed about the role and nature of breast-feeding, women's time constraints, and seasonality within this general framework in order to add precision to the estimated relationships discussed here. The daunting survey task of combining household expenditures, individual calorie intake, and household health and sanitary environment indicators in a single survey remains to be undertaken in Rwanda.

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It should be noted that recent developments in contraceptive availability and family planning may currently be changing behavioral patterns. The nutritional status of a population is not a static concept, but it is constantly changing along with its health and food security environment. As such, it needs to be monitored regularly to be properly measured and understood.

The use of MUAC as an indicator of nutritional status in Rwanda has yielded encouraging results. MUAC is a "cost-effective" and easily collected data source. The collection of MUAC measures can be easily incorporated into ongoing survey activities with a minimum of materials and interviewer training. In addition, the success of the MUAC data in this study suggests that better use can be made of existing Rwandan data sets containing MUAC data. All of these add up to potential improvements in both the level of nutritional status monitoring and the immediacy and precision of subsequent intervention activities in Rwanda.

Appendix A: Survey Background

This report represents the second phase of a two-phased project undertaken by UNICEF/Kigali. The aim is to collect and analyze relevant information concerning the weaning habits of Rwandan households.

The first phase of this project began in 1987 under the direction of Dr. M. Ramakavelo, then acting UNICEF/Kigali Project Officer for Health and Nutrition. It consisted of the design and implementation of the overall survey effort, including the preparation of a questionnaire, the hiring and training of interviewers, contacting the necessary authorities, and overseeing the actual data collection. Interested parties should refer to *Protocole de récherche sur l'alimentation du jeune enfant au Rwanda* by Dr. Ramakavelo (1987) for details on the original study objectives, the survey design, and other background information.

The second phase of the project involved the entry, cleaning, and analysis of the survey data, as well as the writing of subsequent reports (including this monograph).

This monograph produces the results of a statistical analysis. These results reinforce and extend the preliminary results presented in the 1990 UNICEF document, *Results from the Analysis of the UNICEF Weaning Foods Survey: August-September 1987* (Schnepf 1990b). The preliminary document contains a less rigorous but broader presentation of survey results, as well as a detailed description of the many operational problems that were encountered in conducting the second phase of the UNICEF Weaning Foods Study.

Appendix B: Data Shortcomings

The original survey objective was to obtain information on household behavior in the feeding of young children. Postsecondary students were trained as interviewers for the data collection; thus limiting the survey activity to the nonschool months. This schedule required starting the survey before scales were available for weighing. As a result only 1,328 of the total 1,847 households possess information on child weight.

An additional problem arose in the collection of information concerning maternal nursing. The respondents did not always answer for the youngest child (in accordance with the questionnaire); they sometimes answered instead for the most recently "totally" weaned child. More than 100 cases appeared where the mother reported her child's age at "complete" rupture as being older than the child's actual age at the time of the interview. This misunderstanding occurred repeatedly. Also, "heaping" was common among responses from women whose children were already totally weaned.

Several nursing variables were created from the data; however, none of the variables appeared statistically significant in any of the estimation procedures and were thus dropped from the final results.

Appendix C: Difficulties in Adapting Theory to Rwanda

A complete interpretation of the relationship between health and nutrition should take account of the fact that child health status and mortality may be endogenous variables. The prevention of illness and death via adequate nutrition, childcare, household hygiene behavior, and real investments in the sanitary environment is responsive to the level of income and relative prices. Some studies (e.g., Heller and Drake [1979] or Alderman [1990]) use predicted illness in the estimating equations to avoid potential simultaneity bias. Other studies (e.g., Wolfe and Behrman 1984) use latent variable methods to avoid direct specification of the illness variables.

This study also lacks information on lagged values of the relevant health and nutrition variables for the estimation process. As a result, only the causal relationship between child health and nutritional status is examined; the endogenicity of child illness and mortality is not discussed.

The information available is inadequate for the design of the requisite instruments for the illness variables; therefore, the observed incidence of illness is included directly into the estimating equations. Given the cross-sectional nature of the data, this may not be unreasonable. The implication is that illness impacts nutritional status more than nutritional status contributes to illness. However, to the extent that the omitted feedback is important, this approach will lead to an overestimation of the impact of child illness on nutritional status.

Appendix D: Supplementary Information

Table A.1 – Rwanda: Sample Distribution for All Data Sets, by Location

Sector/Commune	Original	Reduced[a]	Reduced[b]
	Number		
Bilyogo	86	56	84
Gitega	1	1	1
Gikondo	60	35	60
Nyarugenge	147	92	145
Remera	12	10	12
Rubungo	118	75	118
Jurwe	52	29	52
Rusororo	38	22	38
Rubungo	220	136	220
Mbazi	114	79	66
Mutunda	4	2	2
Mwulire	74	52	57
Mbazi	192	133	125
Bibare	59	36	45
Rumuri	58	37	40
Manfu	73	39	62
Humure	39	26	0
Muhura	229	138	147
Kanombe	44	19	42
Rogomero	49	26	49
Nyundo	68	35	62
Rusizi	156	78	150
Kanama	317	158	303

Table A.1 (continued)

Sector/Commune	Original	Reduced[a]	Reduced[b]
	Number		
Shangi	80	43	80
Mugera	82	58	82
Bunyangurabe	68	42	37
Bunyenga	38	25	0
Gafunzo	268	168	199
Buremera	46	26	3
Kizi	54	31	15
Gasaka	87	50	56
Remera	86	65	63
Nyamagabe	273	172	137
Nyarubuye	25	15	0
Ruhunda	63	41	1
Gishali	68	46	51
Kabare	46	28	0
Muhazi	202	130	52
Total	**1,847**	**1,127**	**1,328**

Source: *UNICEF/Kigali (n.d.).*

[a] *Includes only children between the ages of 13 and 36 months.*

[b] *After elimination of cases with missing weight-for-age observations.*

Table A.2 – Rwanda: Selected Demographic and Agricultural Production Statistics for 1986, by Commune

	Nyarugenge	Rubungo	Mbazi	Muhura	Gafunzo	Kanama	Nyamagabe	Muhazi	Rwanda
Population[a]	33.7	39.3	28.9	32.8	41.7	45.2	32.1	36.6	5,538
Persons per km^2	774	260	681	277	627	398	323	314	283
Agricultural household[a]	6.7	7.8	5.8	6.6	8.3	9.1	6.4	7.3	1,108
Available hectares[a]	4.4	15.1	4.2	11.8	6.6	11.4	9.9	11.6	1,959
Harvested hectares[a]	1.2	12.4	4.2	8.6	6.8	7.6	4.6	10.0	1,086
Harvested hectare/capita	0.036	0.315	0.146	0.263	0.162	0.169	0.144	0.274	0.196
Calorie[b]	311	3,743	1,830	3,035	1,741	1,608	1,667	2,795	2,167
Protein[b]	5	79	35	69	36	43	43	70	54
Lipid[b]	1	13	4	11	7	6	6	13	8
Coffee production (kg)[a]	2	135	104	8	492	34	329	10	35,594
Cattle[a]	0.5	6.2	2.9	1.7	3.0	4.9	4.7	5.6	728
Goats[a]	1.5	6.7	3.0	6.5	3.9	6.5	4.2	8.7	993
Sheep[a]	0.2	1.2	0.4	4.8	1.4	1.8	2.6	0.3	349
Pigs[a]	0.0	0.3	1.2	0.0	0.6	0.2	2.4	0.0	89
Fowl[a]	7.4	14.1	3.9	4.2	3.6	5.9	4.8	10.5	1,149
Rabbit[a]	1.2	2.0	3.4	0.6	1.3	0.1	1.2	1.2	198
Fish ponds (ha.)	278	0	126	5	28	275	87	0	8,420

Source: *MINAGRI (1988).*

[a] *1986 estimate in thousands.*

[b] *Annual average production per capita per day.*

Appendix E: Anthropometric Indicators

WEIGHT-FOR-AGE Z-SCORE

The child's weight-for-age Z-score (*WAZ*) is constructed by first subtracting the international reference median (*MEDIAN*) weight-for-age, $MEDIAN_w$, for the relevant sex and age group from the child's observed weight-for-age, X_w. Then the difference is divided by the relevant reference group's standard deviation, S_w, as follows:

$$WAZ = \frac{X_w - MEDIAN_w}{S_w}. \tag{3}$$

A Z-score of zero indicates that the child's weight-for-age is exactly in line with the corresponding sex and age reference group. As with any standard normal distribution, plus or minus one standard deviation envelopes approximately 66 percent of all observations. Likewise, plus or minus two (three) standard deviations accounts for approximately 95 percent (99 percent) of all observations. Thus, observed Z-score values below -2 represent potentially malnourished children, while values below -3 are extreme cases and portray instances of severe malnutrition.

PERCENTAGE OF REFERENCE MEDIAN

In order to compare the ith anthropometric measure with the reference median specific to each sex and age group, the ratio of the observed measurement ($X_{i,h}$) for the hth individual over the requisite reference median is multiplied by 100 to convert the resultant statistic to percentage terms as follows:

$$\textit{Percentage of Median} \text{ for } H_{th} \textit{ individual} = \frac{X_{i,h}}{MEDIAN} \times 100. \tag{4}$$

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