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I am submitting herewith a dissertation written by Carol Lynn Jenkins entitled "Patterns of Protein-Energy Malnutrition Among Preschoolers in Belize." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Michael H. Logan, Major Professor

We have read this dissertation and recommend its acceptance:

Mary Ann Bass, Richard L. Jantz, Donald Hastings

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Michael H. Logan, Major Professor

We have read this dissertation
and recommend its acceptance:

Mary A. Bass

R. L. Fox

Donald W. Hastings

Accepted for the Council:

L. Evans Pettit

Vice Chancellor
Graduate Studies and Research

X

PATTERNS OF PROTEIN-ENERGY MALNUTRITION AMONG PRESCHOOLERS IN BELIZE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Carol Lynn Jenkins

August 1980

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ABSTRACT

This study is based on a survey to assess nutritional status among children from birth through 5 years old in Belize, Central America. The survey was conducted in 1979 in two districts, one coastal (Stann Creek) and one inland (Cayo). Four major ethnic groups are represented: the Mestizo, Maya, Creole and Garifuna (Black Carib). Previous studies indicated that early childhood malnutrition is a considerable public health problem in Belize. No anthropometric assessment of protein-energy malnutrition among preschoolers had been conducted. In this project 750 children were measured and their mothers interviewed concerning the feeding patterns and health status of their children. Mothers' reproductive histories were also collected. This information was supplemented with standard ethnographic methods, i.e., key informant interviews and participant-observation. Quantified dietary information, including 24-hour recalls and weekly family dietary patterns, were collected on a selected sample of 50 children from 1 to 6 years old.

The unit of analysis is the ethnic group. Survey results are analyzed to assess patterns of severity, duration, and the geographical distribution of malnutrition among preschoolers. Malnourished and non-malnourished children are contrasted to determine the demographic, dietary, and health-related characteristics of each group.

Following a literature review on the causes and sequelae of protein-energy malnutrition, information is presented on contemporary socio-economic and nutritional conditions in Belize.

Results reveal that ethnicity has a significant effect on the prevalence of protein-energy malnutrition among children. Moreover, the widespread adoption of the infant feeding bottle, high rates of diarrheal disease, low energy intake, and differential access to resources, such as clean water and appropriate medical care, are factors which operate in Belize to predispose certain children to growth retardation. Children exhibiting better-than-average growth often are infants and younger children who are less frequently exposed to the numerous infectious and nutritional stresses to which older preschoolers are subject. The prevalence of acute malnutrition in Belize increases with age, reaching a maximum between the ages of 1 to 2.5 years, while chronic malnutrition continues to increase throughout early childhood. Children living in households with 5 or more children more often experience growth retardation, colds, fevers, reduced appetites, and the death of at least one sibling. This pattern is more frequent among rural than urban residents. Among rural residents the Maya exhibit disproportionately high rates of childhood mortality and growth retardation. In the urban areas the Garifuna experience the highest prevalence of severe malnutrition. Hence, the relative nutritional status (from best to worst) of children in the two survey districts may be ordered as follows: Creole, Mestizo, Garifuna, and Maya. This order roughly approximates the socio-economic positions of these ethnic groups in contemporary Belize.

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CHAPTER I

INTRODUCTION

This study examines biocultural factors associated with early childhood malnutrition in Belize, formerly British Honduras. It was conducted in 1979 in two districts of Belize where four major ethnic groups are represented: the Mestizo, Maya, Creole, and Garifuna (Black Carib). The importance of the ethnic group, defined by cultural identity, is borne out in the present study. Where ethnically patterned behavior varies, as with infant feeding or health care practices, these differences may contribute to different rates of early childhood malnutrition. Socio-economic status and location of residence, both of which are patterned to some extent by ethnicity, also have profound effects on health. In Belize patterns of infant and early childhood malnutrition demonstrate the effects of ethnicity on nutritional status.

By contrasting malnourished and non-malnourished children, it is apparent that other factors are also important in accounting for the patterns of protein-energy malnutrition in Belize. Age significantly contributes to the observed patterns of nutritional status. Differences in severity and duration, measured anthropometrically, reflect the impact of the combined effects of diet, infection, and health care on the growing child. In Belize, as elsewhere in the developing world, high rates of diarrhea, low energy intake, and poor access to resources, such as clean water and timely medical intervention, predispose certain

children to retarded growth and the development of clinically recognizable symptoms of protein-energy malnutrition. This research identifies particular demographic and behavioral characteristics of malnourished and non-malnourished children attending immunization clinics in coastal and inland regions of Belize.

During the early years of malnutrition research, severe forms, particularly kwashiorkor, received the greatest attention. By the late 1950's anthropometry became widely recognized as a useful tool for assessing the degree and prevalence of malnutrition in populations throughout the world. An earlier emphasis on protein deficiency was replaced by the recognition that total energy intake is usually low in children who develop clinical signs of malnutrition, and the term protein-calorie malnutrition (now changed to protein-energy malnutrition) was introduced by Jelliffe (1959). In the past two decades a large number of studies have been conducted which utilize anthropometry as a means of evaluating mild, moderate, and severe forms of protein-energy malnutrition (hereafter referred to as PEM) in community and regional surveys. Unsuccessful attempts at prevention or cure through the introduction of protein-rich food supplements have led investigators to realize that the problem of PEM is rooted primarily in social and ecological dynamics and that protein deficiency per se has often been over-emphasized (McLaren 1974). Therefore, social scientists have become increasingly involved in this field of research.

Much of the research which examines social influences on nutrition focuses on economic status, usually measured by income and occupation (James 1970; Rea 1971; Ariza-Macías et al. 1973; Garn et al.

1978). Some studies have emphasized demographic features, such as family size or infant mortality rates (Lu and Savara 1962; Malcomb 1975; Purohit et al. 1977). Others, usually carried out by nutritionists, have examined feeding patterns (Robson 1974; Puri et al. 1976; Pigott and Kolasa 1979). In some cases, food intake has been quantified and nutrient value assessed (Martorell et al. 1978). Several other investigators have shown the close relationship of PEM with morbidity, especially diarrheal diseases (Harfouche 1966; Gordon et al. 1968). Few studies have attempted to view all these factors simultaneously in relation to measured children. Even fewer have included well nourished children as controls. This study makes use of an epidemiological approach to identify factors associated with a high risk of PEM among infants and preschoolers in Belize.

The present research has several objectives. First, to assess the prevalence, severity, and duration of PEM among children from birth through 5 years of age by means of anthropometry.

Second, to examine ethnic patterning in the rates of PEM as evidenced by growth retardation. For this reason, Belize, a small, distinctly multi-ethnic nation, was chosen as the research site. In past studies, multi-ethnic communities are treated as units without examining ethnicity. When ethnicity is taken into account, homogeneic descriptions often obscure the behavioral variability within an ethnic group.

Third, to evaluate the significance of selected biocultural factors measured in the field in relation to poor and better-than-average growth. Biocultural factors include demographic variables, health status, and dietary variables.

Fourth, to supply baseline data on the growth of a previously uninvestigated population, the infants and preschoolers of Belize. Neither the Instituto de Nutricion de Central America y Panama (INCAP) nor the Caribbean Food and Nutrition Institute (CFNI) has included these children in their surveys. Moreover, the Medical Department of Belize has not had sufficient resources to pursue such a study. It is hoped that this research will be a helpful contribution to health planning in Belize and, in addition, will be a useful source of comparative data for nutritional researchers in Central America and the Caribbean.

CHAPTER II

RESEARCH DESIGN AND METHODS

Research Objectives and Sample Design

The present research has four main objectives. They are:

1. To assess the prevalence and severity of PEM among infants and young children through age 5 by means of anthropometry

2. To obtain average growth curves for these children by age, sex, and ethnic group

3. To examine ethnic patterning in the rates of PEM, and

4. To evaluate the significance of selected biocultural factors associated with PEM.

To accomplish these objectives a sample had to be obtained which would adequately represent the population of children in the ages under investigation and which would possess a balanced representation of the four major ethnic groups. In addition, children from the same environments and ethnic groups had to be available for contrast with those who were malnourished.

Cayo and Stann Creek districts were chosen as survey sites. To acquire a sample representing the true prevalence of malnutrition among infants and young children in the survey areas, random sampling is necessary. It is highly impractical, however, to conduct a house-to-house survey in widely scattered villages. Hence, a clinic population was substituted. The Belize Medical Department and the Caribbean Food and Nutrition Institute were contacted and permission was granted to conduct this survey during sessions of child health clinics. These

clinics have permanent quarters in district capitals and larger population centers. Each clinic has a monthly schedule of visits to selected surrounding villages. The purpose of these visits is to provide immunizations, weigh the children, and to distribute cough syrups, worming tablets, and diarrhea medicines when necessary. Unfortunately, the lack of resources often limits the delivery of these services. At times transportation is also lacking and nurses are unable to reach the rural areas. Whenever the rains permitted, my own vehicle was used. The nurses in charge offered information on the current clinic enrollment, which indicated that approximately 75% to 80% of the children of appropriate ages were receiving immunizations. Approximately 23% of the children enrolled in clinics of both districts were measured. Total sample obtained included 808 children. Omitting Mennonites and children whose ages are over 5.5 years reduces the effective sample to 750.

It is clear that the sample may be biased toward those who attend clinics. An effort was made to measure all children in one village in each district, in order at least to estimate the direction of this bias. These efforts result in evidence suggesting prevalence rates of malnutrition in the community at large may be slightly higher than those calculated from the clinic sample, especially among the older ages and more severe categories.

An effort was made to secure sufficient numbers of rural and urban residents in order to approximate their proportions in each district, and, at the same time, obtain balanced proportions of each ethnic group. The end result works as a compromise. Although

government statistics estimate slightly over 50% urban residents in each district, the sample obtained consists of 43% urban and 57% rural children. Table 1 shows the number of children and percent of total sample by ethnic group and residence.

Maya children are disproportionately under-represented in urban areas, while Garifuna children are under-represented in rural areas. This distribution reflects the geographical distribution of Maya residents accurately but slightly misrepresents the residential patterns of the Garifuna due to poor traveling conditions to Garifuna villages in the rainy season.

Due to the rapid growth of children during their first 2 years of life, age groups are broken down into four categories for the first year and two categories for the second year. Ages are calculated according to the decimal method given by Tanner (Eveleth and Tanner 1976). Table 2 shows the age group distribution. Due to small populations in most Belizean settlements, siblings are not excluded. Of 502 families, 167 have more than one child in the sample. Sexes are distributed as follows: 370 males and 380 females.

Anthropometric Techniques

Anthropometrics were chosen as a valid field measure of malnutrition for a variety of reasons. With anthropometry, effects of both recent and past influences on growth may be detected. Several degrees of malnutrition may be readily distinguished, and overnutrition may be delineated as well as undernutrition. The minimal anthropometry for nutritional assessment was executed as recommended by the Committee on Nutritional Anthropometry (1956) (See also Buzina and Uemura 1973;

Table 1. Sample Size by Residence and Ethnicity.

Ethnicity	Cayo Urban	Cayo Rural	Stann Creek Urban	Stann Creek Rural	Total	% Urban Sample	% Rural Sample	% Total Sample
Mestizo	96	102	4	25	227	31.2	29.6	30.3
Maya	11	83	1	48	143	3.7	30.5	19.1
Creole	51	72	25	50	198	23.7	28.5	26.4
Garifuna	0	3	133	46	182	41.4	11.4	24.2
Total	158	260	163	169	750	--	--	--
% Total Sample	21	35	22	22	--	100.0	100.0	100.0

Table 2. Age Group Distribution of Sample, Birth Through 5 Years.

Age Group (Months)		Age Group (Years)	Number	% Total Sample
0-3 months	or	.00 - .25 years	53	7.1
3-6 months	or	.25 - .49 years	65	8.6
6-9 months	or	.50 - .74 years	64	8.5
9-12 months	or	.75 - .99 years	44	5.9
12-18 months	or	1.00 -1.49 years	99	13.2
18-30 months	or	1.50 -2.49 years	137	18.3
30-42 months	or	2.50 -3.49 years	127	16.9
42-54 months	or	3.50 -4.49 years	105	14.0
54-66 months	or	4.50 -5.50 years	56	7.5
Total			750	100.0

Yarbrough et al. 1973). These measures included weight, height (or length), head circumference, upper arm circumference, and triceps skinfold. Weight was measured on a Triner double-beam balance scale in pounds and ounces and recorded to the nearest ounce. The scale was re-calibrated before each use and after traveling with a pre-determined weight. Infants were weighed lying in a cardboard box of known weight which was then subtracted before recording. All children were weighed without shoes and with very light clothing. Children under approximately 3 years were measured for length in a supine position on a "Baby Board" constructed at the St. Jude's Childrens Research Hospital, Memphis, Tennessee. Children over 3 years were measured standing with a standard anthropometer. Stature was recorded to the nearest millimeter. Head circumference was taken at the point of greatest circumference just above the brows with a flexible steel tape and recorded to the nearest half centimeter. The tape was always held firmly against the head, often having to press against braids and cornrow hair styles. Skinfold thickness and upper arm circumference were measured at the same point over the triceps, estimated as halfway between olecranon and acromion, with the arm hanging at side. The left arm was always used. Skinfolds were taken with a Lange skinfold caliper and recorded to the nearest millimeter. Upper arm circumference was taken with a flexible steel tape and held lightly against the skin. This was recorded to the nearest half centimeter. Triceps skinfold was measured twice, within a few minutes of each other, on a sub-sample of 111 children, in order to estimate observor error. Error was not significant ($T = .515$, $P < .05$).

Ethnographic Techniques

Scheduled interviews were conducted with 494 mothers whose children were measured. Factors covered in the interview may be found listed in the Appendix, Table 32. Four months were spent in each district in order to assure a wide range of children and to gather sufficient ethnographic data. Toward the end of each four month period, a sample of 25 women was selected who had children in the home between the ages of 1 and 6 years. These women represented a variety of socio-economic statuses, ranging from schoolteachers (whose husbands were also employed) to single, unemployed mothers. They were visited in their homes on at least one occasion and were interviewed intensively regarding food availability, preparation techniques, ceremonial foods, and feeding practices during illness. Twenty-four hour recalls of their children's diets were also collected and quantities estimated with standard local measures. In addition, a weekly food intake for the entire family was collected with the aid of a standardized interview schedule. All interviews were conducted in either Spanish or English, as necessary. Food items were referred to by their Spanish, English, Garifuna, or, when possible, by their Maya names. A list of these terms are offered in the Appendix, Tables 33-36. The seasonal availability of major fruits and vegetables is charted and presented in Chapter VI.

In each district a small group of key informants having specialized knowledge, such as midwives, nurses, sanitation inspectors, and traditional healers, was interviewed on repeated occasions. Observations and participation contributed to the ethnographic aspects of this study.

Ethnic affiliation was established, whenever possible, through self-identification. In most cases, language, surnames (maiden and married), clothing, or place of residence and home village provided sufficient information to allow accurate ethnic designation. Whenever there was ambiguity, clinic personnel were consulted. Most often this occurred in the ethnic designation of a child of a mixed couple, e.g., Creole father and Garifuna mother. Clinic personnel were quite skilled at discerning the local social rules in such cases and usually knew the family personally. Their judgments were used whenever my own could not be trusted and interethnic mixing made the question of ethnic identification a sensitive one.

Birthdates were known by all mothers, with the exception of a few Maya women in Stann Creek district. In these cases, clinic records were consulted which usually possessed a birthdate recorded shortly after the child's birth. Where a birthdate was unknown, the child was deleted from the sample.

In addition to the information obtained from interviews, clinic records were copied, mainly in order to expand the demographic data sample for each district and ethnic group. Reproductive histories and birthweights were recorded. Records of measured children were consulted for verification of birthdates and birthweights.

Methods of Analysis

The data gathered are treated in a variety of ways, the results of which are presented in the ensuing chapters. Most calculations are accomplished on the IBM 360/65 at The University of Tennessee Computer Center. All coding and almost all keypunching are done by the author.

Three packaged computer programs are utilized: Statistical Analysis System (subroutines Univariate, ANOVA, Contingency Tables); Statistical Package for the Social Sciences (subroutines Discriminant Function-Direct Method, General Linear Models); and the Biomedical Data Program 7M (subroutine Step-Wise Discriminant Analysis with Jackknife Classification).

For all anthropometric data, including muscle dimensions, means, standard deviations, and medians are obtained by age, sex, and ethnic group. These may be viewed in the Appendix, Tables 37-45. Because local standards are not available and ethnic composition varies so widely, The United States National Center for Health Statistics Growth Curves (Hamill et al. 1977) are judged the most appropriate reference standards for use in Belize at present.

Nutritional status is assessed by means of five different measures: weight-for-age, height-for-age, weight-for-height, a combination of these three, and arm circumference. The major difficulty with the use of anthropometry for the evaluation of nutritional status rests in the interpretation of measurements. The literature on malnutrition contains considerable debate concerning which measures and cut-off points are acceptable for assessing significant degrees of growth retardation (for summaries, see Waterlow 1972, 1973). Weight-for-age has received the widest use in national and local surveys despite the fact that more sensitive measures are well recognized. For reasons of simplicity and cost, most nutritional surveys are cross-sectional, thus excluding the use of weight increments through time, which yield a more accurate estimate of the growth performance of a child (Morley

1973). Moreover, the measurement of stature may pose problems for public health departments in developing nations. For example, in children under 2 or 3 years old, length is measured in a supine position. An apparatus with a fixed headboard and moving footboard is essential (Jelliffe 1966; Cameron 1978). Older children are measured standing, but, often in field situations, children are seen out of doors or in buildings where no right angles may be available for the vertical positioning of child and measuring device. Hence, a scale of malnutrition based on weight-for-age alone is practical. In the international literature most rates of malnutrition are reported according to the Gomez Scale, which divides children into four levels of weight-for-age compared to a reference value. The reference values used often are those derived from British or United States growth studies, unless standards based on adequately nourished local children are available. The four levels of the Gomez Scale (Gomez et al. 1955) are given as follows:

Normal - between 90% and 110% of reference value (50th centile of U.S. or other standards); 84% of the children in a healthy population are expected to fall into this category.

Grade I - below 90% to 75% of reference value; 16% of healthy children are expected to fall into this grade.

Grade II - below 75% to 60% of reference value; no healthy children are expected to fall into this grade; among those who do, however, many may be of normal weight-for-height but stunted, while others may be very thin or wasted, reflecting recent weight loss.

Grade III - below 60% of reference value; this indicates severe undernutrition, and, in the case of an infant, implies a life-threatening

condition; in the older child, this grade includes those who have experienced recent excessive weight loss and those exhibiting nutritional dwarfing.

One of the major shortcomings of this scale is that children who develop clinical signs of severe PEM may not fall below expected weight-for-age values (Morley 1973). Because these children often exhibit edema, a modified version of the Gomez Scale has been formulated by the Wellcome Trust International Working Party (Lancet 1970). In this version, degrees of malnutrition are discriminated by using weight-for-age and the presence or absence of edema. If a child weighs less than 60% of standard and shows no edema, the term marasmus is applied. If a child in the same weight range exhibits edema, the condition is designated as marasmic-kwashiorkor. The term kwashiorkor is applied to children with edema who are between 60% and 80% of expected weight-for-age. Children of the same weight range but without edema are classified simply as underweight.

According to the Eighth Report of the Joint FAO/WHO Expert Committee on Nutrition (1971), measurements of stature may be regarded as indicative of the duration of undernutrition. As Seone and Latham (1971) point out, weight-for-height is an index of current nutritional status, while height-for-age gives an indication of past nutritional history. The standard Gomez Scale may correctly discriminate underweight children from normal most of the time, but a deficit in weight may have several different meanings. For example, if a child has a normal height-for-age but his weight is only 70% of expected value for his height, this is likely to indicate recent weight loss and is labelled

"wasting" (Waterlow and Rutishauer 1974). If a child is markedly low in height-for-age, this indicates undernutrition of long duration which took place in the past and has ceased or may be continuing. This condition is labelled "stunting" (Waterlow and Alleyne 1971). Several degrees of both wasting and stunting are delineated. Concomitant with weight loss, arm circumference may be reduced, as a function of either the loss of subcutaneous fat, or, if more severe, as a result of muscle wasting.

Upper arm circumference is a useful indicator of malnutrition. Beghin (1969) found a perfect correlation between nutritional status judged by Gomez grades and by arm circumference in Haiti in the assessment of a nutritional intervention program. The QUAC stick has been developed and found effective for measuring arm circumference in relation to height during emergency nutritional survey work (Lowenstein and Phillips 1973). Arm circumference, as a measure of subcutaneous fat and skeletal muscle (and, of course, bone) may detect recent changes in nutritional status more sensitively than does weight (McKay 1969; Hofvander and Eksmyr 1969) and is recommended by several investigators (Jelliffe and Jelliffe 1969a; 1969b; Burgess and Burgess 1969). A limit set at 13.5 cm, below which children are classified as malnourished, is a simple, sex-and-age-independent measure, i.e., no children over 6 months old should have an upper arm circumference below 13.5 cm. Those who do have values below 85% of standards using either the U.S. Ten-State sample (Frisancho 1974)or that of Wolanski (Burgess and Burgess 1969). Children under 6 months may fall below this cut-off and should be examined separately. In a recent international comparison

of over 3,000 children, the age-constant arm circumference limit of 13.5 cm identified nearly all children with severe or acute malnutrition by weight-for-age or weight-for-height (Anderson 1979).

The operationalization of these categories represents an arbitrary decision no matter where the cut-off points are placed. In some instances, children with clinical symptoms of PEM are missed. In other cases, normal children may be included in a category of malnutrition. The regular variation in any population is so great that this is an unavoidable problem (see, for example, Rao and Singh 1970; Rao and Rao 1975). In this study, the following limits are considered to have the greatest utility for purposes of public health assessments. They are:

1. Weight-for-Age (Gomez Scale): Grade I, mild malnutrition - less than 90% to 75% of expected; Grade II, moderate malnutrition - less than 75% to 60% of expected; Grade III, severe malnutrition - less than 60% of expected.

2. Arm Circumference - acute or severe malnutrition below 13.5 cm (among children over 6 months old).

3. Stunted - less than 90% of expected height-for-age; this corresponds to the cut-off between Grade I and Grade II stunting as defined by Waterlow and Rutishauer (1974); this is also approximately between 2.5 and 3 standard deviations below the mean (Waterlow et al. 1977).

4. Wasted - less than 80% of expected weight-for-height; this corresponds to the cut-off between Grade I and Grade II wasting as defined by Waterlow and Rutishauer (1974) and Keller et al. (1976);

this is also approximately 2 standard deviations below the mean and corresponds to values less than 75% of expected weight-for-age, or the U.S. 3rd centile. This cut-off may be considered especially appropriate in Latin American countries where rates of severe PEM are lower than those in Asia and Africa (Anderson 1979).

Obesity is defined as weight-for-height at or above 120% of standard, which corresponds roughly to 2 standard deviations above the mean.

To ascertain the duration of growth retardation, measures of reduced linear growth are combined with measures of weight. Using a combination of three measures, i.e., weight-for-age, height-for-age, and weight-for-height, the children are classified into types of malnutrition according to duration, as suggested by Seone and Latham (1971). These categories are delineated as follows:

1. Past chronic malnutrition, or nutritional dwarfism, if height-for-age is equal to or less than the 5th centile, weight-for-age is equal to or less than the 5th centile, and weight-for-height is equal to or greater than 5th centile.

2. Current short-term malnutrition if height-for-age is equal to or greater than the 5th centile, weight-for-age is equal to or less than the 5th centile, and weight-for-height is equal to or greater than the 5th centile.

3. Current malnutrition of long duration if height-for-age is equal to or less than the 5th centile, weight-for-age is equal to or less than the 5th centile, and weight-for-height is equal to or less than the 5th centile.

Poor and better growth. To obtain contrasting groups of children whose nutritional statuses differed markedly, poor and better-than-average growth classes are defined. Those children falling at or below the U.S. 5th centile on any two out of three counts (weight-for-age, height-for-age, or weight-for-height) are assigned to a category labelled "poor growth." Those children with any two out of three values at or above the U.S. 75th centile are assigned to a category labelled "better-than-average growth." These categories are designed to include both short- and long-term growth deficits in the past or present as well as to maximize the differences between those who grow satisfactorily and those who do not.

Each of the foregoing categories is examined for differential rates by ethnic group. In addition, these groups of children are examined for differences by sex, age, and residence. The resulting patterns are described. Using discriminant function analyses, both direct and step-wise, it is possible to test a series of demographic, dietary, and health-related variables for their power to discriminate between the poor and better-than-average growth classes. In the step-wise discriminant analysis, only interval and ordinal scale variables are entered. In the direct method, all variables, including several dummy variables constructed to accommodate nominal scaling, are entered. Classification results differ only slightly (see Chapter VI). Nominal variables of interest are examined with contingency tables yielding measures of association and correlation.

Reproductive Histories

Reproductive histories include the number of pregnancies, miscarriages and stillbirths, the number of children who died during their preschool years, and the number of living children. These variables are examined by ethnicity and residence using Scheffe's and two-way ANOVAS in addition to standard descriptive statistics.

Operational Definitions of Health Status

Several health-related factors are assessed on the basis of the mother's own perception of her child's health status. Accurate scaling of a mother's responses is accomplished with care. Other variables, such as family size, the number of dead siblings, and the number of months breastfed, present no difficulties. But diarrhea frequency and severity together represent a particularly important health-related variable which requires continued questioning in order to ascertain an accurate ordinal scale. Common responses to the question of the frequency of diarrheal episodes include "not often," "only when teething," and "constantly." Severity is estimated on the basis of behavioral responses, for example, the episode is considered serious if the child was brought to the hospital or mild if home remedies were used and symptoms disappeared within 48 hours. The following response categories are delineated:

1. Mild - self-limiting episodes or not at all; "only when teething" or when milks were changed; easily treated with home remedies.

2. Chronic - fairly often, averaging once per month, but never requiring a doctor's care; off and on almost constantly but never taken to doctor.

3. Severe - child had to "go out" 5 times a day or more, or, in infants, watery stools at every defecation for several days, requiring a doctor's care; required hospitalization 1 or more times.

A similar scale is utilized for colds, fevers, parasitic infections, and the mother's assessment of her child's current appetite.

Dietary Analysis

In addition to information on the length and duration of breast-feeding, bottle feeding, and the patterns of both, data on the age at introduction to semi-solid and solid foods are examined. Types of solids, as well as semi-solids, and the last type of milk used are analyzed as frequency lists and examined for ethnic variation.

Twenty-four hour recalls are analyzed for nutrient values. These values are obtained from food composition tables designed for the English-speaking Caribbean and Mexico (CFNI 1974; Hernandez et al. 1977). Nutrient values for items imported from the United States are obtained from the U.S. Department of Agriculture Handbook No. 456 (Adams 1975). Recommended daily allowances are taken from Caribbean Food and Nutrition Institute values (CFNI 1976). The percentages of recommended dietary allowances provided by the children's diets are calculated. These are presented as means and medians, along with the range of variation, for each age group, residence type, ethnic group, and socio-economic category. These and other findings regarding diets are presented in Chapter VI.

In sum, the techniques of both physical anthropology and cultural anthropology are used in gathering data to meet research

objectives. Various methods of analysis permit the delineation of several distinct categories of malnutrition. Ethnic and residential patterns are deduced and selected demographic, dietary, and health-related variables tested for their significance in explaining the observed patterns of malnutrition. Before reporting the results of this study, background information on PEM and Belize are presented.

CHAPTER III

CAUSES AND CONSEQUENCES OF PROTEIN-ENERGY MALNUTRITION

Definitions

Many investigators have attempted to define protein-energy malnutrition. Measuring dietary intake alone is usually inadequate due to factors related to the bioavailability of nutrients in foods, the health status of the individual, his or her activity level, and the practical difficulties involved in obtaining quantitative data on total food intake. Biochemical measures of PEM are also confounded with problems, such as the assessment of stored as opposed to circulating nutrients. Complex chemical methods that require expensive and skilled technicians also pose problems. Clinical evaluation similarly requires highly trained personnel yet often remains fairly subjective. Consequently, anthropometry has emerged as a relatively accurate method of nutritional assessment that requires less investment in training and equipment than other methods (Roche and Falkner 1973).

The terms kwashiorkor and marasmus denote severe, clinically recognizable forms of PEM (Joint FAO/WHO Expert Committee 1962), which occasionally intergrade with each other. Kwashiorkor was first identified as such in the medical literature by Cicely Williams (1933, 1935) who made use of the Ga language term (Ghana) connoting "child displaced from the breast." This syndrome has also appeared in the medical literature as "fatty liver disease" (Waterlow 1948), "Mehlnährschaden" or "starch dystrophy," a variety commonly found in

early twentieth century Europe, "nutritional edema syndrome," or "sugar babies" (Jelliffe et al. 1954). Over three dozen local names for this syndrome have been identified in cultures all over the world (Calder 1966). Currently, the etiology of kwashiorkor is believed to involve low protein, high starch carbohydrate diets, often, but not always, in association with recent acute infections. The four major and constant diagnostic features of kwashiorkor include edema, muscle wasting with some retention of subcutaneous fat, psychomotor changes, and growth failure. Other less constant features of kwashiorkor include hypochromatia and other hair changes, skin depigmentation, "moon face," skin lesions, including "flakey paint rash," and an enlarged, fatty liver (Jelliffe and Welbourn 1963). Some kwashiorkor cases exhibit features of marasmus (marasmic-kwashiorkor), and both types may be found in the same family (Gopalan 1968), or in the same child at different times (Gopalan 1975).

Nutritional marasmus involves a diet low in both protein and energy, a condition of so-called "balanced starvation" (Scrimshaw et al. 1968). Marasmus is more prevalent than kwashiorkor and tends to replace it in areas undergoing rapid socio-cultural change. Marasmus is also more difficult to treat (McLaren and Pellett 1970; Gopalan 1975). It usually occurs during the first year of life, as opposed to the usual later appearance of kwashiorkor (McLaren et al. 1975). Marasmic children are characterized by growth retardation and the loss of muscle and subcutaneous fat (Jelliffe and Welbourn 1963). Because marasmus usually reflects recent starvation, height is less reduced than weight.

Severe forms of PEM are much less prevalent than are mild and moderate forms. Clinical symptoms are often lacking in mild-moderate forms, yet, from a public health point of view, mild-moderate PEM is the greater problem because it is at this point in the continuum of deficiency disease that prevention may best take place. Mild-moderate forms of PEM are almost exclusively detected through anthropometry. Various methods have been devised to measure stunting or dwarfing, wasting, growth retardation and growth failure (see Chapter II). It should be stressed, however, that a small unknown percentage of children in any population is likely to exhibit clinically severe signs of PEM without evident growth retardation. Conversely, even growth failure is not always accompanied by clinical symptoms (Scholl et al. 1979). It has been suggested that metabolic disturbances comprise an additional component of PEM, which may or may not accompany growth retardation (Waterlow 1963; Hoorweg and Stanfield 1976).

Prevalence

PEM in infancy and early childhood is identified as one of the most serious public health problems for developing nations throughout the world. Between the years 1963 and 1972, point prevalence rates of severe PEM in South America, Africa, and Asia ranged between 0.5% and 20% of the under 5 year old population, while 3% to 74% exhibited moderate forms of PEM (Bengoa 1974). In Central America, the range for mild-moderate PEM was 55% to 75.5% and for severe PEM the range was 1.1% to 5.9% among preschool age children (Department of Health, Education, and Welfare 1972). Moreover, it appears that all forms of

malnutrition, including obesity, are increasing in prevalence (Scrimshaw et al. 1968). It is suggested that this apparent increase may be due, in part to rapidly changing patterns of infant feeding which often accompany urbanization and the more frequent employment of women. Starchy, low protein gruels are substituted for breast or formula by many mothers. Others, to whom bottles are a recent innovation, often over-dilute milks and use contaminated containers (Gonzalez and Behar 1966; DeMorales 1972). The synergistic effect of infection with undernutrition further exacerbates the nutritional condition of many young children (Scrimshaw et al. 1968).

Biological Factors Associated with PEM

The metabolic, biochemical, and physiological changes occurring in the child with PEM are numerous, although only passing mention of these changes are made here. Alterations have been identified which involve insulin, growth hormone, and cortisol (Waterlow and Alleyne 1971); sodium, potassium, and intracellular water balance (Metcoff 1975); erythropoitic activity (Finch 1975); the metabolism of many vitamins and minerals (McLaren 1975; Alleyne 1975; Sanstead 1975); humoral and cellular immunity, leucocytic response, and epithelial surface formation (Scrimshaw 1975).

Infection. The interactions of infection and PEM are synergistic and are more life-threatening than PEM alone. Any infection, including those which are sub-clinical, is likely to produce a stress response (Beisel 1977). As a result, nitrogen is lost through urea due to the deamination of protein, mainly derived from skeletal muscle. Although

continued low protein intake may result in an adaptive response tending to conserve protein (Waterlow 1975), the additional insult of infection overwhelms the mechanism of protein balance, and increased amounts of nitrogen are lost, further compromising the nutritional status of the malnourished child (Lowenstein 1963). This synergism helps to explain why even slight infections may precipitate kwashiorkor in the child with mild-moderate PEM (Mata and Behar 1975; Scrimshaw 1975).

In addition, PEM is associated with low serum iron concentrations due to a variety of mechanisms including the blood loss associated with ankylostomiasis, inadequate dietary intake, malabsorption, and low transferrin levels secondary to protein deficiency. No matter its etiology, iron deficiency appears to lower resistance to infection (Scrimshaw 1975). Several studies report significantly higher levels of respiratory illnesses (Andelman and Sered 1966) and meningitis fatalities (Fortuine 1966) among children with low hemoglobin levels.

The frequency and severity of infection in malnourished children is extremely high (Scrimshaw et al. 1968). For instance, mortality rates for measles in developing countries often are several hundred times those of the United States or Western Europe (WHO 1965). Measles usually attacks younger children, takes a more severe form, and apparently produces greater weight loss than any other disease (Puffer et al. 1971). Clearly, measles immunization is one of the best public health measures now available. Whooping cough, tuberculosis, and malaria also pose serious threats to the child with PEM. Bacterial and fungal skin infections are extremely common as well. Tropical ulcers and streptococcal skin infections occur more

frequently in malnourished children than in others (Morley 1973).

The most common diseases in malnourished children are diarrheal. The total number of cases and deaths subsequent to diarrheal episodes are especially high among children under 5 years of age. So-called "weanling diarrhea" develops at the time of the first introduction to solid foods and underscores the relationship between nutrition and infection (Gordon et al. 1963). Until recently, recognizable pathogens have been found in only about 25% of examined cases (Sinha 1979). Among severely malnourished children, symptoms may last a month or more and occur intermittently. In more mild cases, children are ill about 4 or 5 days, often experiencing a simultaneous upper respiratory infection.

While high frequencies of diarrheal diseases reduce weight (Mata et al. 1971; Mata and Behar 1975; Condon-Paoloni et al. 1977), it is reported that height is little affected (Miall et al. 1970; Rowland et al. 1977). Weight, however, is affected, particularly during the first 3 years of life. But even during these years, if adequate food is available after the illness, catch-up growth usually occurs and long-term weight gains may not be altered (Miall et al. 1970). It has been suggested that about 9% of the food available to preschool age children in poor countries is not utilized for maintenance, growth, or activity due to the presence of infection (Briscoe 1979). This represents a considerable loss of a country's vital resources.

Of greater significance is the loss of children resulting from high rates of mortality due to diarrheal diseases. Recent statistics

indicate continuing high death rates from enteritis and other diarrheal diseases in the Caribbean, including Belize (Sinha 1979). These rates, presented in Table 3 are compared to those for Canada and the United States.

Where PEM is prolonged, growth of intestinal epithelial cells is much reduced, and malabsorption results. Recurrent intestinal infection further reduces nutrient absorption by damaging the intestinal villi, producing so-called "tropical enteropathy." This condition is believed to be extremely common where levels of nutrition and sanitation are low (Lindenbaum et al. 1972). With intestinal changes, lactase and other digestive enzymes are diminished as well. In a recent review of the mechanisms by which infections worsen nutritional status, Scrimshaw (1975) includes the following: a reduction in appetite; a tendency for solid foods to be withdrawn, especially of animal origin; decreased absorption when the infection is gastrointestinal; increased nitrogen losses; the use of medications, including home remedies, which adversely affect absorption. This last mechanism is referred to by Morley (1973) as "the urge to purge" and is a frequently found ethnomedical practice.

Behavioral Effects of PEM

The behavioral effects associated with severe PEM are notable. Apathy and listlessness, for example, are common behavioral signs in children with kwashiorkor (Brock and Autret 1952; Jelliffe and Welbourn 1963). By contrast, the marasmic child is more irritable and alert, but has little extra energy available for normal activities.

Table 3. Selected Age-Specific Death Rates from Enteritis and Other Diarrheal Diseases in the Caribbean, Canada, and the United States, 1971-1976.

Countries	Year	Under 1 Year Per 100,000 Live Births	Per 100,000 Population 1-4 Years	Per 100,000 Population Under 5 Years
Bahamas	1972	469.0	N.A.	76.9
Barbados	1975	14.9	3.8	29.7
Belize	1975	1076.7	65.1	274.2
Dominica	1975	1087.4*	N.A.	N.A.
Jamaica	1972	N.A.	N.A.	192.5
St. Lucia	1975	557.6	N.A.	N.A.
St. Vincent	1974	1156.2	N.A.	N.A.
Trinidad and Tobago	1974	803.4	43.2	217.9
Canada		18.4	1.1	4.5
U.S.A.		22.7	0.7	5.0

Source: Adapted from Sinha 1979.

*Figure for 1971.

Measurement of the possible long-term effects of PEM on learning and psychological development has proved to be a far more difficult task than the measurement of brain size. Early post-natal PEM is implicated in reduced brain cell size and quantity, in reduced dentritic growth (Winick and Rosso 1975), and in reduced head circumference up to the first birthday (Winick and Rosso 1969). Measurements such as these are indices of growth and reveal little about behavioral development. These findings should not be interpreted as necessarily representing reduced mental capacity (Dobbing 1979).

The task of finding the influence of nutrition on learning ability and other behaviors requires control of a large number of intervening factors which are also likely to influence mental development. Measurement of such factors as mother-child interaction (Katz et al. 1972), the social position of the family, maternal efficiency (Waldmann 1975), and the micro-environment of the home (Klein 1979) have been attempted. A composite measure, such as an index calculated from a set of variables, has been useful to some investigators (Klein 1979; Marchione 1980). An additional problem in studies designed to assess long-term behavioral effects of malnutrition involves the timing of the episode of PEM. Many earlier studies were retrospective in design and examined ex-patients a number of years after hospitalization with PEM. Results have been mixed. In Jamaica, for example, Birch et al. (1971) followed up once severely malnourished children some 5 to 7 years later and compared them with siblings and other children in the same schools and villages. As a

group the ex-patients were more retarded both physically and mentally than either of the other groups of children, but, as individuals, the results were less clear. Some of the most severely malnourished children caught up with controls both physically and mentally. Other investigations have also had mixed results, often concluding with a statement regarding the importance of the home environment (Moodie et al. 1972; Waldmann 1976; Cravioto 1979). Investigations utilizing a prospective design which examine the behavioral effects of supplementation in populations exhibiting chronic malnutrition appear to have less confusing results (Chávez and Martinez 1979; Klein 1979; Cravioto 1979).

For example, Chávez and Martinez (1979) report demonstrable behavioral effects of supplementation from pre-natal life to 3 years of age among women and children in San Jorge Nuchita, a poor rural community in Mexico. In this study, one group of pregnant women was supplemented, as were their children beginning sometime after birth, as indicated. A control group of mothers and children was not offered supplements. The authors claim that the community from which both groups were drawn was homogeneously poor, although unsupplemented children showed no clinical signs of PEM. Any child who developed symptoms of severe PEM was treated and removed from the study. Therefore, the results apply to children with mild-moderate forms of PEM and a demonstrably better nourished group. Utilizing an observational approach, a scalographic classification of 31 indicators concerning the effects of the environment upon the child was developed; other observations were measured as well.

The results of supplementation included far greater activity levels, greater independence from mother, more interaction with father, and generally enhanced manipulation of the environment. Moreover, supplemented children experienced greater growth, 30% fewer days of illness, and were able to move about and to walk earlier. Unsupplemented children spent much of their time asleep, even at age 3. As late as 72 weeks, these children used crying to communicate with their mothers far more often than supplemented children, who were verbalizing. Furthermore, the unsupplemented group rarely talked, rarely walked, and was breastfed as a comforter far more often. Interaction between mother and child was very limited. One of the most interesting results was increased family interaction with the supplemented child, especially among fathers, who, through gift-giving and other means, exhibited pride in their well-developed children. In addition, the heavier children were more difficult to carry in the traditional "rebozo" or shawl and mothers were forced to give them greater freedom of movement. These children had such increased activity levels that home furnishings had to be rearranged and mothers had to take special care that children would not fall out of cribs. Increased family interaction and altered family behavior were direct results of the supplemented child's own demands. Increased self-assertiveness in response styles to testing is also reported to accompany supplementation (DeLicardie and Cravioto 1974).

Socio-Cultural Factors Associated with PEM

A wide variety of socio-cultural factors is associated with childhood PEM, thus reflecting its complex etiology. For this reason several investigators have attempted to articulate ecological models for understanding malnutrition (see, for example, Sims et al. 1972; Malcolm 1973; Cravioto and DeLicardie 1976; Sims and Smiciklas-Wright 1978). However, not all factors commonly entered into these models operate in the same manner universally. In other words, particular variables that are significantly associated with PEM in one cultural and geographical setting may not be significant in other settings. In addition, certain variables may interact to produce indirect effects. In such cases statistical significance may be slight but importance within a causal network may be considerable. Furthermore, many studies are conducted on a community-wide basis and do not differentiate between those children who exhibit symptoms of PEM and those who do not.

In this section of the literature review, those factors bearing directly on the situation in Belize are considered. These fall into four major categories: (1) Demography, (2) Diet, (3) Sanitation, and (4) Health Care. Studies have been selected which clearly demonstrate a relationship between PEM and factors included in these categories.

Demography. In a recent review of the nutritional and socio-demographic trends in Central America and Panama during the past several decades, Teller et al. (1979) concludes that demographic factors such as differential mortality, fertility, and migration, while influential, do not function as primary determinants of

malnutrition. This study also points out that lowering of infant mortality rates through public health interventions has led to increased population growth. Effective fertility has increased and children who would have died are instead among the severely malnourished. The authors maintain that significant reduction in both malnutrition and fertility depends upon more general societal change, particularly in income, employment, land and social service policy. Recent evidence seems to indicate that among Central American nations (excluding Belize), Costa Rica alone has experienced a reduction in both fertility and the prevalence of malnutrition largely due to economic development and government policy (Correa and Jacoby 1978; Rutstein and Medica 1978).

Family size may be a more effective indirect measure of nutritional status in the household than fertility. High prevalence rates of PEM among preschool children are significantly associated with larger family size in urban India (Rao and Gopalan 1969), Bogotá, Colombia (DeGwynn and Sanjur 1974), and Bangkok (Wray 1971). This effect is neither simple nor direct. For example, with increasing parity, birthweights are lower as is lactation performance (Morley et al. 1968). Furthermore, even in Cleveland, Ohio, larger family size is significantly associated with increased incidence of diarrhea and other illnesses (Dingle et al. 1964). The relationship between mother's age and larger family size is obvious but the relationship between father's age, increased family size, and malnutrition is somewhat more complex. An interesting study among Colombian subsistence farmers relates the sum of money available per person for

food, the father's age, the number of children in the family, and the proportion of children with PEM. As the father's age increases, the number of children increases and the amount of money spent per person on food declines, while the proportion of malnourished preschoolers increases (Aguirre and Wray 1965). However, Muñoz et al. (1974) report no difference in family size between groups of malnourished and non-malnourished children in a community near Mexico City.

In some areas it is the youngest child who suffers most, in which case the crucial variable is the number of children in the family under 5 years old. This situation is found in Malawi (Burgess and Wheeler 1970) and in Candelaria, Colombia (Wray and Aguirre 1969). On the island of St. Vincent, Antrobus (1971) found that children living in homes with not more than 2 children under 5 years old were consistently heavier up to 2 years of age than those in homes with more than 2 siblings under 5.

Birth order or rank in family is frequently an indicator of high vulnerability to PEM. In Emesi, Nigeria, Morley et al. (1968) reports that family size is unimportant until a child belongs to a birth order above 7. This seems very high. Rao and Gopalan (1969) found that the incidence of severe PEM among hospitalized Indian children belonging to birth orders 3 or below was approximately half of that among children belonging to higher birth orders.

The relationship of birth interval to malnutrition is less well documented, but sufficient evidence exists to establish a relationship between increased mortality during both the first year of life and up to the age of 5 among children born after a short interval

(Yerushalmy et al. 1956). Morley (1973) points out the wide variation in birth interval in developing countries. For one-third of the families on two sugar estates in South America, the birth interval was as short as 14.8 months, while in Africa, where long post-partum sex taboos are still extant, the median birth interval is 34.7 months. Where birth interval is short, the infant may receive special care for about 12 to 18 months, after which weaning is likely to precipitate a variety of nutritional difficulties. The well-known association of kwashiorkor and a mother's new pregnancy underscores this process.

Variation in prevalence of PEM among urban and rural dwellers is another important demographic factor. Residential variation is closely related to the economic conditions existing in a given country. In general, urban areas offer greater variety of economic opportunities and wealth differentials are more pronounced. Widespread PEM is a common finding in slums and shantytowns throughout the world (Rea 1971; Rao et al. 1974). Rural subsistence farmers exhibit greater economic homogeneity (Robson 1964; Valverde et al. 1977). Where agriculture development projects successfully raise both production levels and per capita income, one might expect a decreased incidence of PEM, but this is not always the case. Newly acquired income may be spent on consumer items, such as bicycles, or radios (Newman 1970) or on less nutritious food than that which a cash crop replaced (Neitschmann 1973). Infants and toddlers may receive greater amounts of expensive proprietary formulas and baby foods only to experience greater diarrhea and malabsorption (Pellett 1977).

Additional labor requirements of intensified agricultural production is likely to result in increased caloric intake only for the men of the family who are performing that labor, as Gross and Underwood (1971) demonstrate among sisal workers in Brazil. Most commonly, the entire population is not similarly affected by increased income levels. Although farm production increased six-fold in La Chontalpa, Tabasco, Mexico, prevalence rates of PEM dropped very slightly (Hernandez et al. 1974). Increased participation in a market economy promotes greater socioeconomic stratification in rural communities and the "trickle down" effect hoped for by agro-economic planners is very frequently thwarted (Dewey 1979).

Diets. The most important dietary factor contributing to high rates of PEM among preschool age children is bottle feeding. By foregoing or shortening the amount of breastfeeding, mothers deprive their children of immunoglobulins A, G, M, and D, neutralizing antibodies to various viruses (including polio, Coxsackie, and Echo), and passive antibodies to several types of *Escherichia coli* (Mata and Wyatt 1971). The bifidus factor in human milk also promotes characteristic microflora which are antagonistic to *Shigella* and other pathogens, including certain intestinal protozoa (Mata and Urrutia 1971). Reduced attack rates of infectious disease in breastfed infants have been demonstrated repeatedly (Jelliffe and Jelliffe 1971; Mata 1978; Wray 1978). Additional beneficial aspects of breastfeeding include those which promote mother-infant bonding (Newton 1971; Kennel and Klaus 1979), longer birth intervals (Buchanan 1975; Short 1976; Mondot-Bernard 1977), better growth (György 1971; Jelliffe and Jelliffe 1978b), and

greater economy of time and money (McKigney 1971; Latham 1979). Additional long-term effects, such as reduced likelihood of carcinoma of the breast (MacMahon et al. 1970) and better cerebral development in the child cannot be overlooked.

The decline of breastfeeding is cause for concern, yet few studies have investigated the interplay of changing economic factors and a woman's decision to commence bottle feeding. In a recent study of modernization in rural Spain, Fernandez (1979) outlined the loss of traditional supports and the influence of national economic policy and media on women's self-image. Similar cultural changes appear to be operative in Sardinia (Mathias 1979), urban Latin America (Solien 1963; Puffer 1979), among Eskimos (Berman 1972), and elsewhere (Jelliffe 1962).

Among the reasons frequently given health workers for early weaning is a complaint that there is not enough milk and the baby is hungry. Recent studies seem to indicate no substantial loss in breast milk quantity or in vitamin C or folate content among women subsisting on inadequate diets (Rajalakshmi 1979). While conceding that the volume and composition of human milk in poorly nourished women is surprisingly good, Jelliffe and Jelliffe report that "it is often suboptimal in quantity and in quality with lower values of fat (calories), water soluble vitamins, vitamin A, and somewhat lower calcium and protein, than in well nourished women" (1978b:506). In general it appears that adequate infant growth is maintained for about 3 to 6 months among populations whose women are inadequately nourished. Maternal depletion frequently results from prolonged lactation or

rapidly repeated pregnancies with ensuing lactation. But, for many women, especially those of higher economic status, the decision not to breastfeed or to cease breastfeeding within the first few months is not related to insufficient nutrition. Any reduction in sucking may be perceived as a mark of inadequate lactation. At such a juncture, the advice of neighbors or kin often exerts great influence on the mother. In Jamaica, DeMorales and Larkin (1972) found that weaning occurs earlier when friends or relatives provide information in contrast to a later weaning time when doctors or public health nurses are consulted. In other cases, physicians and nurses recommend formulas whenever women complain of lactational problems (Carballo 1977). The work of Dana Raphael (1973, 1979) and others has begun to delineate the psychosocial, economic, and familial factors associated with lactational failure.

Investigators in communities with high prevalence rates of PEM often call local weaning foods into question (Gerlach 1964; Vamoer 1969; Sanjur et al. 1970). In traditional areas of Mexico, as in other parts of the world, young children's diets are restricted by prohibitions as well as by heavy reliance on only one or two major staples. Withholding food, or even water, during illness as an aspect of treatment is also often implicated (Brown 1978). In tropical areas where adult diets depend in large part on roots and tubers, low protein, starchy carbohydrate weaning gruels are commonly employed. Cultural "superfoods," having been selected for ease of cultivation, productivity and storability are usually better sources of calories than of protein (Jelliffe 1967). Where a society is undergoing

modernization, newer introduced weaning foods vary more in quality than do traditional ones, but poor women are unlikely to be able to afford the more expensive varieties. Cheaper starches and sugary liquids suffice.

Other dietary factors which may be of importance in understanding malnutrition include the age at weaning onto bottles, semi-solids or solids, the quantities of food consumed (Muñoz et al. 1979), intra-familial food distribution patterns (Montgomery 1977; DeWalt et al. 1980), and the quality of the family diet (Arroyo et al. 1972).

Concepts and beliefs about food may also play a part in determining food behavior and nutritional status (Burgess and Dean 1962; Muñoz et al. 1979). Meat, for example, is frequently believed to cause worms in Africa and Central America (Burgess and Dean 1962). Eggs are considered to promote greed in children and a host of fruits are commonly thought to produce diarrhea. Most commonly, various milks are associated in the mother's mind with diarrhea in her children and are, therefore, avoided. The lack of sanitation and refrigeration contribute heavily to these observations. Foods and other substances eaten in ritual or healing contexts as well as traditional modes of preparation and serving are additional domains of food-related behavior which warrant consideration in the study of PEM.

Sanitation. Closely related to the problems of disease frequency, nutritional status, and mortality is the problem of adequate sanitation. Contaminated water, food, and habitation sites are

extremely common in developing nations today as they have been in the past in developed nations. The dramatic and continued decline in mortality in England beginning in the eighteenth century has been variously attributed to increased food supply (McKeown et al. 1972), better immunological resistance (Dubos 1961), and changes in personal sanitation and shelter accompanying the Industrial Revolution (Kleinman 1980). More effective sanitation and public health measures certainly contributed to the outstanding improvement in urban mortality rates during the early twentieth century.

Based largely on the experience of developed nations, it is often maintained that the availability of clean domestic water supplies is of prime importance for the control of diarrheal diseases (Watt et al. 1955; Stewart et al. 1955; Rubenstein et al. 1969). In lowland Guatemala, however, a longitudinal study carried out between 1973 and 1976 failed to demonstrate significant changes in the incidence of diarrheal attacks with improved water supplies (Schneider et al. 1978). Similar results are reported from Bangla Desh (Briscoe 1978), East Africa (White et al. 1972), Egypt (Weir et al. 1952), and elsewhere. But, in Kampu, India (Trivedi et al. 1971), lower diarrheal disease rates ensued after water quality was improved. Behavioral factors appear to hold great significance in this area, as do technical and mechanical features of the water improvement systems (Kawata 1978). Cheaply constructed wells often become contaminated, chlorination systems are interrupted with mechanical failures, and such factors as taste, distance, and crowding at communal pumps influence domestic usage. Household water storage may also favor re-contamination.

Even the addition of latrines may be open to question. In Costa Rica, Moore et al. (1966) indicated that parasitism persisted despite the widespread use of latrines. A study in Egypt concluded that the installation of water supplies and latrines did not appear to have a marked effect on infant death rates. Another study of 31 Panamanian communities demonstrated that the frequency of enteric infections was actually somewhat greater among the children who drank water from faucets and had access to flush toilets than among those who did not have these facilities (Kourany et al. 1971). It is not surprising that many authors have concluded that better control of diarrheal diseases can only be achieved when water supplies are part of a more complete sanitation program which includes actions to prevent fecal contamination of the water supplies and home containers, actions to improve hygienic behavior in the care of food and water, and better housing facilities with animal control (Wolman 1975; Chen 1978; Latham 1978). One study in Candelaria, Colombia, demonstrated that skimmed milk supplementation along with an educational component giving sustained treatment to the issue of hygiene in the preparation of these supplements had a greater impact upon the frequency of diarrhea than piped water (Wray 1978).

Health care. Several aspects of community health care are pertinent to our discussion of PEM. First, the economic constraints on health care delivery in underdeveloped nations are great. The availability of personnel, equipment, medicines, and even immunizations is likely to be inadequate. Poorly equipped hospitals and clinics do not well represent the better qualities of cosmopolitan medicine to

villagers. Doctors and other health care workers frequently seem out of touch with the needs of their patients (Kay 1978). Even those whose experience and sensitivities enable them to establish a working rapport with the people they serve are often overworked or otherwise frustrated in their efforts to ameliorate the poor conditions of health in the community. The problems of health care providers coupled with the problems of consumers, such as transportation and cost, generally result in poor utilization of existing facilities, especially among the more traditional or socially marginal members of the community.

A second major aspect of the health care problem concerns the responses of families, especially mothers, to the illnesses of their children. Traditional healing practices are rationally derived from an ethnomedical system's own principles of disease causation. Uneducated persons cannot be expected to comply fully with the physician's (or nurse's) advice when the principles underlying that advice are unknown to them. Therefore, even after consulting medical personnel, behavioral change in the realm of health care may not be forthcoming. For example, while women may initially boil water for their new infants on the advice of a nurse, the cost in time, labor, and fuel may gradually become unacceptable (Wellin 1955). Without a clearly understood concept of germs and their probable consequences, water boiling may be abandoned. Or, alternately, boiled water may be mixed with unboiled water to balance their qualities, either from the perspective of humoral medicine (Currier 1966; Cosminsky 1975) or simply to attain a lukewarm temperature. Some women may deliberately attempt to accustom the infant to the local unboiled water by gradually mixing both types. A wide variety of problems in

communication underlies poor modern health care utilization (Morley 1973; Williams 1978).

Whatever the quality of modern health care facilities, traditional ethnomedical systems offer alternatives that are inexpensive, locally available, and supported by the recommendations of neighbors and kin. Furthermore, many herbal and other remedies are empirically effective (Ortiz de Montellano 1975; Etkin 1979). Where a large ethnomedical repertoire is still widely known or where traditional healers are still active, cognitive alienation from the modern medical system is likely to exist. The attribution of illness in children to the jealousy of witches, persons with the evil eye, ancestors, ill winds, improper bathing, or the child's own envy of his mother's unborn child are beliefs which address fundamental human emotions in culturally prescribed, and, therefore, comprehensible ways (see, for example, Foster 1966, 1972; Middleton 1967). It is essential that these ideological factors are taken into account in a systematic manner.

Few studies of the socio-cultural factors underlying the prevalence of malnutrition do more than make passing reference to the native's point of view, yet several areas require investigation. What, for example, are the locally recognized signs of illness and malnutrition in infants and children? What conditions or foods are considered likely to produce illness or good health? When and under what circumstances will different remedial actions be initiated? When is recovery recognized? These and other questions relating to the prevalence of particular beliefs and practices and their changing

expression have received little attention in investigations of malnutrition. It appears that this is due to an a priori conviction that social and economic conditions more often are responsible for malnutrition than are beliefs. Yet it behooves those who would like to ameliorate the problem to recognize the public health significance of ethnomedical belief systems in order to design better treatment and educational programs. In chronically malnourished communities, gastrointestinal infections and poorly growing children may be so common that these are not locally perceived as signs of illness at all, unless quite extreme. Helping mothers recognize early symptoms could result in better health care utilization and lower infant mortality.

Finally, traditional midwives and healers may play important roles in the life of a community. If they are driven out of their positions by cosmopolitan medicine, it is likely that other functions they have fulfilled will be neglected. For example, the support of breastfeeding through the administration of galactogogues or the arbitration of intra-familial stress is commonly the role of the midwife or healer, yet may be seldom addressed by the physician. Nurses at distant or irregularly visiting clinics cannot be reliable counsels for the stressed mother on the verge of lactational failure. Making use of the traditional midwife or healer could be an effective extension of public health services.

In summary, many biological and socio-cultural factors commonly underlie the existence of PEM among preschoolers. Of these, the following were considered to be relevant to this major public health problem in Belize:

1. diet (type, amount, frequency)
2. frequency and severity of infection
3. family size (number of pregnancies, sibling deaths, children in household)
4. urban or rural residence
5. health care practices.

Because these factors may cluster according to ethnic status in pluralistic settings, the ethnic group was chosen as the unit of analysis. Wherever PEM is found, unique geographical, historical and cultural circumstances condition its expression and the success of any eventual intervention. The particular situation in Belize is explored in the following chapters.

CHAPTER IV

CONTEMPORARY SOCIO-ECONOMIC AND NUTRITIONAL CONDITIONS IN BELIZE

Contemporary Socio-Economic Conditions

Belize, formerly British Honduras, is located on the Caribbean coast of the Yucatan Peninsula. Figure 1 on the following page shows the major topographic and political features of the country. Although it is one of six Central American countries, historic and economic factors place it equally within the sphere of English speaking Caribbean nations. The organization of contemporary Belizean society reflects a mixture of British influence, local traditions, and emerging class interests. The political position of Belize in relation to Guatemala and the interests of other Caribbean nations remains unsettled. Although Belize has enjoyed internal self-government officially since 1963, the British remain in control of the civil service and military forces.

The estimated total population of Belize in 1977 was 127,603 (Central Planning Unit 1979). Due to the lack of recent census data on ethnic affiliation, the contemporary ethnic distribution is not precisely known. However, the composition of the population may be estimated as follows: 56% Creole, 25% Mestizo, 8% Maya, 7% Garifuna (Black Carib), 2% Mennonite, 2% Lebanese, Syrian, Chinese, East Indian, and others combined (based on Waddell 1961; Belizean Independence Secretariat 1972; Sanford 1974b; Segal 1975; Davidson 1976; Government of Belize 1976; Brockmann 1977).

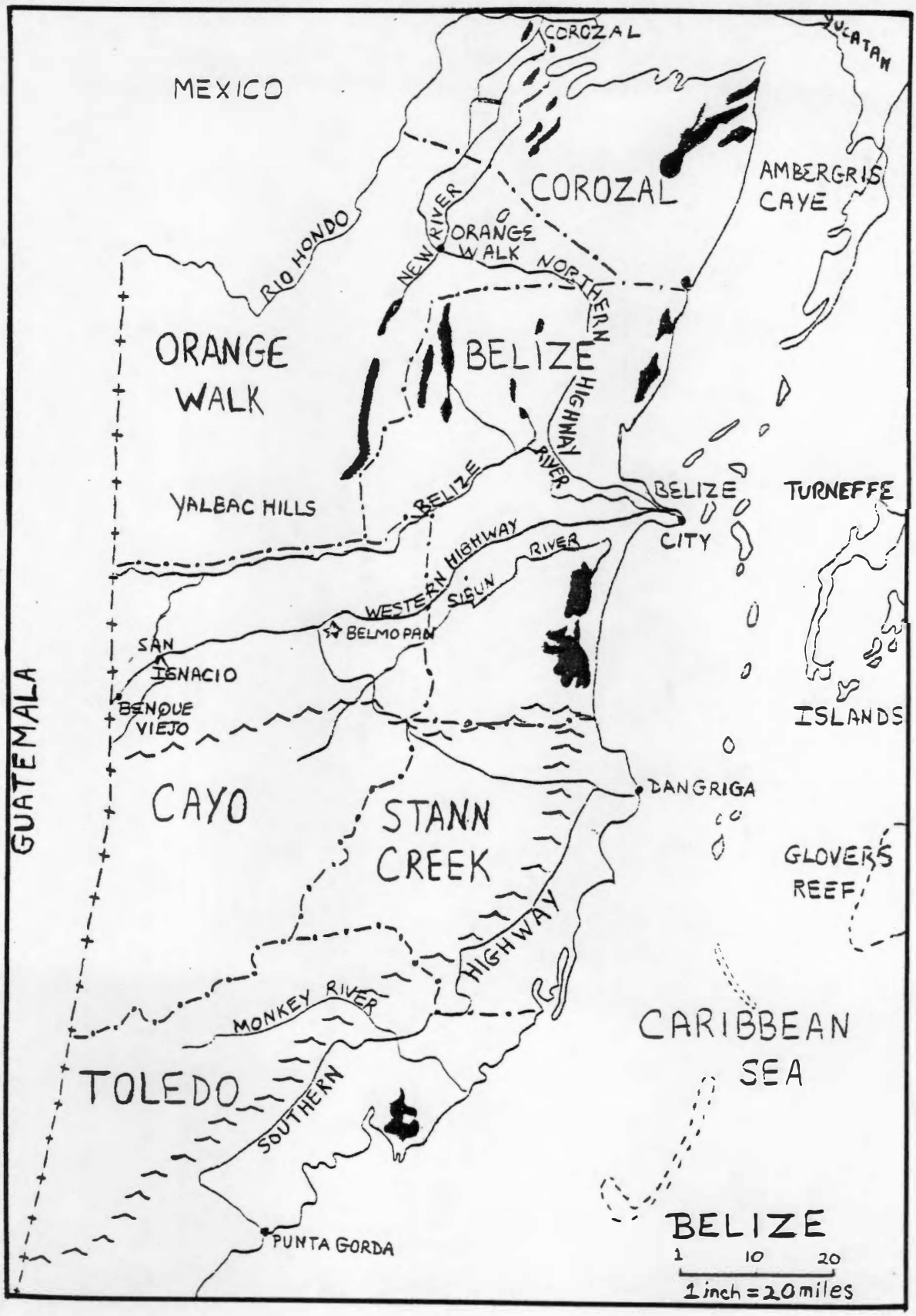

Figure 1. Map of Belize.

The ethnic multiplicity of Belize has attracted the attention of many anthropologists. For a more complete treatment of ethnicity and interethnic relations see, for example, Mazzarelli (1967), Sanford (1974a, 1974b), Howard (1975), Cosminsky (1976, 1977), Brockmann (1977) and Gregory (1976, 1978).

Economically, Belize presents a profile not unlike other ex-colonies. Lumbering once dominated the economy, but agriculture has now replaced it, with sugar cane supplying two-thirds of the agricultural revenue. Customs duties and income taxes together provided 84% of the total revenue in 1977 (Central Planning Unit 1978). Food items represent a considerable portion of total imports, 22.3% in 1977.

Family income levels largely depend upon the number of workers in the family, the type of work done, and the number of different cash-earning activities engaged in throughout the year. Although the nuclear family appears to be the most common household unit, reliance on kin-based economic cooperation is widespread. A significant portion of children are raised in female-headed households, especially among the Creole and Garifuna. Among all major ethnic groups, except the Maya, women may work for wages, however, opportunities are severely restricted. If a woman has many small children, wage labor is unlikely unless child care is easily arranged within the kin network. Child-lending, or fosterage, is practiced by some groups (Sanford 1976).

Many women earn cash through the sale of home-prepared foods or wines. Fruits and eggs are also commonly sold in homes. Small shops,

corn mills, and market stalls are frequently run by women. Restricted opportunities for education and employment place women, in general, at an economic disadvantage. Since about 50% of the population is under 15 years old, the dependency ratio is estimated at 55% (Blades 1979). Thus, the greater responsibility to earn cash falls on the adult male.

Wages are generally low and no wage minimums exist outside of government and waterfront labor. Special union agreements have been negotiated with individual companies. As of 1979, wages in a citrus canning factory were $1.00 (BZE) per hour for men and $.78 (BZE) per hour for women. Seasonal, non-skilled labor, such as orange picking, is paid by the box ($.40). Manual laborers on the government payroll receive somewhat higher wages, $58.00 (BZE) per 48-hour week. School teachers begin at approximately $100.00 (BZE) per month.

The contribution of wages made in the United States or elsewhere and sent back to Belize is unknown but appears to be considerable. Kerns (1977) estimates that a quarter of all Belizeans are presently employed in other countries, mainly in the United States. Based on U.S. Department of Immigration Reports, Segal (1975) estimates that 6,500 Belizeans are working in the United States. Although a high rate of migration may reduce the competition in Belize for jobs, housing, or services, it significantly decreases the number of available workers. The rate of population decline is a source of anxiety to Belize's planners. Even though the rate of natural increase is 3.5%, the net rate of population growth is only 1.8%, the difference due mainly to out-migration (Central Planning Unit 1979).

Belize has an estimated 2.2 million acres of arable land, but only 10% of this is presently used as farms (Caribbean Agroeconomics Society 1979). Very large tracts held by a few families and leases granted to lumber companies significantly reduce land availability. One-third of the farmers in Belize are slash and burn cultivators, locally known as milperos (Caribbean Agroeconomics Society 1979). Most of these farmers rent their lands from the government or from private owners and abandon them after one or two crops. Few are able to produce sufficient harvests year after year to meet family subsistence needs. Transportation and marketing difficulties are also great. One Mennonite farmer said his brethren has a saying, "One crate of eggs makes a profit, two crates make a loss." Local markets are easily over-supplied and prices drop precipitously. Transporting produce to Belize City, where prices remain more stable, is a common practice. But this practice contributes to inequitable food distribution throughout the country and is costly for the farmer who owns no vehicle. Theft, insect and animal damage further reduce agricultural production.

Wage labor often is the only alternative for the milpero who leaves his village on an average of four months at a time (Ashcraft 1972; Chibnik 1975) and returns between jobs to his neglected fields. In several large villages included in the present study, as many as 50% of adult men were away at work, a situation which engenders considerable social and economic hardship among many families. Finally, government policies and international market conditions have combined to pressure many small-scale farmers into abandoning domestic

food production in favor of cash crops, especially sugar cane (Henderson 1972; Chibnik 1975; Stavrakis and Omawale 1978). Others have given up farming altogether and have moved into town or city in search of improved economic opportunities.

Socio-economic stratification is evident in the growing towns of Belize where ethnic composition is mixed. Rural villages are more ethnically homogeneous and exhibit less stratification. Intra-ethnic socio-economic variability is most pronounced among Mestizos and Creoles. Fewer wealth differentials are apparent among the Garifuna and even fewer among the Maya.

Survey Areas

Two districts, Cayo and Stann Creek, were chosen as research areas on the basis of ecological diversity and ethnic representation. Cayo district is located inland and consists primarily of savannas and highland forests, dissected by numerous rivers. Its population is composed mainly of Mestizo, Maya, and Creole. Very few Garifuna people reside in this district. The second area chosen is a coastal district, Stann Creek, which is located farther south and is characterized by a zone of beaches, swamps, and lagoons behind which rise the Maya Mountains. In this district, Creole, Garifuna, and Maya are well represented.

Both districts include rural and urban populations. The use of the term urban in the context of Belize refers to towns with more than 2,000 inhabitants. Only Belize City, which is not included in the survey, exceeds this population level. District capitals function as administrative, trade, and health care centers. In Cayo district,

there are three urban communities, the largest of which is the capital, the combined town of San Ignacio y Santa Elena. Benque Viejo, with about 2,000 people, is located at the Guatemalan border, has its own police force and public health clinic. Belmopan, the nation's new capital, has a population of about 3,000 and a government hospital. The only major urban center in Stann Creek district is the capital, Dangriga. For the most part, urban areas receive chlorinated piped water supplies, but many households maintain rainwater collection systems as well. These vary from large, expensive, closed metal and wooden structures to open oil drums, painted on the inside to inhibit rust formation. In most homes, sewerage consists of latrines of the outhouse variety. Few households have indoor plumbing. In Belmopan, however, which was built quite recently, a majority of buildings possesses modern plumbing, but open street-side ditches remain a constant feature throughout Belize's urban areas.

The rural people in both districts live in villages ranging in size from less than 100 to over 1,500 inhabitants. In Cayo, larger villages are located along the Western Highway, except for the Mennonite settlement of Spanish Lookout. Smaller villages are located at a distance off the roads and a few are reachable only by dugout or horseback. Most villages are composed predominantly of one ethnic group, although individuals and families of several ethnic groups may also be residents. In Cayo, Georgeville and Unitedville are largely Creole while San Antonio and Sucotz are almost entirely Maya. In Stann Creek, all Garifuna villages, save Georgetown, are located directly on the beach. The major Maya village, Maya Mopan, is

situated at the foothills of the Maya Mountains, while several newer settlements, made up primarily of migrants from Toledo district (both Mopan and Kekchi Maya speakers) are situated along the Southern Highway. Other Maya settlements are scattered along the Hummingbird Highway. One large Creole village, Gale's Point, which is located in Belize district on a spit of land between two branches of the Southern (or Manatee) Lagoon, was included in the survey since it was being served at the time by the Stann Creek public health clinic.

Figures 2 and 3 show the villages and towns visited during this study. Altogether 28 villages and 7 urban communities are included. Many of the children measured actually resided in an additional 14 villages, but these villages were not on the route covered by the public health department. Mothers brought their children to the nearest village provided with a mobile clinic.

Village life differs from town life. In the villages, latrines are few and water supplies are usually drawn from a nearby river or a centrally located hand pump. House construction often is of cane, sticks, and thatch. Food supplies are less reliable than in towns and shortages are a recurrent feature of domestic life. Transportation is a major difficulty for all rural residents and available health care consists mainly of home remedies. Few villages have resident midwives or traditional healers, locally known as "bush doctors."

Contemporary political and economic conditions in Belize share many features in common with other developing nations. High rates of out-migration, low wages, under-developed industry and agriculture, inadequate education, transportation, sanitation, and health care

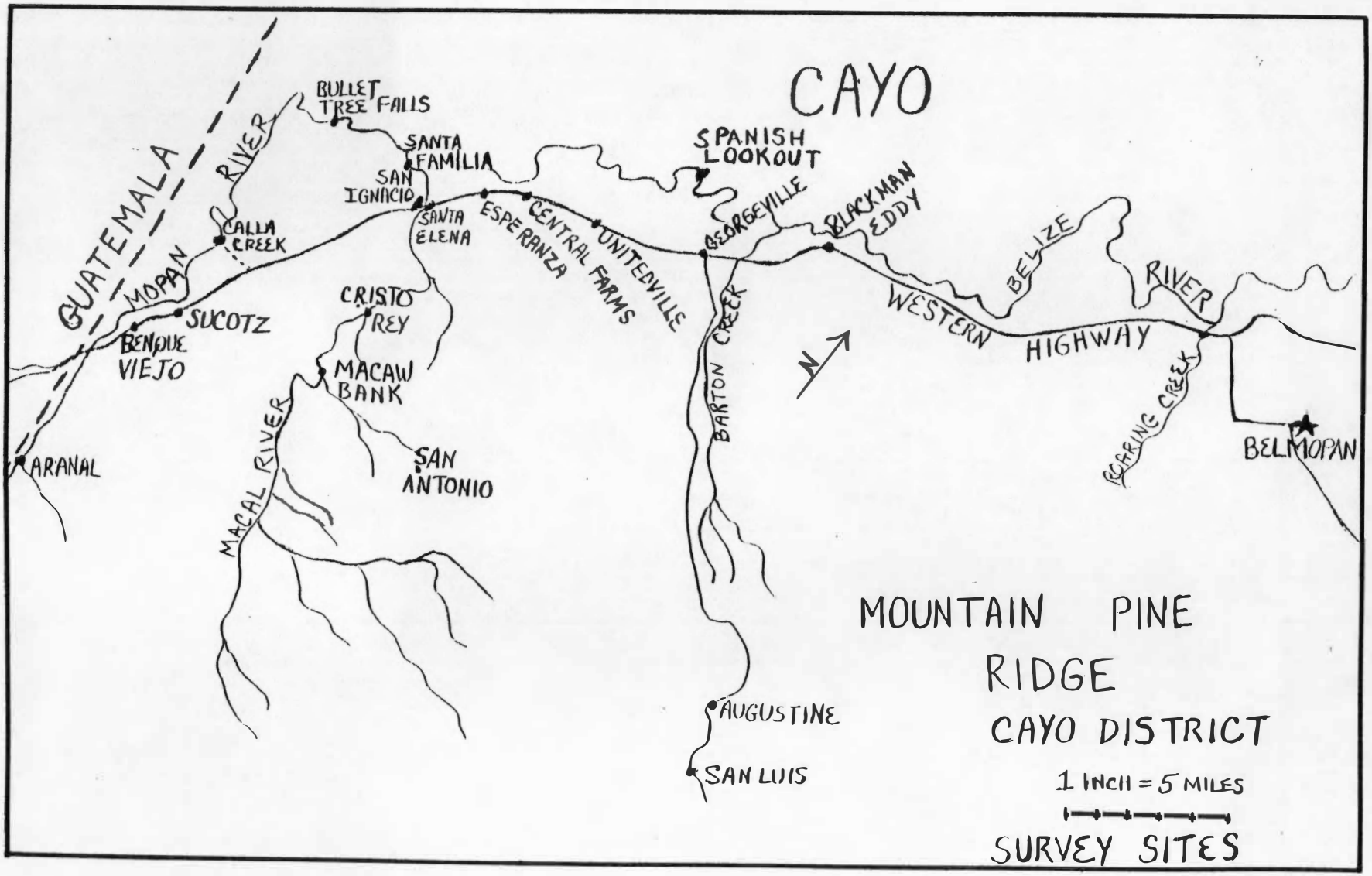

Figure 2. May of Cayo District Showing Survey Sites.

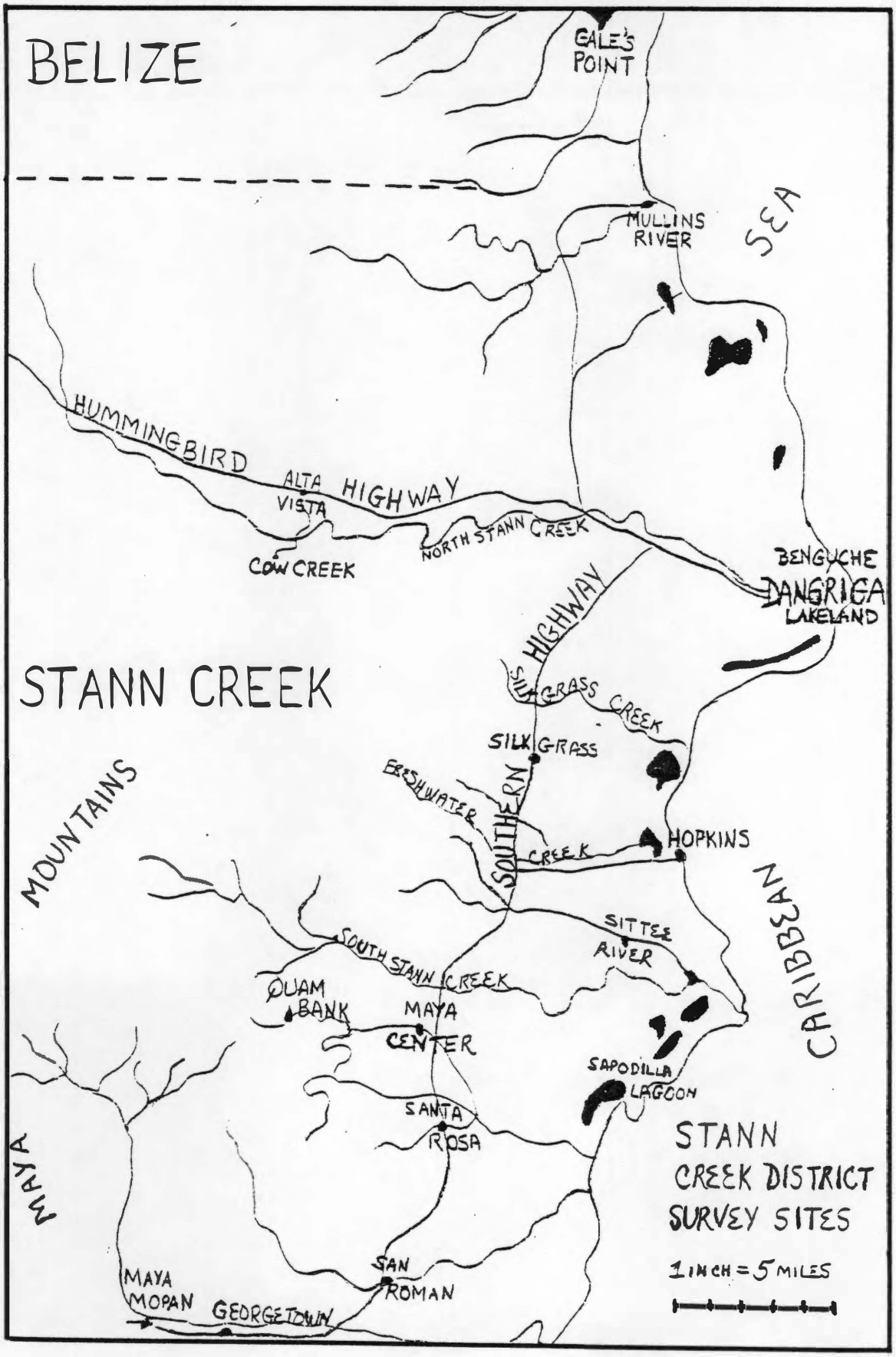

Figure 3. Map of Stann Creek District Showing Survey Sites.

services contribute to a network of frustrating problems for the nation as a whole. Language, modes of subsistence, sex roles, and other behaviors and beliefs differ notably by ethnic group. Consequently, each ethnic group is subject to different degrees of social, geographical, and economic constraints. The cumulative effects of these differences are demonstrable in the health status of the most vulnerable age group, infants and preschoolers.

Nutritional Studies of School Age Children

Although little research in Belize has been conducted on the age group covered in this report--i.e., those from birth through 5 years--several studies of school age children are available. Under the auspices of CARE, Barry Nocks (1967) completed an anthropometric survey of a sample of 8 and 9 year olds attending primary schools in Belize City. His sample of 1,649 was divided into three categories: Creole, Spanish, and miscellaneous. In this scheme, all children of obvious African ancestry, including Garifuna, are classed as Creole, and all Spanish-speaking children are considered Spanish. The miscellaneous group included Chinese, Lebanese, and others. Nocks measured height and weight and distributed questionnaires to be taken home to parents. His results showed that the average heights and weights fell between the 10th and 50th U.S. centiles (Harvard standards). Spanish children were closer to the 10th centile, while the miscellaneous group showed values nearer the 50th centile. Comparing these means with those of Puerto Rican private school children, Belizeans were consistently below average. A comparison of Belizean values with pre-war and post-war English children revealed

Belizean children to be taller and heavier than the pre-war group but not as accelerated as those measured after the war. An examination of the children's conjunctivae showed significantly less apparent anemia in the miscellaneous children than in the Creole or Spanish children. Similarly, his questionnaire results revealed greater milk and red meat consumption by the miscellaneous group, little leafy vegetable consumption by all groups, and generally inadequate diets. High frequencies of colds and headaches were also reported. CARE was at that time providing a glass of milk and a bun every day to 81% of the children in Nocks' sample. Comparison of the supplemented and unsupplemented children revealed no significant differences. However, the majority of the miscellaneous children were included within the unsupplemented group. He concluded that Belize City children were underweight and short in stature for age, but further work was needed, especially in the rest of the country.

The geographers May and McLellan (1972) attempted to synthesize the information then available on the ecology of malnutrition in Belize. Their work presents considerable basic information on agriculture and emphasizes its underdevelopment and future potential. They also present three-day menus collected by CARE workers in 1967. Although the data are unquantified and somewhat confusing, the authors conclude that the diets of Belizean children appear scant, with the possible exception of the Creoles. Nutritional disease patterns are discussed, based primarily on anecdotal information. They report kwashiorkor as a common finding among the Garifuna and blame its occurrence on the use of cassava lab, a weaning food made of cassava

starch, sugar, and water. In addition, they report high levels of anemia, symptoms of specific avitaminoses, especially of riboflavin, and parasite infections.

In 1972-73, Neil Hammond (CFNI 1975) weighed 3,546 children attending their first year of school throughout all six districts. Using the Gomez Scale and measuring weight only, he found 40%, 18%, and 1% of these 5-1/2 year old children were in Gomez grades I, II, and III, respectively. At that time, little information was available with which to interpret district and urban-rural differences. Severe malnutrition (Gomez grade III) appeared most frequently in Dangriga, followed by Belize district, and Punta Gorda, all urban areas. He also derived average weights from clinic data at birth, 6 months, 12 months, and 18 months. His methods of sampling and analysis are not given. He concluded that birthweights were adequate, but by the age of 1 year, growth had failed to keep up with potential.

No other nutritional reports appeared on Belize until the Caribbean Food and Nutrition Institute published an assessment in 1975. This report included the results of Hammond's weight survey, a family-based dietary survey consisting of three days' intake among 111 large families throughout the country, and a food consumption pattern survey conducted in 1969 in Belize City, using expenditures as the indicator. Although these results are interesting, inflation and demographic changes since that time have probably significantly altered the nature of the population and its consumption patterns. This was noted in the report and a number of additional studies were suggested, including "a more rigorous analysis of the structure and

changes in the population especially since 1970," and an "identification of the degree and level of poverty as well as major nutritional problems existing in the country" (CFNI 1975:46-47).

Another study of interest was conducted in a Maya village in Orange Walk district, San Antonio Rio Hondo (Stavrakis and Omawale 1978). Quantified dietary data were collected with the aid of Dr. Claire Cassidy of the Smithsonian Institute in both 1973 and 1974. This village is one of several affected by the displacement of small subsistence farmers with the development of sugar cane as a cash crop (cf. Henderson 1972). A significant decrease in corn (tortilla) and rice consumption in favor of increased wheat flour and kidney bean consumption was observed. Sugar consumption rose at least 250%, mainly in the form of bottled sodas and cookies. Mango consumption also increased. In general, the number of persons with a minimally acceptable diet increased between 1973 and 1974, but this did not affect the children under 3 years of age. The disparity between adult and child intake is notable and has been reported many times previously in similar Latin American peasant communities (Gross and Underwood 1971; DeWalt et al. 1980).

Mortality and Morbidity Statistics

Published statistics on infant and early childhood mortality and morbidity in Belize have been sketchy. Private studies which make use of Medical Department records have recently been made available (CFNI 1975, 1979; Vasquez 1975; Blades 1979; Caribbean Agroeconomics Society 1979; Medical Department Reports 1979). These materials, along with the latest published vital statistics report

(Central Planning Unit 1978), have been utilized to compile the tables which follow. Where discrepancies among sources exist, these have been noted.

Table 4 presents data on infant mortality. Under-reporting is likely, even among those children born in hospitals. Infant mortality rates have declined steadily since the mid-1950's.

Increased infant mortality in 1976 may be due to better reporting or to the indirect effects of an extended drought during 1975.

Other mortality rates of nutritional significance are shown in Tables 5 and 6. Unlike infant mortality rates, the mortality rates of older preschoolers appear to be increasing.

In 1970, 37% of all deaths occurred in children under 5 years of age, and by 1976, this figure had increased to 42% (Central Planning Unit 1978). In addition, Medical Department records show a rise in neonatal death rate (infants less than 1 month old, given per 1,000 live births) from 60 in 1975 to 85 in 1976. Maternal death rates have not increased and stillbirth rates are unavailable.

Infant and early childhood mortality rates by district are not published. The last census in which the number of persons per age group was recorded in each district took place in 1970. The Caribbean Food and Nutrition Institute (1979:29) has calculated the district mortality rates for that year. Using the 1970 census data and the 1973 data on live births and mortality by age group, Table 7 has been constructed comparing the years 1970 and 1973. It should be stressed that under-reporting of infant and child deaths has been noted by public health personnel, especially in Stann Creek district.

Table 4. Infant Mortality in Belize (Per 1,000 Live Births), 1956-1977.

Year	Rate	Year	Rate
1956	69	1967	60
1957	92	1968	52
1958	83	1969	52
1959	67	1970	51
1960	64	1971	45*
1961	55	1972	34
1962	70	1973	42+
1963	52	1974	43
1964	54	1975	39*
1965	49	1976	46*
1966	50	1977	40‡

Source: Figures are those of Medical Department records made available to the author and rounded off.

* CFNI publications show different figures for these years: 1971--31; 1975--43; 1976--45.

\+ In Blades (1979) this rate is given as 39.

‡ Source: CFNI 1979:27; given as 34 in McIntosh (1980:21).

Table 5. One to Four Year Old Mortality Rates, 1970-1977 (Per 1,000 in Age Group).

Year	Rate
1970	3.4
1971	N.A.
1972	4.1
1973	4.5
1974	3.6
1975	3.4
1976	5.6
1977 (July)	4.1*

Source: CFNI 1979:28.

*McIntosh 1980:21.

Table 6. Mortality Rates by Selected Age Groups, 1972-1976 (Rates Given Per 1,000 Mid-Year Population).

Year	Age Groups	
	4 Years and Under	5 to 9 Years
1972	10.85	0.72
1973	12.47	1.25
1974	11.96	0.58
1975	12.03	0.54
1976	14.35	0.60

Source: Adapted from Central Planning Unit 1978:39.

Table 7. Infant and Early Childhood Mortality Rates by District 1970 and 1973 Compared (Rates Per 1,000 of Age at Risk).

District	Age in Months		
	Birth-11	12-23	24-59
Belize			
1970	57.0	4.9	1.4
1973	36.6	6.6	1.9
Corozal			
1970	77.0	21.5	3.2
1973	46.6	10.9	1.5
Orange Walk			
1970	54.0	5.0	1.4
1973	33.0	2.5	1.8
Cayo			
1970	39.0	4.7	1.0
1973	31.2	4.0	3.4
Stann Creek			
1970	98.0	25.2	5.5
1973	13.4	7.6	1.3
Toledo			
1970	56.0	10.5	3.8
1973	104.0	54.9	13.3

Source: CFNI 1979:29 and Central Planning Unit 1978.

During the years 1970 to 1973, infant mortality rates decreased in all locations except Toledo district. Deaths in the second year of life increased in Toledo and Belize districts, declining elsewhere. Among 3, 4, and 5 year old children, these statistics show an increased mortality in Cayo and Toledo districts.

The five leading causes of death in children under 5 years of age in 1974 are reported in the following order and categories: enteritis and other diarrheal diseases, respiratory diseases, deficiency diseases (including severe malnutrition), all other infective and parasitic diseases (Vasquez 1975). Diarrheal and deficiency diseases combined accounted for about 50% of all deaths in this age group.

Further information on infant and early childhood nutritional status is reported in a study conducted in 1974 by Vasquez (1975) on feeding practices. Questionnaires were sent to public health clinics in four districts (Orange Walk, Corozal, Cayo, and Belize rural). A sample of 260 was obtained. Results showed that 65% of the children had received some breastfeeding while 35% had not. Breastfeeding had ceased by the age of 6 months in 50% of the children. Out of a sample of 108 infants, 4 to 6 months old, 37% were receiving dry cereals or gruels with condensed milk daily, 22% received the same only occasionally, while 3% were fed only condensed milk. Gruels were most often made of cornstarch. Yet, an unexpected number of mothers were purchasing vitamins and commercial baby foods. The average expenditure per week was $5.00 (BZE) but ranged up to $15.00 (BZE) for some babies.

In 1977 an investigation of intestinal parasitism was carried out in Toledo district by Frederick Garcia of the Central Medical Laboratory, Belize City (Garcia 1977). In this study fecal samples were collected and hemoglobin levels were assayed by Sahli's Acid Hemoglobin Method in five Maya villages. The major results are summarized in the following tables.

Table 8 presents the frequencies of the three most common helminthic infections in children, birth through 14 years of age.

In general, children were more often infected than adults. Hookworm was more frequently found in children 6 years old and above than in the birth to 5 year old group, reflecting different opportunities for exposure. Many infants were as yet unaffected. The youngest child with evidence of intestinal parasitism was 9 months old. Multiple infections were common. In addition to hookworm, ascaris, and trichuris infections, several other parasites were identified with lesser frequency. These include Taenia sp. (probably a pork tapeworm), Enterobius vernicularis (a nematode carried by rats), Trichostrongylus sp. (found in the digestive tracts of herbivores and rodents), and Entamoeba hystolica. The low reported incidence of Entamoeba in this survey may have been due to inadequate methods of testing.

The author attributes heavy worm burdens to poor hygiene, in particular to the lack of footwear and untidy defecation habits. Eating without cutlery and with unwashed hands also appears to be implicated.

Hemoglobin levels were low and not confined to those with hookworm infections. Table 9 shows the rates of anemia by age group

Table 8. Prevalence of Most Common Types of Intestinal Parasitism in Toledo District Among Children Birth Through 14 Years.

Age Range Number Examined	0-5 (215) N	 %	6-14 (280) N	 %
Necatur americanus (Hookworm)	82	38.1	231	82.5
Ascaris lumbricoides (Roundworm)	141	65.6	201	71.8
Trichuris trichiura (Whipworm)	88	40.9	151	53.9

Source: Adapted from Garcia 1977.

Table 9. Prevalence of Low Hemoglobin in Children Birth Through 14 Years in Toledo District.

			Hemoglobin Levels (Grams %)			
					< 9 gms %	
Age	Sex	No. Examined	Mean	S.D.	N	%
0-5	M	97	8.82	4.44	53	54.6
	F	77	8.56	4.46	47	61.0
6-14	M	117	9.20	5.82	50	42.7
	F	124	8.88	5.68	54	43.5

Source: Adapted from Garcia 1977.

of children. In addition to children, women of child-bearing age were also seriously affected.

The latest nutritional data available to the author in 1979 are presented in Table 10. These are the percentages of children, birth to 36 months old, attending child health clinics during the years 1975 to 1978 arranged by Gomez grades of weight for age. These data represent weights measured by clinic personnel which have been compiled yearly and submitted to the Chief Medical Officer. It should be stressed that weighing conditions differ markedly from place to place. Scales used on mobile clinics are usually of the bathroom variety and poorly calibrated. Those which are stationary equipment in hospital or clinic are probably somewhat better; however, children are weighed in an inconsistent manner from clinic to clinic, or even at the same clinic. Sometimes shoes are left on and at other times removed. In the villages many children are barefoot. Often

Table 10. Gomez Grades of Children, Birth to 36 Months, Attending Child Health Clinics by District, 1975-1978.

District	Total	% Normal	% Grade I	% Grade II	% Grade III	% Obese
Belize	3626	71.4	18.9	2.9	0.3	7.6
Corozal	1250	63.5	27.3	5.2	0.6	8.7
Orange Walk	1247	64.2	20.8	4.9	0.6	9.4
Cayo	2278	72.4	16.5	3.5	0.7	4.9
Stann Creek	1009	67.5	24.7	3.6	1.2	3.1
Toledo	1226	49.3	31.4	15.8	1.9	1.6

Source: Medical Department Reports, Belize 1979.

children balk at getting on the scale and occasionally a weight is recorded while the child is being held, or is holding onto the mother, the scale, or the wall. Consequently, these data possess some unknown degree of inaccuracy.

Table 10 indicates that approximately 30% of the children under 3 years old exhibit some degree of malnutrition, as measured by weight deficits (see page 13 for Gomez classification). Of this total, 23% are considered mildly malnourished, 6% moderately malnourished, and 0.9% severely malnourished. An additional 6% are obese. Compared to average rates in the rest of the Caribbean (Grade II = 8% and Grade III = 1.2%), Belizean children in this age group appear to compare favorably (CFNI 1979). When considering only the year 1977 and including children up to 5 years old, the picture worsens, mainly with respect to grade II of the Gomez Scale. Table 11 presents the percentages of children under 5 years in the three grades of the Gomez Scale for the Commonwealth Caribbean. Belize exhibits the highest rate of second degree malnutrition in this comparison.

In summary, although infant mortality rates have been decreasing since the mid-1950's, there has been little improvement over the last decade. The average infant mortality rate for the Caribbean is 32 per 1,000 (McIntosh 1980) in 1977, whereas the rate in Belize for the same year may be as high as 40 per 1,000. Infant mortality in Belize is twice as great as that in North America (18 in 1977). The 1-4 year old mortality rate has shown no upward trend during the past decade, but is 5 times that of North America in 1977 (4.1 compared to 0.8). Morbidity patterns appear to be similar to

Table 11. Percentages of Children under 5 Years in Gomez Grades I, II, and III in the Commonwealth Caribbean as of July 1977.

Country	Percentages of Children under 5 Years Old		
	Grade I	Grade II	Grade III
Jamaica	39	9	1.4
Trinidad and Tobago	37	11	1.4
Guyana	44	17	1.4
Barbados	36	3	0.2
Belize	40	18	1.2
St. Lucia	33	9	1.9
Grenada	29	9	1.6
St. Vincent	47	14	1.5
Antigua	36	7	0.8
St. Kitts/Nevis	33	7	0.3
Montserrat	20	2	0.2
Cayman Islands	14	2	0.0
Turks and Calcos Island		<7	0.3
Commonwealth Caribbean	39	11	1.3
North America	16	0	0.0

Source: Adapted from McIntosh 1980:21.

those in less developed countries, with diarrheal and respiratory illnesses extremely common. In addition, the incidence rates of measles and malaria have been increasing over the past decade (CFNI 1979:31). Malnutrition, measured by the Gomez Scale, is notably worse than the rest of the Caribbean with regard to Grade II. Within Belize, Stann Creek and Toledo districts exhibit the highest rates of severely low weights. Child feeding practices may account for some of the differences by district. The only available information indicates that breastfeeding is still practiced by the majority of women but ceases, on average, by 6 months and is supplemented with commercial infant foods and canned milks. Hemoglobin levels are likely to be low in many children, often complicated by intestinal parasitism.

No studies have been conducted to assess to what extent familial factors, morbidity, or changing feeding practices may be responsible for the patterns of infant and early childhood malnutrition and mortality found in Belize. Although it is clear from all reports that young children are often poorly nourished, no anthropometric study has been undertaken among preschoolers. The chapters which follow present the results of an anthropometric, dietary, and health status survey designed to fulfill these research needs.

CHAPTER V

PREVALENCE OF PROTEIN-ENERGY MALNUTRITION AMONG PRESCHOOLERS ATTENDING CLINICS IN STANN CREEK AND CAYO DISTRICTS

Birthweight

Birthweight is recognized as an indicator of early post-natal nutritional status and maternal well-being during pregnancy. Low birthweights (less than or equal to 2,500 gm) are associated with closely spaced pregnancies (Rosa and Turshen 1970), with reduced placental protein synthesis (Lechtig et al. 1977), and with increased maternal morbidity (Lechtig et al. 1976). In children, low birthweights are associated with increased infant mortality, increased morbidity during the preschool years, growth retardation, and increased incidence of neurological handicaps (Drillien 1958; Niswander and Gordon 1972; Lechtig et al. 1977).

The Belizean data reported here are based on mothers' recalls and clinic records which may be subject to inaccuracy due to poor and inconsistent weighing procedures. Gestational age at birth is unknown. Despite these shortcomings, mean birthweights are presented in Table 12 for a sample of 468 children arranged by ethnic group. Mean birthweights for each ethnic group appear unexpectedly high. However, 52 or 9% are at or below 2,500 gm. This percentage is considerably higher than that reported by Chow (1973) in rural Taiwan (6.7%) and by Acosta et al. (1974) for Mexican-Americans (5%). Those with heavy birthweights (at or above 3,700 gm) include 86 or 18% of

Table 12. Mean Birthweights by Ethnic Group and Total Sample.

Ethnicity	N	$\bar{X}$ (gm)	S.D. (gm)
Mestizo	51	3179	609
Maya	45	3188	514
Creole	102	3264	577
Garifuna	270	3422	525
Total	468	3263	553
F ratio	5.325		
F probability	0.0013		

the children, a lower percentage than that reported by Acosta et al. (1974) in Mexican-Americans (23%). As seen in Table 12, results of a Scheffe's ANOVA demonstrate a highly significant difference between the Garifuna and other ethnic groups. Additional tests using medians and rank scores yield similar results (Wilcoxen score Chi Square = 18.06, $P < .004$; Median 1-Way Analysis Chi Square = 16.33, $P < .001$). In addition to the sources of inaccuracy mentioned previously, it should not be forgotten that these are the birthweights of survivors. It is very likely that many small birthweight infants have not survived peri-natal and early post-natal stresses.

Growth Patterns

Means, standard deviations, and medians are derived from the data on height (or length), weight, weight-for-height (or length), head circumference, upper arm circumference, and triceps skinfold. Arm muscle dimensions are also calculated (see Appendix, Figure 29 and Table 43). Table values by age and sex (Appendix, Tables 37-42)

and by age and ethnic group, sexes combined. Appendix Tables 44 and 45 are presented for all measurements.

On average, Belizean children begin their lives with values on all measures closely comparable to those of the U.S. 50th centile. Figure 4 presents weight by age in males and Figure 5 presents weight by age in females. Before 6 months of age, both sexes begin to drop away from the median. By 15 months, female weight values reach the U.S. 10th centile, while male values reach the U.S. 5th centile. After 15 months, both sexes exhibit slightly greater gains in weight, approximating the 10th centile until they reach 48 months of age, at which time values drop to the 5th centile.

As shown in Figures 6 and 7, average values for stature among females remain at the U.S. 50th centile until about 4.5 months, while males drop away from the median somewhat earlier. Both sexes approximate the 5th centile in stature from 18 months to 48 months of age. After 48 months, stature is reduced even further relative to standards.

Weight in relation to stature (sexes combined) is shown in Figure 8. At 1.5 months, Belizean values are very close to those of the U.S. median, but by 12 months, growth retardation is evident. At 12 months, the average difference between the U.S. and Belize is 2 cm in height and 0.6 kg in weight. These differences become progressively greater with age. By 60 months or 5 years, Belizean values are 6.8 cm and 1.2 kg below those of the U.S.

Head circumference means shown in Figure 9 are reduced to the level of the U.S. 5th centile by 12 months in males and by 18 months

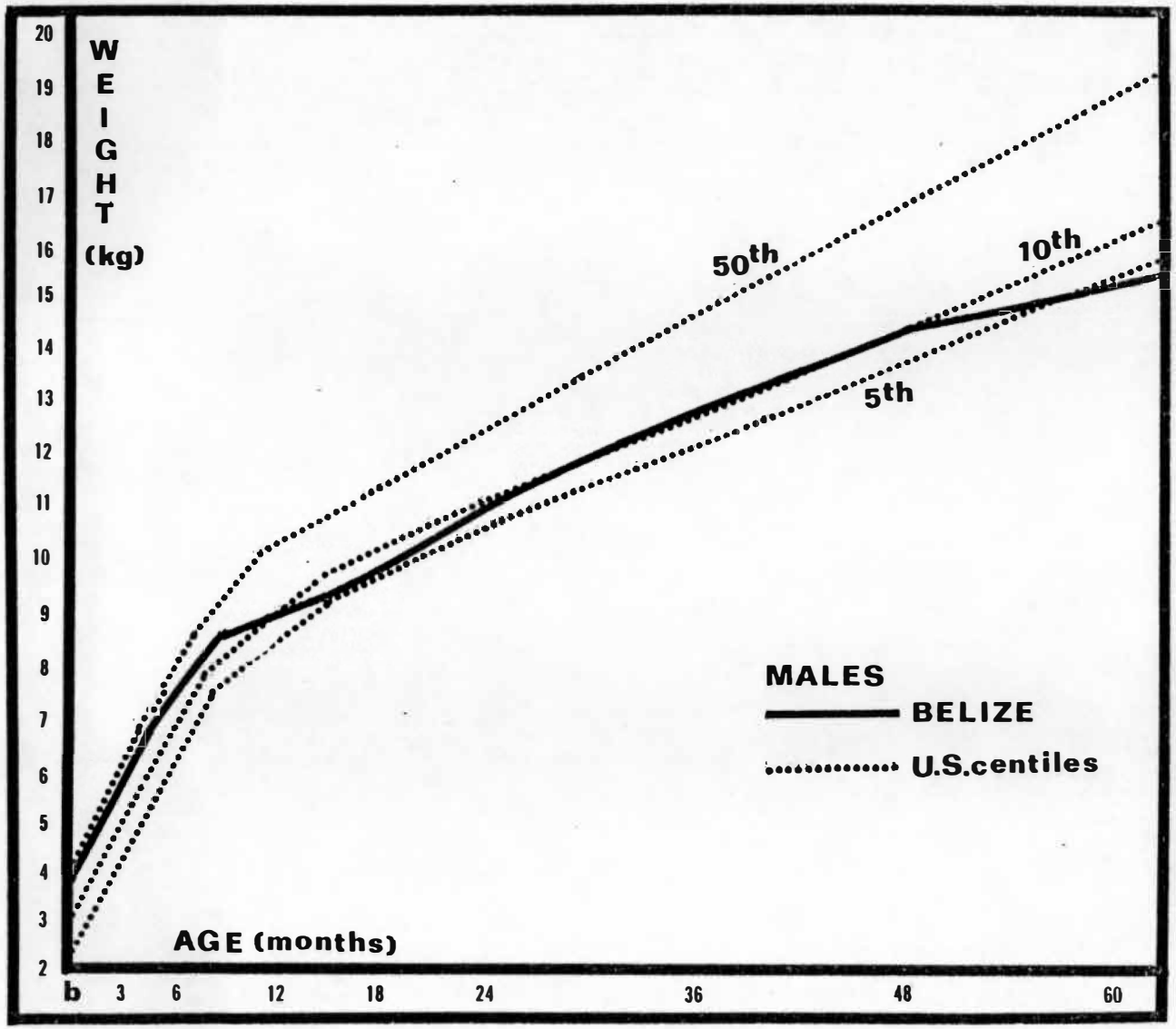

Figure 4. Weight by Age in Males, Birth Through 5 Years.

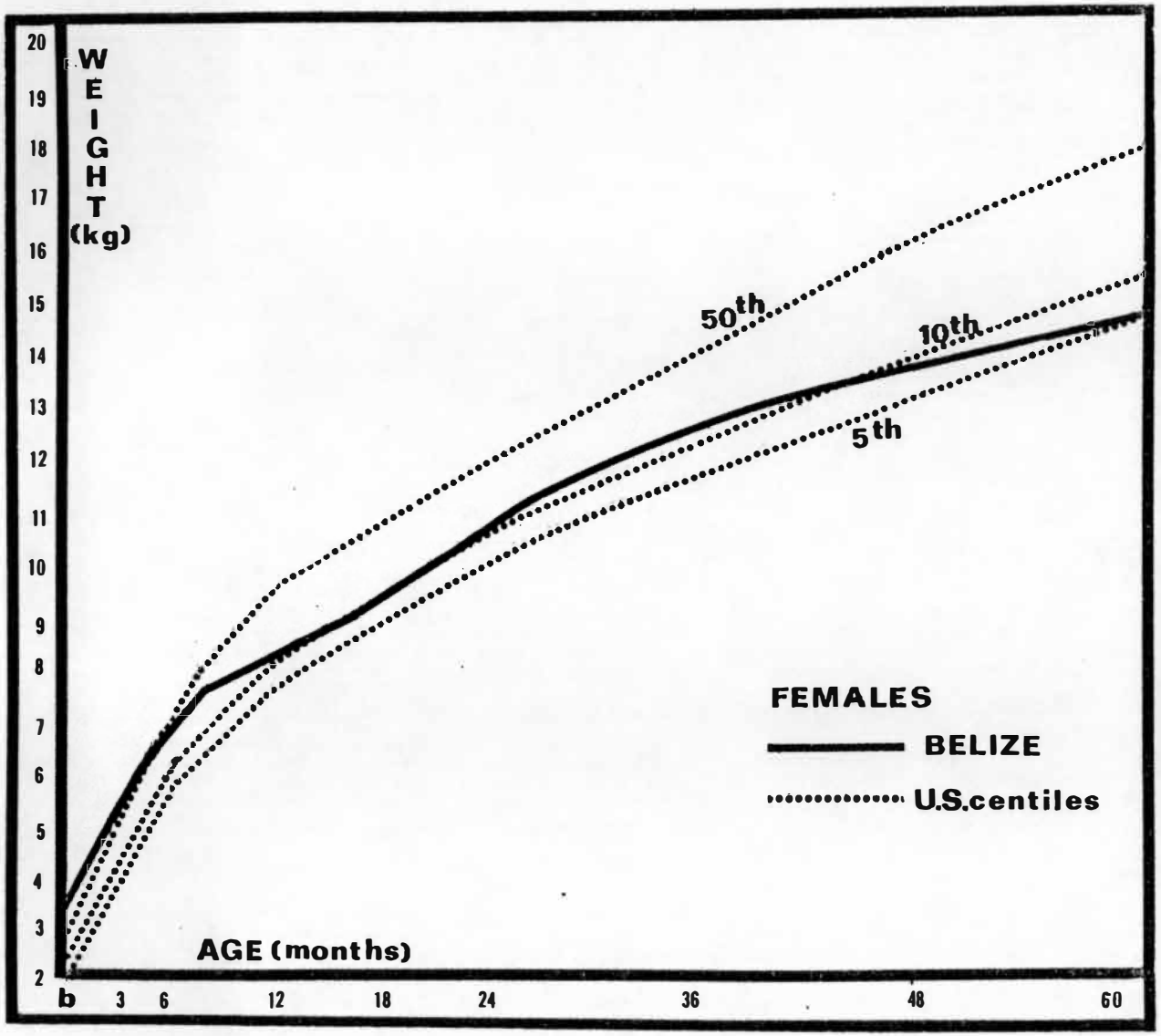

Figure 5. Weight by Age in Females, Birth Through 5 Years.

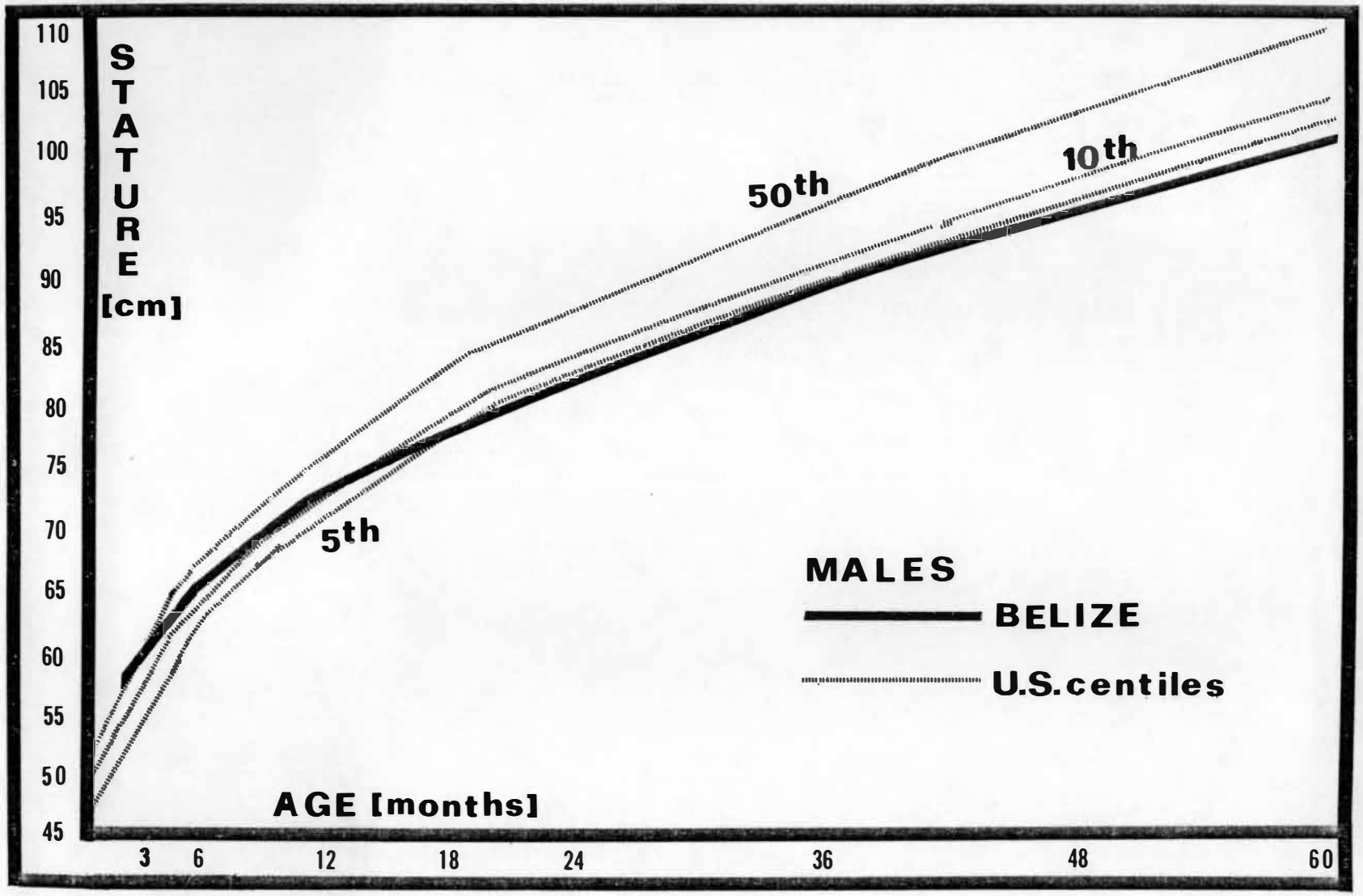

Figure 6. Stature by Age in Males, Birth Through 5 Years.

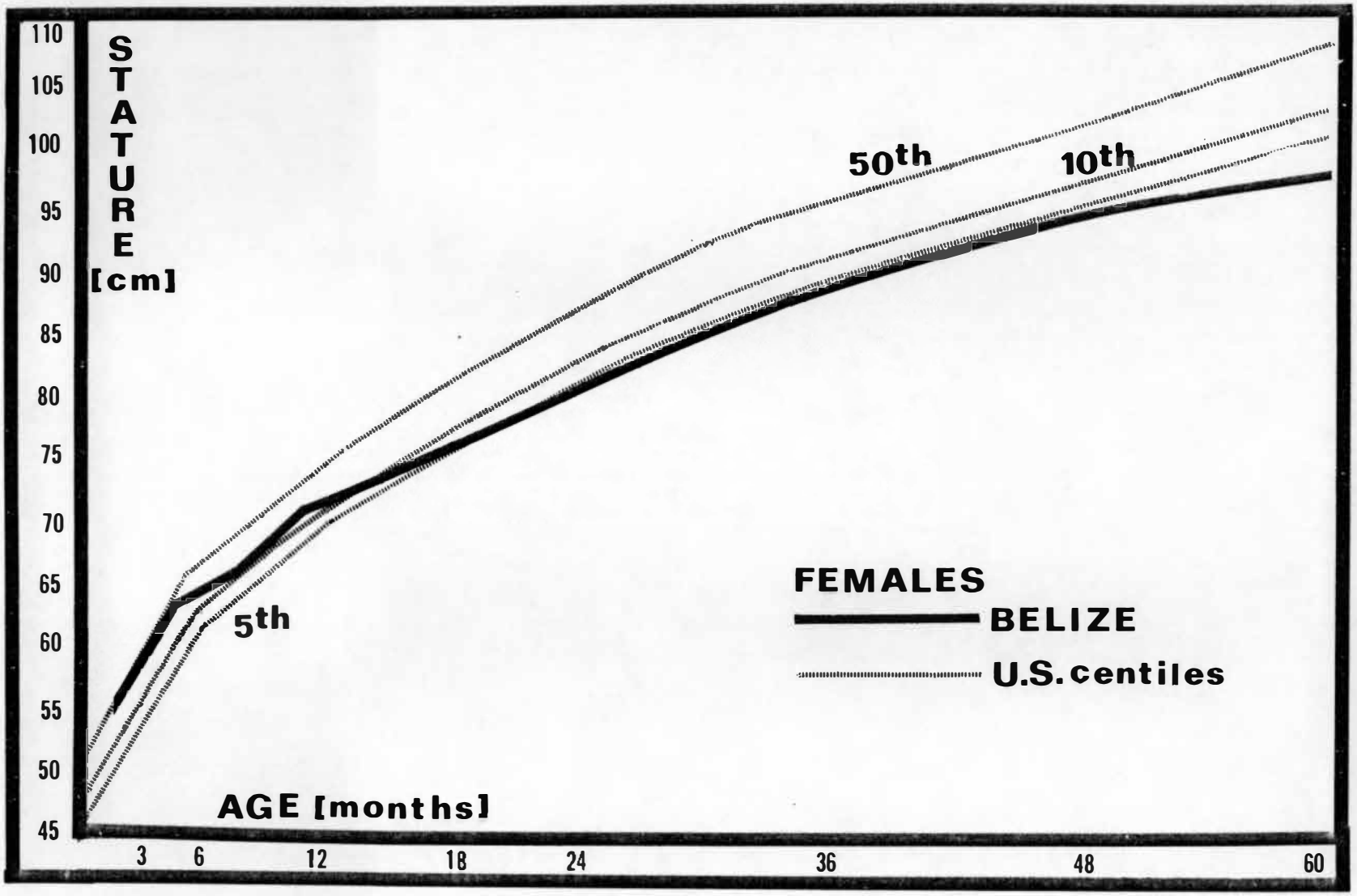

Figure 7. Stature by Age in Females, Birth Through 5 Years.

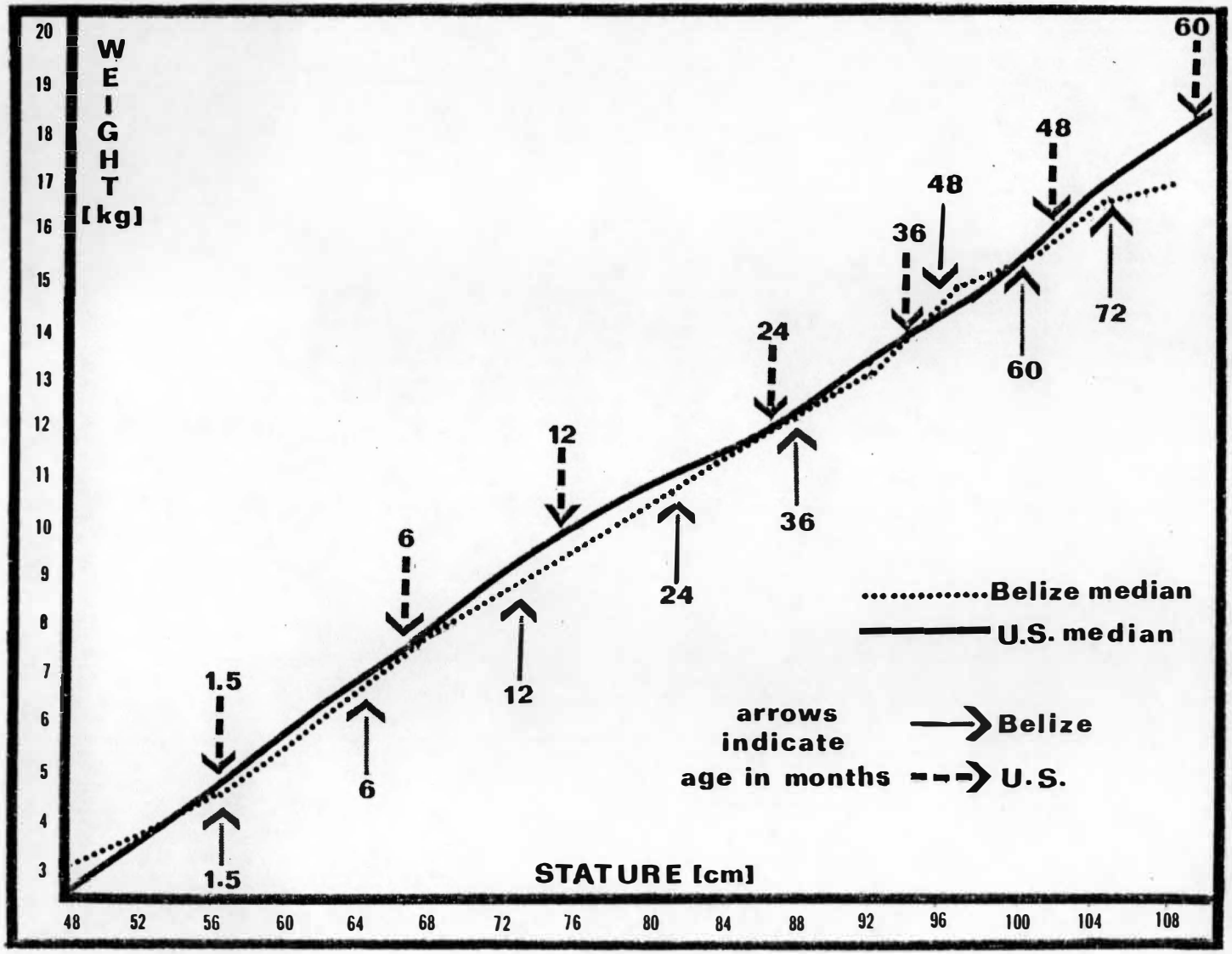

Figure 8. Weight by Stature, Sexes Combined, Belize and U.S. Compared.

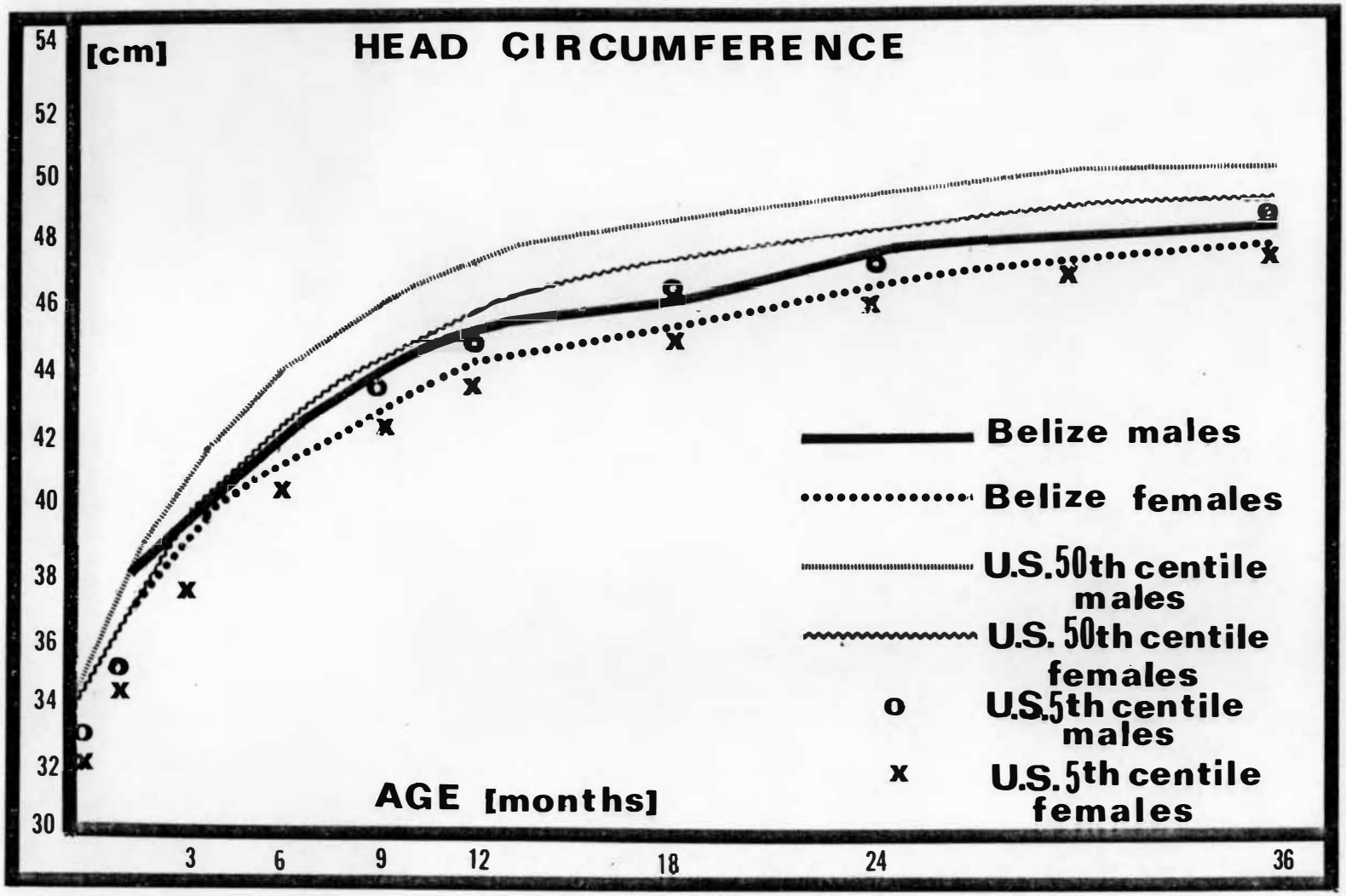

Figure 9. Head Circumference by Sex, Birth to 36 Months, Belize and U.S. Compared.

in females. Both sexes remain at the 5th centile throughout early childhood.

Figure 10 compares median arm circumference and triceps skinfold values with those of a sample of white children from the Ten-State Nutrition Survey (Frisancho 1974). Belizean values for arm circumference are above those of the U.S. for the first year, then approximate the 25th centile until the age of 48 months, when values begin to drop closer to the 15th centile. Triceps skinfolds are also thicker during the first year among Belizean children. By the age of 24 months both sexes exhibit median values precisely comparable to those of median U.S. males. After 48 months, Belizean males drop to approximately the U.S. 25th centile values, while females remain at expected values. Arm muscle circumference and arm muscle area values are nearly the same for both sexes up to 36 months of age, approximating the U.S. 25th centile. After 36 months, however, females show little gain in muscle until 48 months, while males exhibit the opposite pattern, i.e., males gain muscle between ages 36 and 48 months, then lose between ages 48 and 60 months.

Ethnic differences in growth patterns are often attributed to genetic influences. Figures 11-14 compare all measurements for the two Belizean ethnic groups of African ancestry, i.e., the Creole and the Garifuna, with other children of African ancestry in both Africa and the Americas (Antrobus 1971; Eveleth and Tanner 1976). Figures 15-17 compare weight, stature and triceps skinfold values in Mestizo and Maya children to other Mestizo (or Ladino) and Amerindian populations in the American tropics (Eveleth and Tanner 1976).

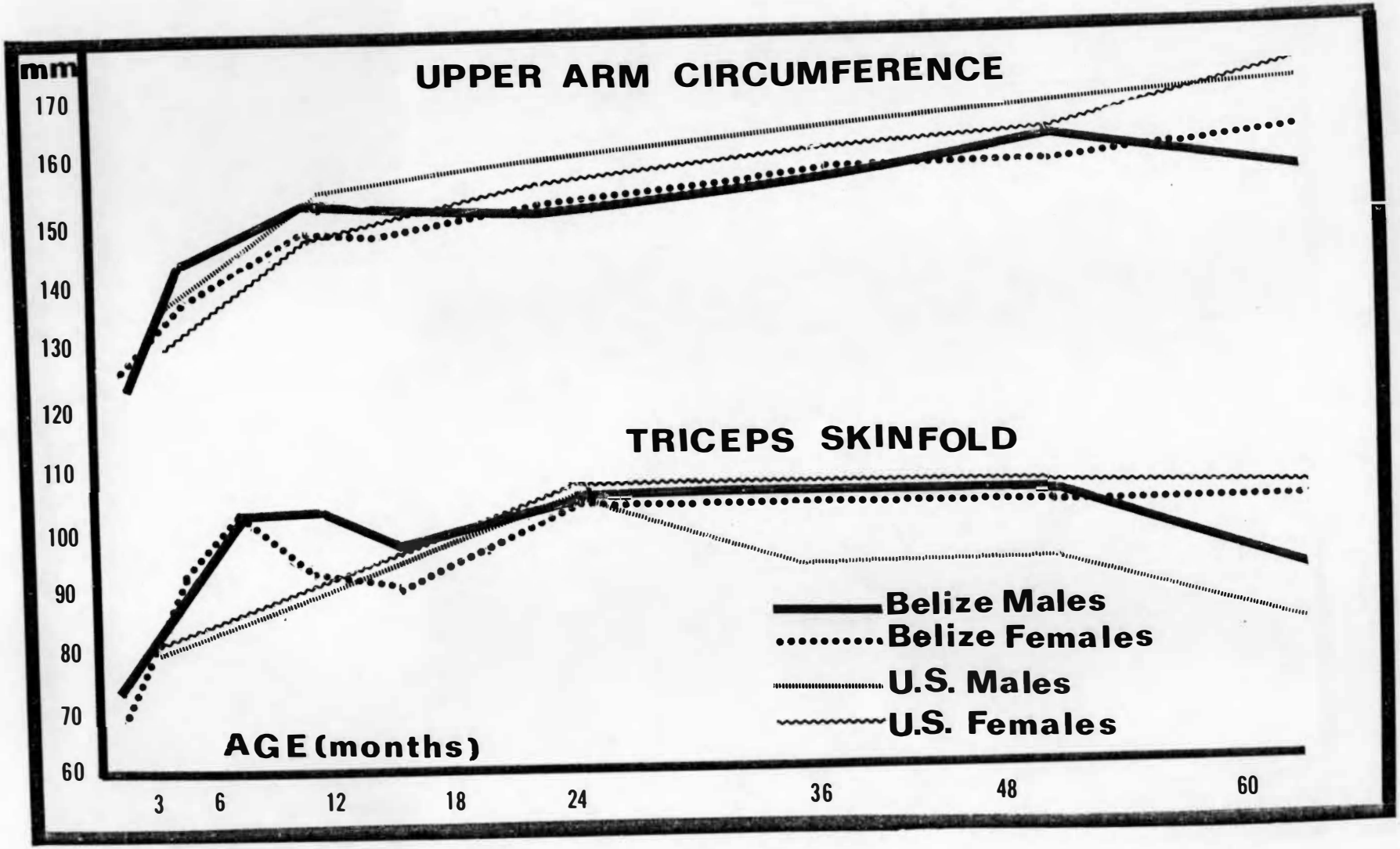

Figure 10. Upper Arm Circumference and Triceps Skinfold by Sex, Belize and U.S. Compared.

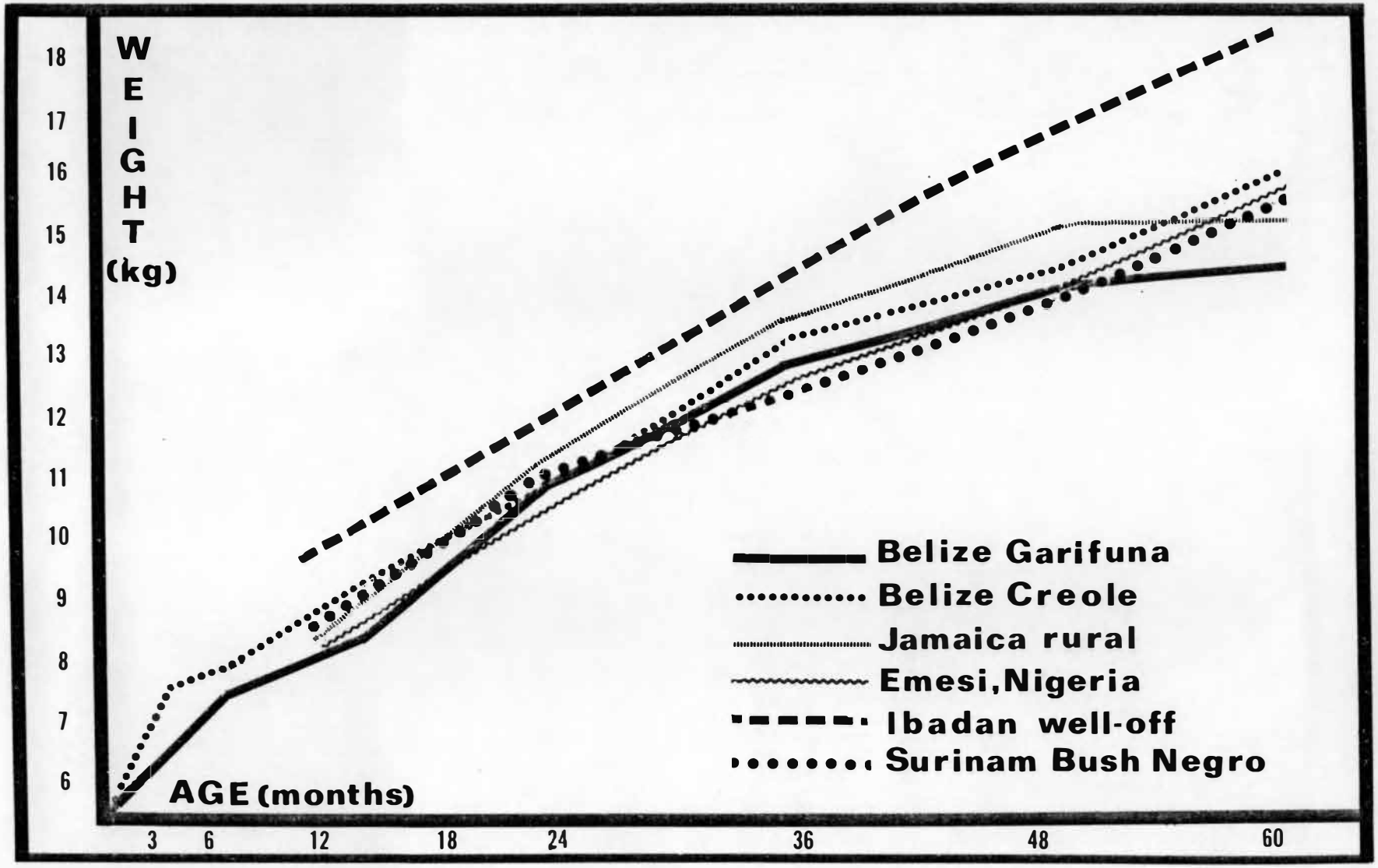

Figure 11. Weight by Age, Children of African Ancestry Compared.

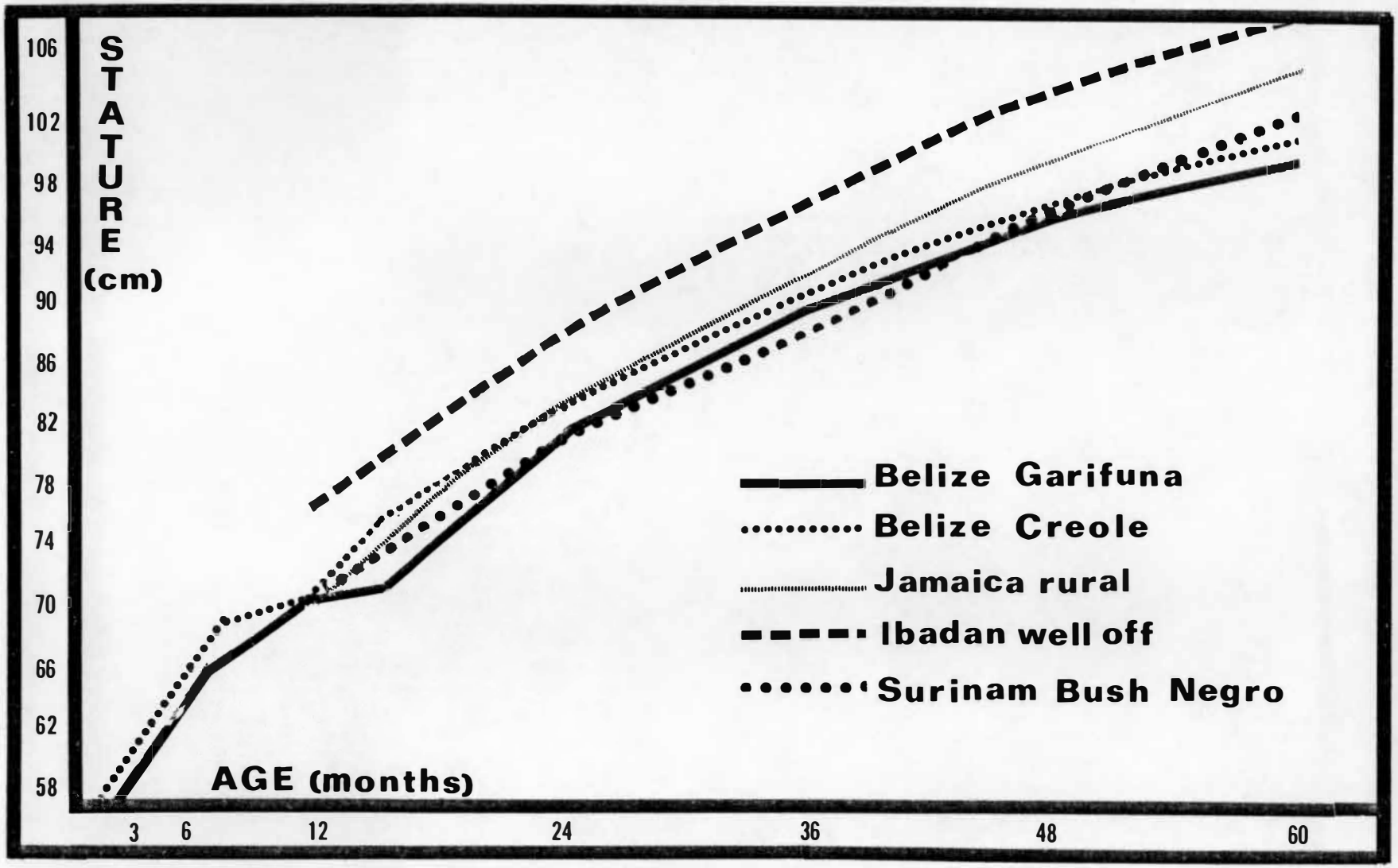

Figure 12. Stature by Age, Children of African Ancestry Compared.

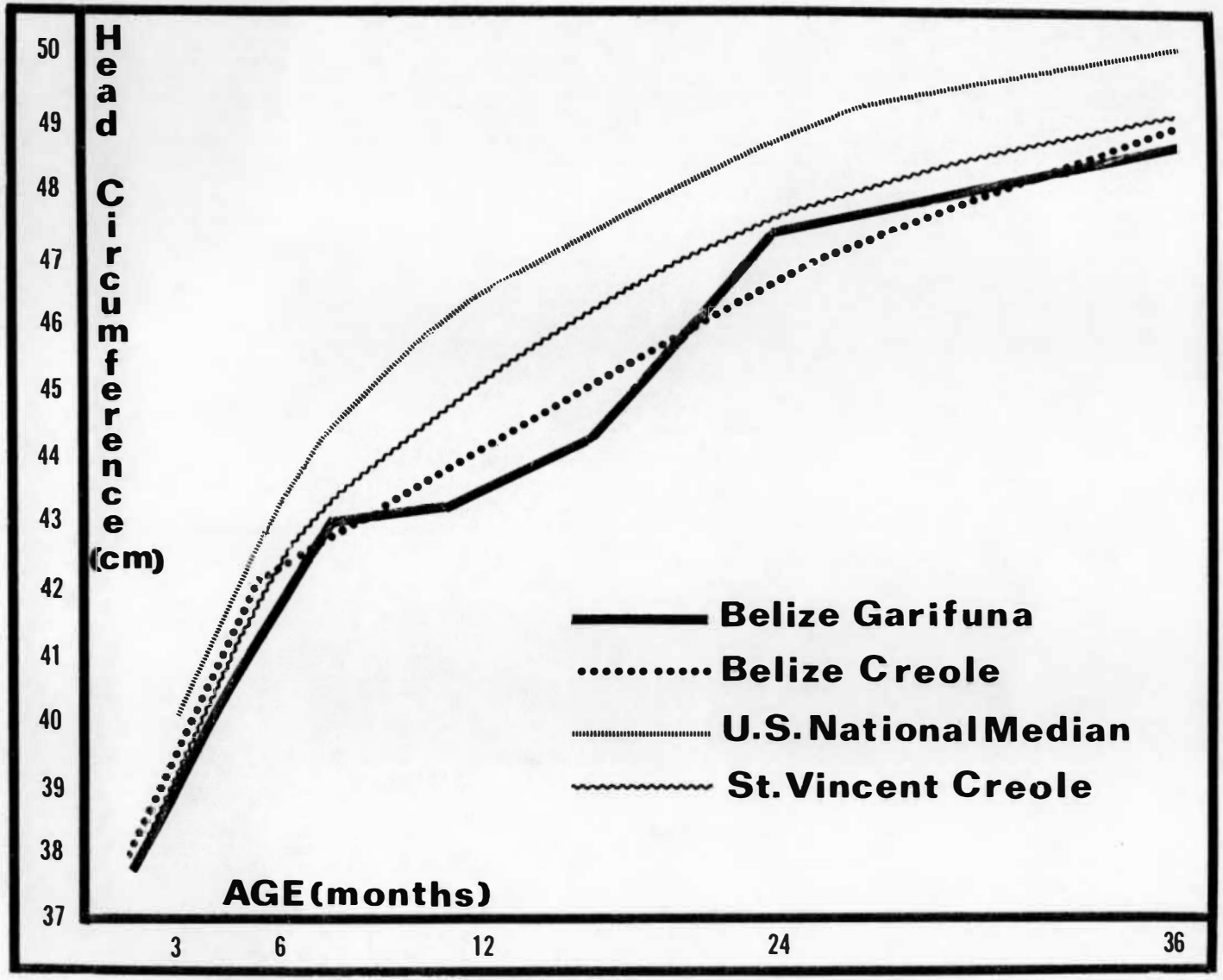

Figure 13. Head Circumference, Afro-Caribbeans and U.S. Compared.

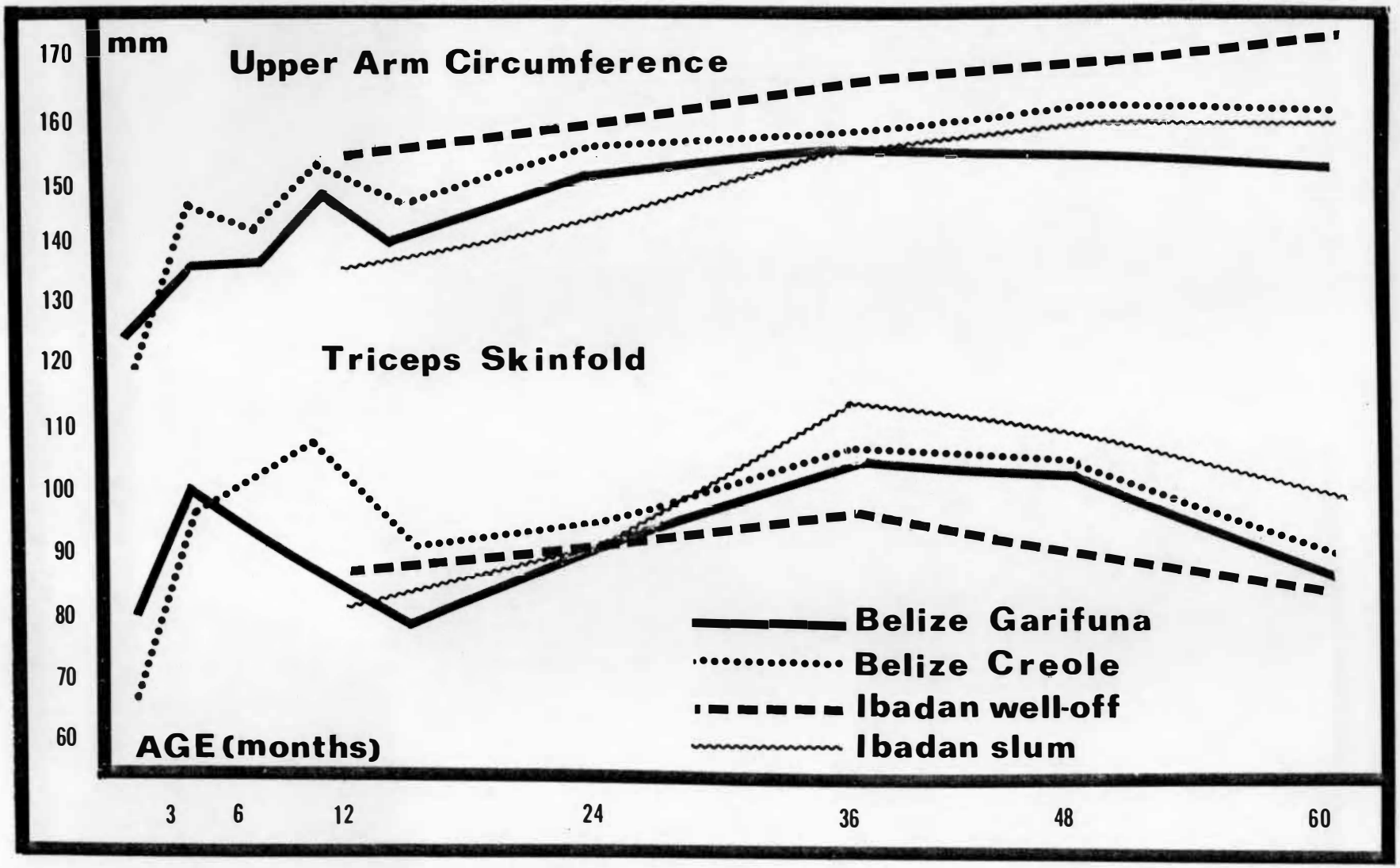

Figure 14. Upper Arm Circumference and Triceps Skinfold, Afro-Belizeans and Africans Compared.

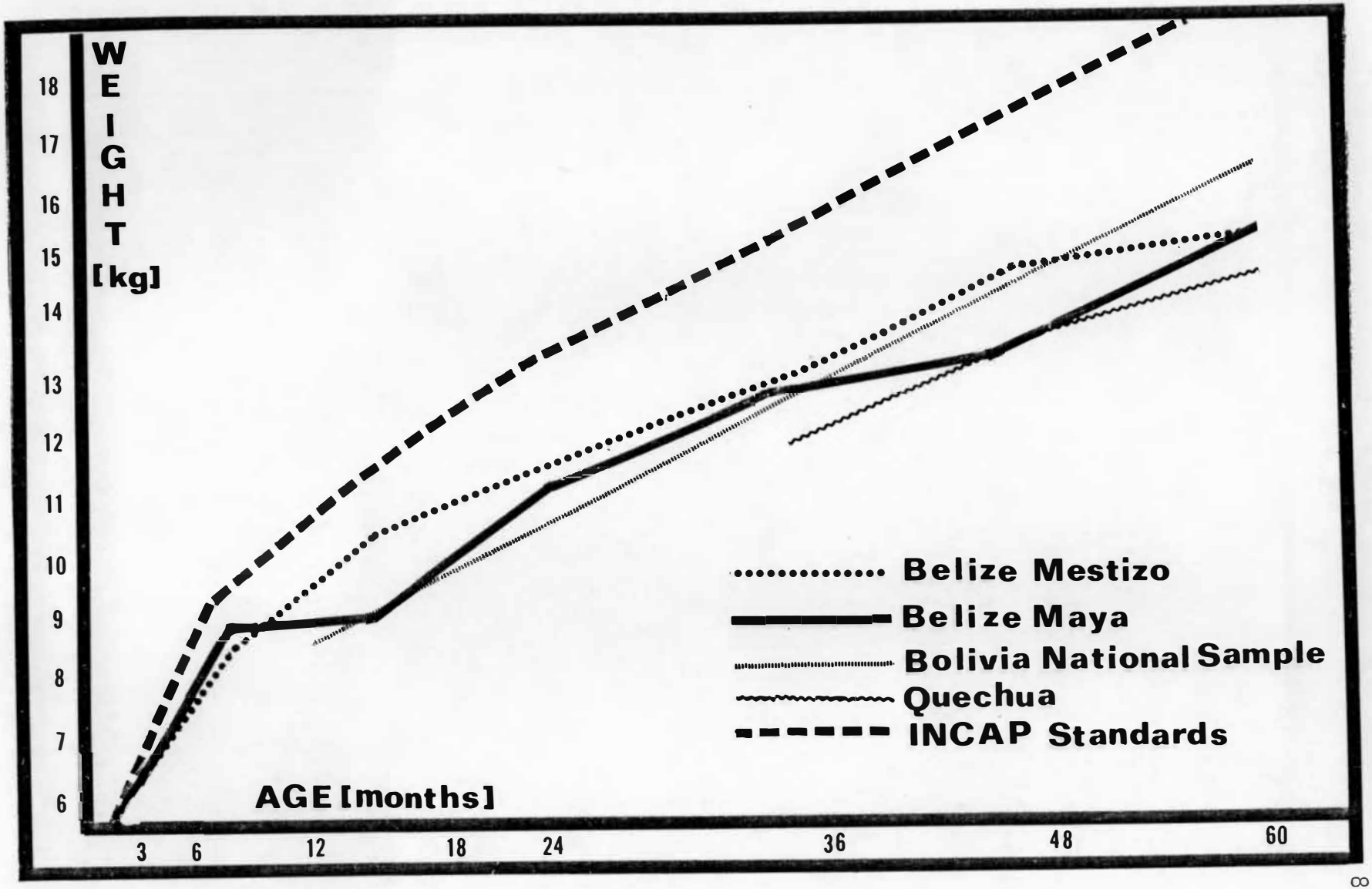

Figure 15. Weight by Age, Mestizo and Amerindian Samples Compared.

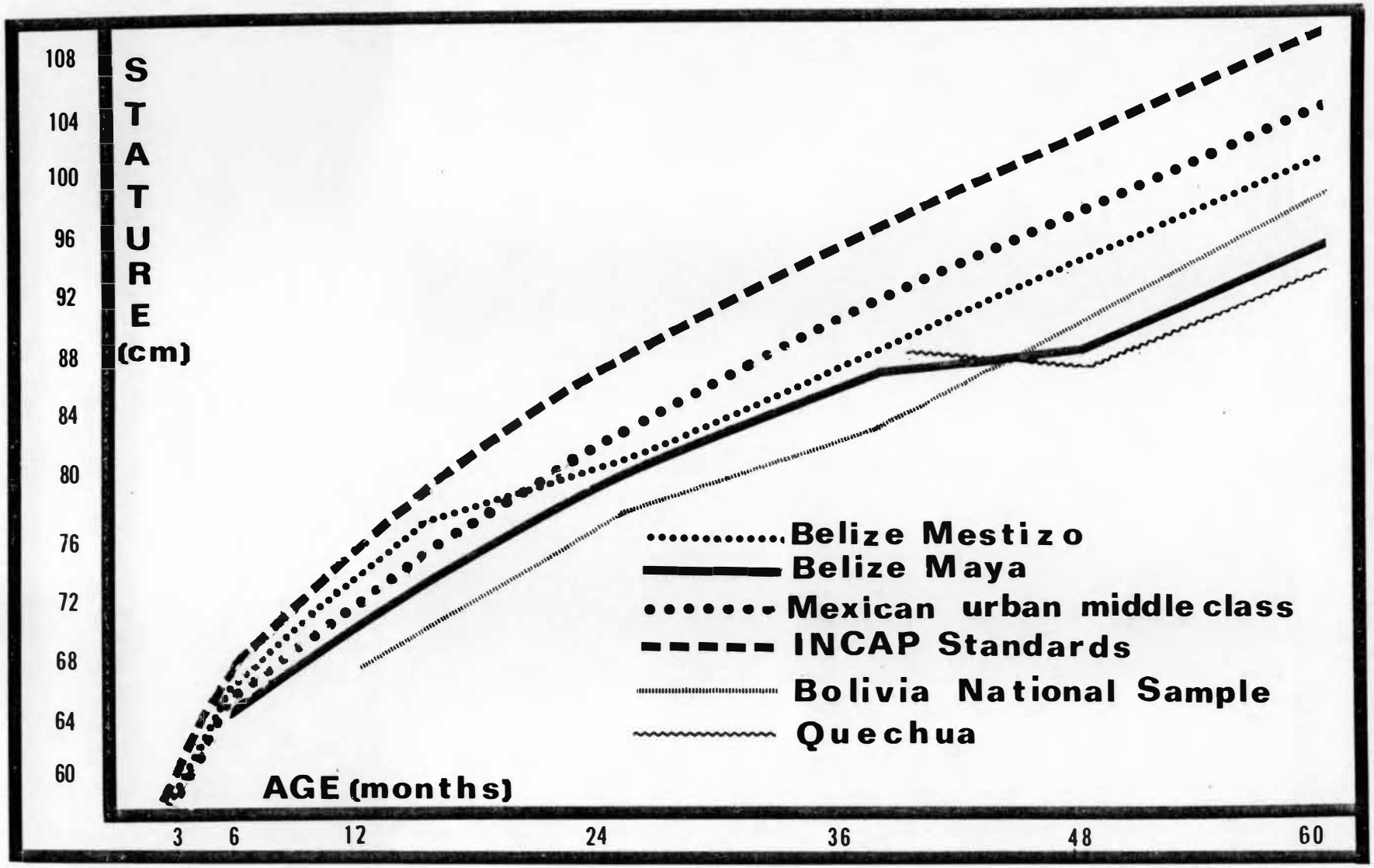

Figure 16. Stature by Age, Mestizo and Amerindian Samples Compared.

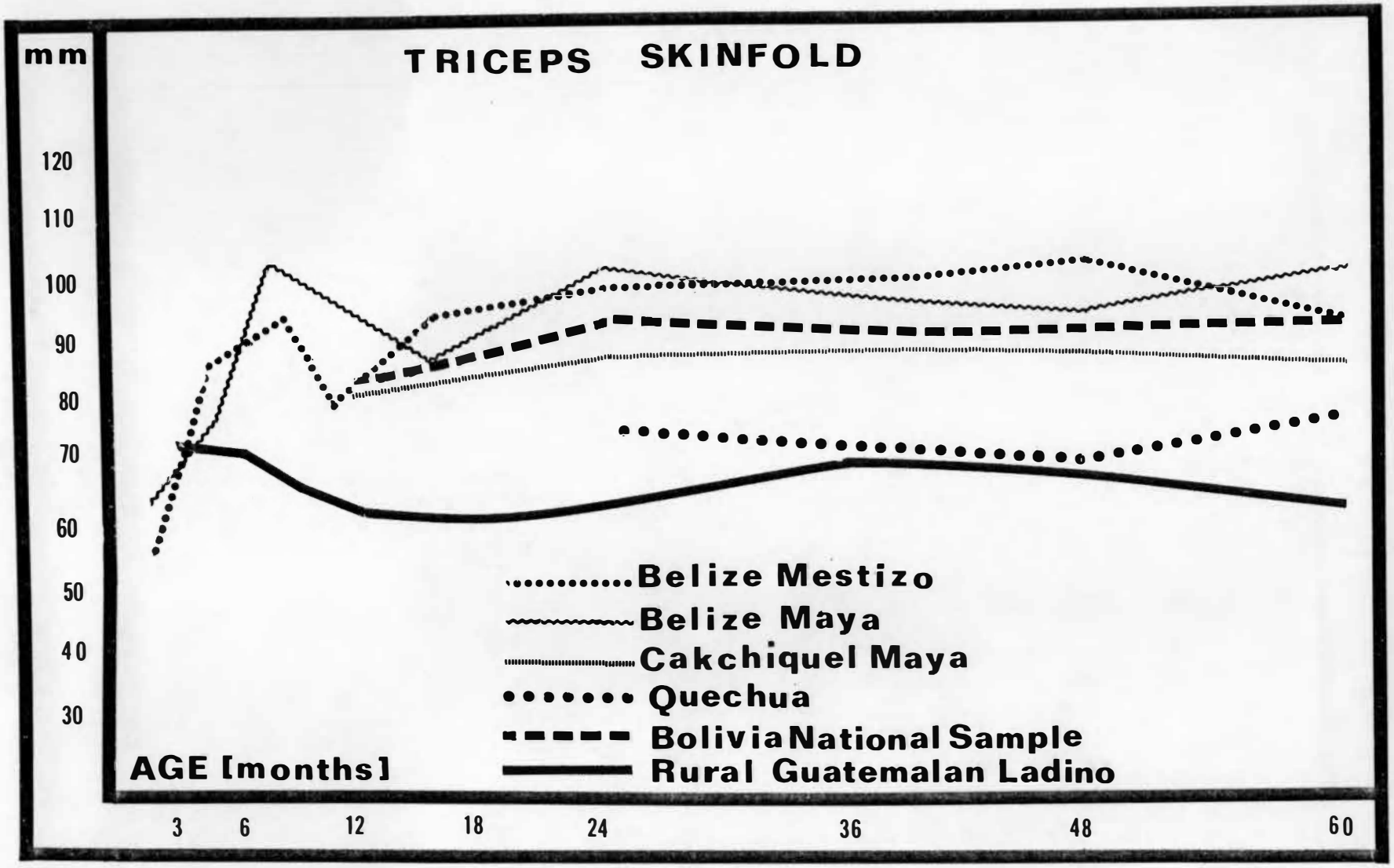

Figure 17. Triceps Skinfold, Mestizo and Amerindian Samples Compared.

It is apparent that the relatively low position of Belizean children compared to others of similar genetic backgrounds cannot be fully explained by factors of inheritance (cf. Habicht et al. 1974). The reader may examine internal comparisons of Belizean ethnic groups in the Appendix, Figures 25-29.

Indices of PEM

In the analysis which follows, each child is examined individually and compared to the established limits for several indices of malnutrition as explained in Chapter II.

Gomez Scale. Despite the shortcomings of the Gomez classification of malnutrition based on weight-for-age (see Chapter II), children in this sample are classified according to the Gomez Scale in order to compare the findings of this study with those of the Belizean Medical Department. Corrections for edema are not made in either case. In this sample, percentages of children in each grade are as follows: Grade I--36% (N=266); Grade II--14.1% (N=104); Grade III--2% (N=15). These results are slightly different from those of the Medical Department for the year 1976-77, with 40%, 18%, and 1.2%, respectively (McIntosh 1980), and may reflect differences in sample size and location. Government statistics are drawn from all six districts, but the present sample is drawn from Stann Creek and Cayo districts only. Although there are more males than expected in Grades II and III, sex differences are not significant at the .05 level.

Figure 18 presents the percentages of children in each ethnic group by Gomez grades. Differences among the four ethnic groups

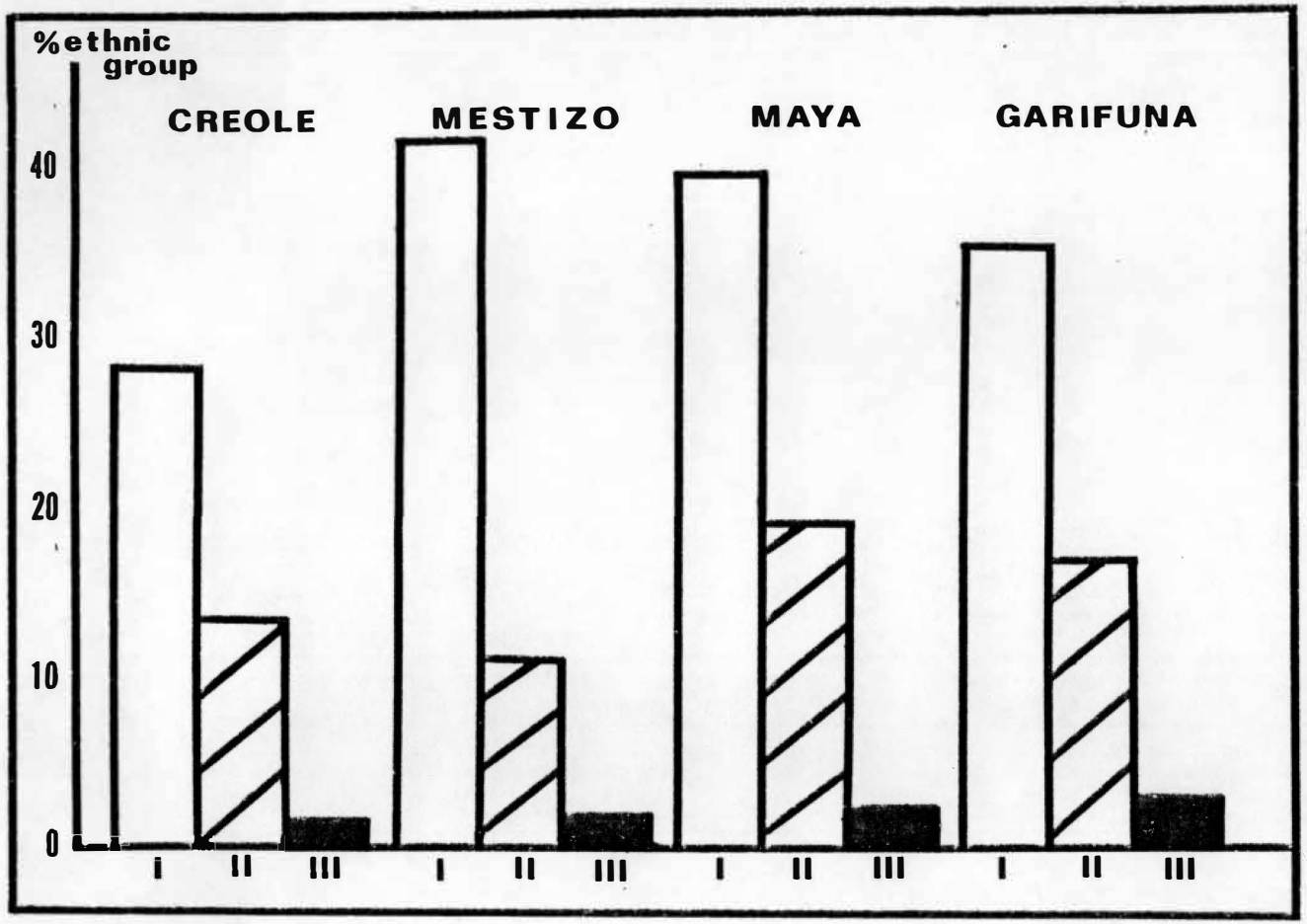

Figure 18. Gomez Grades by Ethnic Group. I = Mild Malnutrition, II = Moderate Malnutrition, III = Severe Malnutrition.

compared to normals are significant (Chi Square = 18.64, df = 6, P < .005), with the Creole having the fewest children in any of the three grades. Maya and Garifuna have the highest rates of Grade II, or moderate malnutrition, and the Mestizo has the highest rate of Grade I, or mild malnutrition. No significant ethnic differences exist among children in Grade III, or severe malnutrition.

The percentages of children in each Gomez grade increase with age. This trend is highly significant (Chi Square = 59.02, df = 8, P = .001). Table 13 presents the distribution of Gomez grades by age. With the exception of the age 2.5 to 3.5 years, greater evidence of malnutrition is seen with increasing age. Considering only Grade III or severe malnutrition, this pattern by age runs counter to that of the rest of Central America and bears greater similarity to that observed in Africa (DeMaeyer 1976).

Table 13. Distribution of Gomez Grades by Age, Number and Percent of Age at Risk.

Age in Years	Grade I (90-75% Expected Weight-for-Age)		Grade II (75-60% Expected Weight-for-Age)		Grade III (< 60% Expected Weight-for-Age)	
	N	%	N	%	N	%
0-.5 (N=120)	28	23	6	5	1	0.8
.5-1 (N-110)	28	25	11	10	2	1.8
1-2.5 (N-248)	88	36	42	17	6	2.4
2.5-3.5 (N=129)	56	43	16	13	1	0.8
3.5-5.5 (N=164)	71	43	29	18	5	3.0

Chi Square = 59.02, df = 8, P = .0001

Arm circumference. An upper arm circumference limit set at 13.5 cm yields an estimate of the prevalence of severe or acute malnutrition. Of the children over 6 months old (N=622), those with arm circumferences less than 13.5 cm represent 8.8% (N=55) of the sample. Correspondence with inclusion within the 3 Gomez grades is very high, since only 1 child with an arm circumference below 13.5 cm had a weight above 90% of expected.

Differences in frequencies of low arm circumference are not significant by sex, but ethnic differences are significant (Chi Square = 8.78, $P < .05$). Ranking by ethnic group from least to greatest frequency of low arm circumference yields the following order: Creole, Mestizo, Maya, and Garifuna, as shown in Figure 19.

Age differences in arm circumference either above or below 13.5 cm among children over 6 months old are highly significant ($P < .005$), but in a direction different from the age trend in weight. While weight deficits generally increase with age, low arm circumferences decrease with age. This distribution indicates that, after 1.5 years of age, the prevalence of severe or acute PEM appears to decrease. Table 14 shows the age and ethnic distribution of children with arm circumferences below 13.5 cm.

Obesity. Obese children, those with weight-for-height values at or above 120% of expected, comprise 3.1% (N=23) of the sample (N=746). Females are obese far more often than males, with only 2 obese males to 21 obese females. This difference is highly significant (Chi Square = 15.47, $P < .001$). No significant differences occur among the obese by age or by ethnic group.

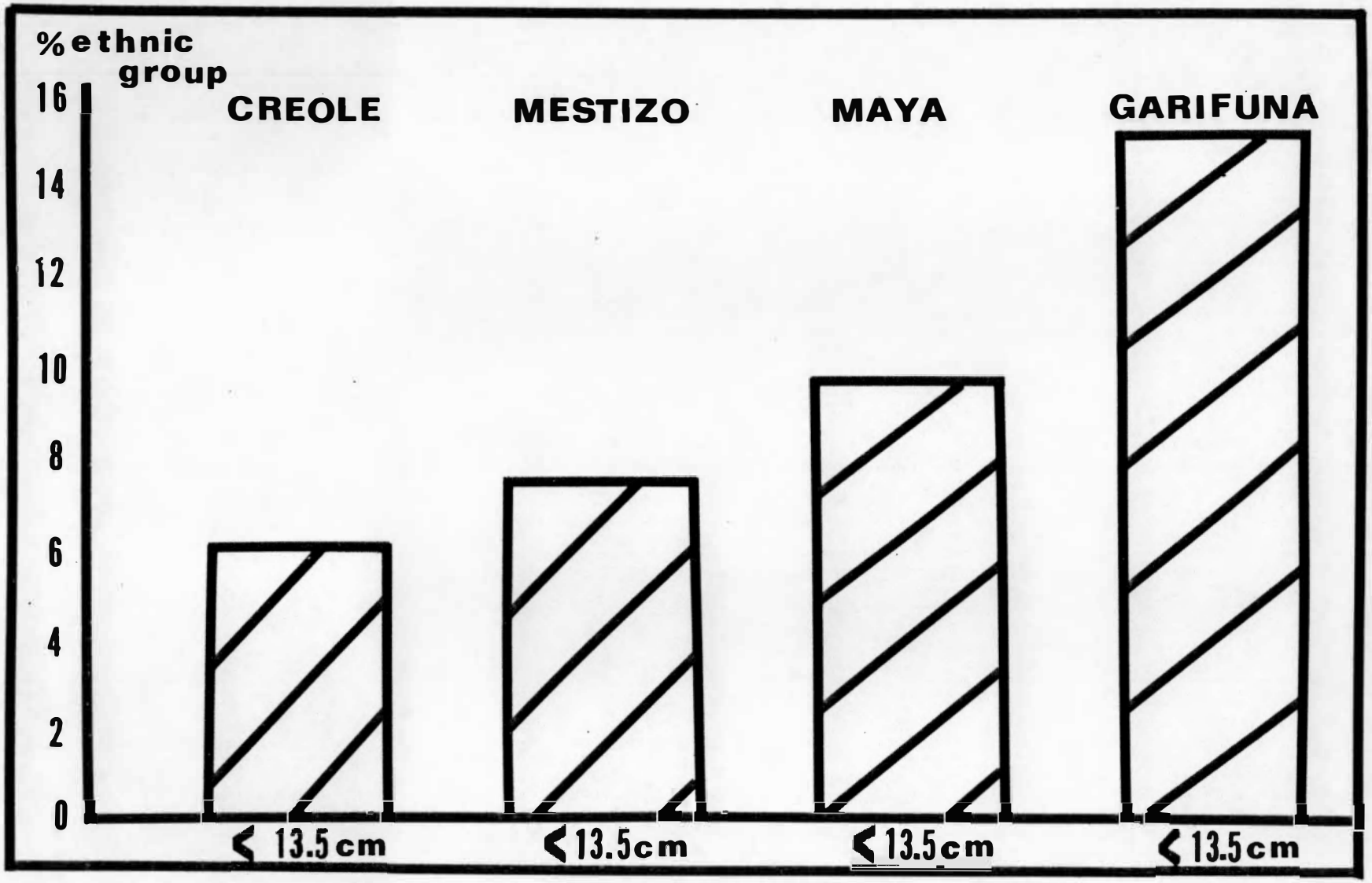

Figure 19. Low Arm Circumference by Ethnic Group Among Children over 6 Months Old.

Table 14. Age and Ethnic Distribution of Low Arm Circumferences (Less Than 13.5 cm) Among Children over 6 Months Old.

Age in Years	Low Arm Circumference N	Low Arm Circumference % Age at Risk	Ethnicity	Low Arm Circumference N	Low Arm Circumference % Ethnic Group
.5-1 (N=105)	16	15.2	Mestizo (N=133)	10	7.5
1-2.5 (N=233)	27	11.6	Maya (N=123)	12	9.8
2.5-3.5 (N=126)	7	5.6	Creole (N=166)	10	6.0
3.5-5.5 (N=158)	5	3.2	Garifuna (N=150)	23	15.3
Chi Square = 15.49, df = 3, P < .005			Chi Square = 8.78, df = 3, P < .05		

Stunting and wasting. Children classified as stunted (less than 90% expected height-for-age) or as wasted (less than 80% expected weight-for-height) are distributed throughout the population in somewhat different patterns than those classified as malnourished by weight-for-age or by arm circumference. Table 15 reports the percentages of children, by sex, classified as stunted in the total sample.

Table 15. Frequency of Stunting Among Preschoolers by Sex.

Sex	Stunting N	Stunting %
Male (N=364)	95	26.1
Female (N=378)	87	23.0
Combined (N=742)	182	24.5
Chi Square = 1.08, n.s.		

Sex differences are not significant, but age and ethnic distributions exhibit significant patterns. Table 16 presents the distributions of stunted children by age and ethnic group.

Approximately 26% of the children in the total sample show evidence of long-term, chronic undernutrition. Since linear growth reflects the cumulative effect of poor nutritional status over time, stunting clearly increases with age ($P < .001$). It is also possible, as several authors have suggested (Garrow and Pike 1967; Frisancho et al. 1970) that children whose inherited rate of growth is more rapid are subject to greater morbidity and mortality in nutritionally stressful environments. If this is the case, then a cross-sectional sample of preschoolers would reflect a bias toward slower growing children, and hence, shorter children at any age.

Creole and Garifuna children, both groups of predominantly African ancestry (Lees and Byard 1978), exhibit less stunting than either the Maya or the Mestizo ($P < .001$). While it has been suggested that ethnic differences in children's stature reflect evolutionary adaptations to different nutritional stresses in the past (Ashcroft et al. 1966; Walker 1967; Garn et al. 1974), increasing evidence indicates that, in most environments, reduction in body size is a developmental response to nutritional conditions in the present (Stini 1972, 1975; Habicht et al. 1974; Newman 1975; Nickens 1976). It is difficult to ignore that the Maya are the aboriginal inhabitants of Belize and have, therefore, had a longer opportunity for adaptation through natural selection than Belize's other ethnic groups. Accumulating evidence suggests that, in general, nutritional stresses have increased through time in Mesoamerica

Table 16. Age and Ethnic Distribution of Children Classified as Stunted (Less Than 90% Expected Height-for-Age).

Age in Years	Stunted N	Stunted % Age at Risk	Ethnicity	Stunted N	Stunted % Ethnic Group
0-.5 (N=116)	6	5.2	Mestizo (N=227)	63	27.8
.5-1 (N=107)	11	10.3	Maya (N=142)	55	38.7
1-2.5 (N=233)	65	27.9	Creole (N=193)	33	17.1
2.5-3.5 (N=127)	46	36.2	Garifuna (N=182)	32	17.6
3.5-4.5 (N=105)	32	30.5			
4.5-5.5 (N=54)	22	40.7			
Chi Square = 55.18, df=5, P < .001			Chi Square = 27.3, df=4, P < .001		

(Nickens 1976). Working with the skeletal remains from Altar de Sacrificios in the Peten, Guatemala, Saul has stated that "Regardless of the formulae used and permutations upon them, the most striking features of the data presented are the decline in male stature over time at Altar itself and the tallness of both the male and female Altarians as compared with modern Maya" (1972:29). The secular decline in adult stature in the Yucatan is likely to involve the interactions of diet, climate, disease, and natural selection. Nonetheless, similarity in optimal growth among preschoolers in a wide variety of ethnic groups indicates that there has been little selection for differential growth during this age period (Habicht et al. 1974). It is, perhaps, of greater pertinence to note that higher social status at Tikal (associated with burial in tombs) is associated with taller adults (Haviland 1967), indicating that stature, then as now, has an important socio-economic component.

Wasting, defined as less than 80% of expected weight-for-height, is a far less common finding in Belize than is stunting. Table 17 reports the percentages of children classified as wasted, by sex. In Figure 20 bar graphs represent the percentages of children in each ethnic group classified as either stunted or wasted.

Approximately 2.5% of the total sample shows evidence of wasting. This figure corresponds closely to the estimated 2% prevalence of severe malnutrition based on Gomez Grade III frequencies in this clinic population. Sex differences in wasting are not significant, as may be seen in Table 17. Comparing all children under 2.5 years of age with older children reveals significant differences in wasting by age at the

Table 17. Frequency of Wasting (Less Than 80% Expected Weight-for-Height) Among Preschoolers by Sex, Age, and Ethnic Group.

Sex	Wasting N	Wasting %	Age (Years)	Wasting N	Wasting %	Ethnicity	Wasting N	Wasting %
Male (N=358)	9	2.5	0-.5 (N=117)	2	1.7	Mestizo (N=227)	6	2.6
Female (N=372)	9	2.4	.5-1 (N=104)	4	3.8	Maya (N=142)	2	1.4
Total (N=730)	18	2.46	1-2.5 (N=231)	8	3.5	Creole (N=184)	5	2.7
			2.5-3.5 (N-124)	1	0.8	Garifuna (N=181)	5	2.8
			3.5-4.5 (N-102)	1	1.0			
			4.5-5.5 (N=53)	2	3.8			
Chi Square = .05, df=1, n.s.			Chi Square = 3.61, df=1, P = > .05 < .1			Chi Square = .60, df=3, n.s.		

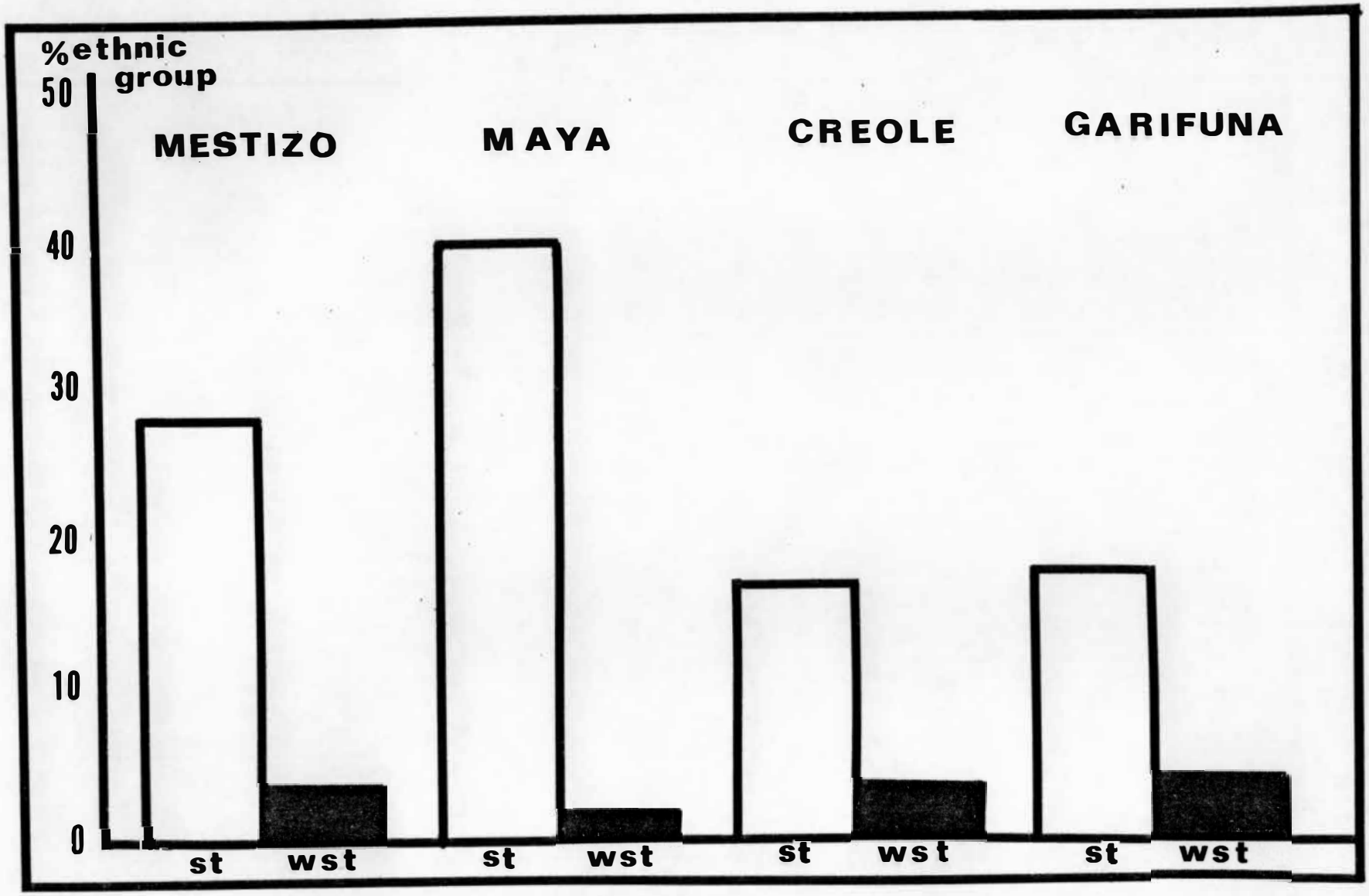

Figure 20. Stunted and Wasted by Ethnic Group.

.1 level of probability, with younger children exhibiting more frequent wasting. Ethnic differences are not significant, even though the Maya appear to have a lower frequency of wasting than the other ethnic groups.

Duration of malnutrition. Combining weight-for-age, stature-for-age, and weight-for-stature may offer a method of measuring variation in the currency and duration of poor nutritional status (see Chapter II). Figure 21 presents the percentages of children in each ethnic group classified into three types of malnutrition, according to duration, i.e., past chronic malnutrition or nutritional dwarfing, current malnutrition of short duration, and current malnutrition of long duration. Of a total of 746 children, for whom both weight and height (or length) were recorded, 20.9%, or 156, are classified as nutritional dwarfs. Neither sex is significantly over- or under-represented and, as would be expected, the frequency of dwarfing increases with age ($P < .001$).

Table 18 presents the percentages of children with chronic, long-term malnutrition by age at risk and by ethnic group.

There are several differences between the measure of stunting and the measure of past chronic malnutrition, or dwarfing. Since stunting is based on height-for-age alone, the relationship between linear growth and growth in mass is undetected. In other words, some of the children considered stunted may be proportionately reduced in size, relative to standards, and may be in current good health. These include the children classified as nutritional dwarfs. It is noteworthy that Maya children have the highest rates of both stunting and dwarfing. The major

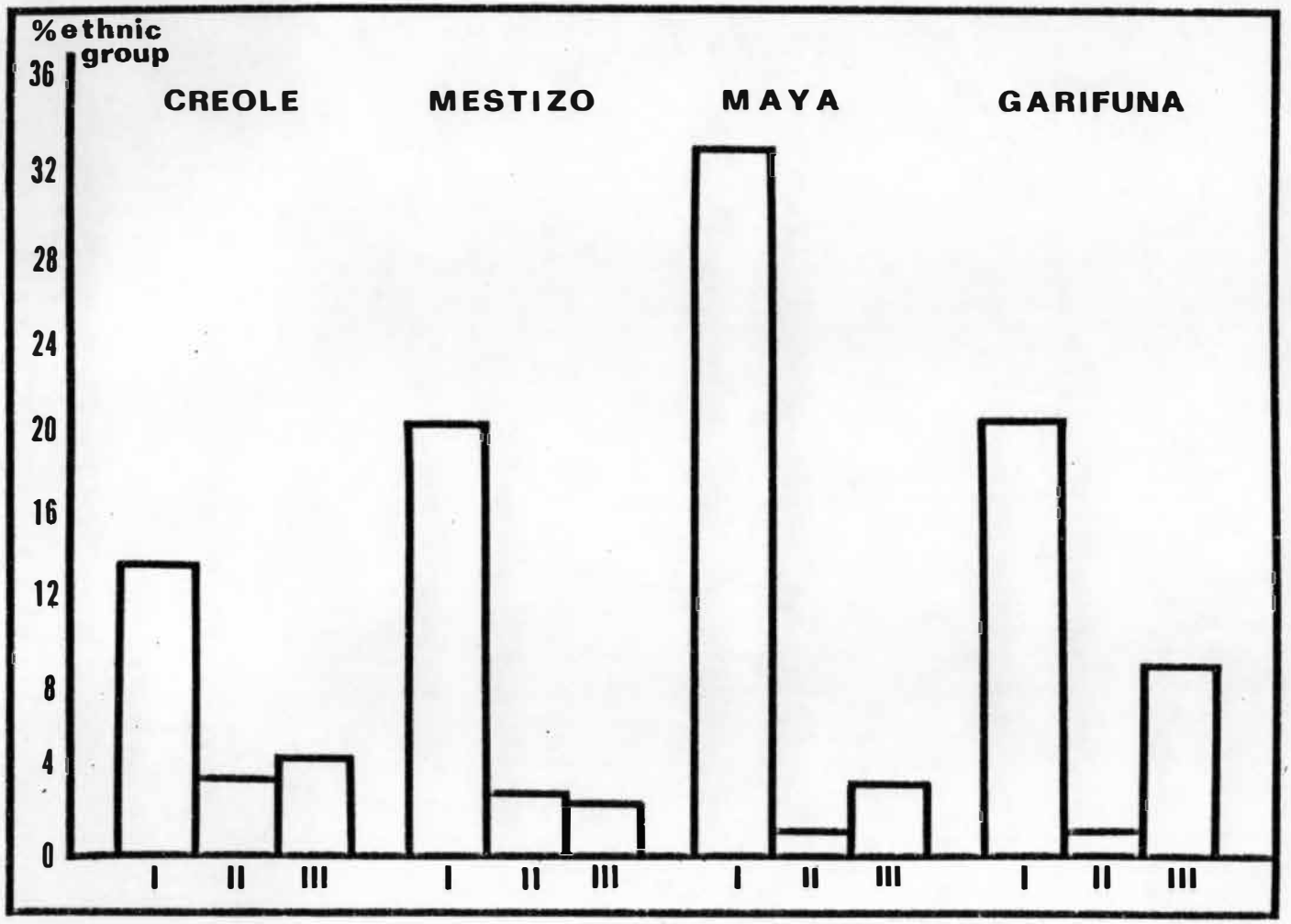

Figure 21. Duration of Malnutrition by Ethnic Group. I = Past Chronic, II = Current Short-Term, III = Current Long-Term.

Table 18. Children with Past Chronic Malnutrition or Nutritional Dwarfing, Percentages by Age at Risk and by Ethnic Group.

	Past Chronic Malnutrition				
Age in Years	N	% Age at Risk	Ethnicity	N	% Ethnic Group
0-1 (N=224)	18	8.0	Creole (N=188)	25	13.3
1-2.5 (N=236)	58	24.6	Mestizo (N=232)	47	20.3
2.5-3.5 (N=128)	29	22.7	Garifuna (N=181)	37	20.4
3.5-5.5 (N=158)	51	32.3	Maya (N=145)	47	32.4
Chi Square = 36.95, df=3, P < .001			Chi Square = 24.37, df=3, P < .001		

difference in the ethnic patterns of the two measures is that Garifuna children appear to show greater dwarfing than stunting, i.e., of the Garifuna children with low statures, most have proportionately reduced weights. Mestizo and Garifuna children, who are relatively distant genetically, show closely similar rates of dwarfing.

Children classified as having current malnutrition of short duration comprise 2.4% (N=18) of the total sample. No significant differences are observable by sex or ethnic group. Children under 1 year old are less likely to show evidence of short-term, current, poor nutritional status than are older children (Chi Square = 9.49, df=3, P < .02). Table 19 presents the distribution by age and ethnic group of children with current short-term malnutrition.

The third pattern, that of current malnutrition of long duration is defined by low values for stature, weight, and weight-for-stature. These children comprise 4.6% (N=34) of the sample. This is the only

Table 19. Children with Current Short-Term Malnutrition, Percentages by Age at Risk and by Ethnic Group.

	Current Short-Term Malnutrition				
Age in Years	N	% Age at Risk	Ethnicity	N	% Ethnic Group
0-1 (N=224)	3	1.3	Garifuna (N=181)	2	1.1
1-2.5 (N=236)	4	1.7	Maya (N=145)	2	1.4
2.5-3.5 (N=128)	3	2.3	Mestizo (N=232)	7	3.0
3.5-5.5 (N=158)	8	5.1	Creole (N=188)	7	3.7
Chi Square = 9.49, df=3, P < .02			Chi Square = 3.85, df=3, n.s.		

nutritional status, in addition to obesity, in which sex is a significant factor. Whereas, females greatly outnumber males among the obese children, males greatly outnumber females among the chronically and currently malnourished children. There are 23 males and only 11 females classified as having on-going malnutrition; this difference is statistically significant (Chi Square = 4.98, df=1, P < .05).

Table 20 presents the percentages of children by age and ethnic group exhibiting evidence of current malnutrition of long duration.

Poor and Better-Than-Average Growth Classes

The patterns of malnutrition discussed in the preceding sections of this chapter may be combined in a manner which yields a composite measure of nutritional status. Children with at least two out of three values below the U.S. 5th centile for height-for-age, weight-for-age, and weight-for-height are placed in a category labelled "poor growth."

Table 20. Children with Current Malnutrition of Long Duration, Percentages by Age at Risk and by Ethnic Group.

Age in Years	Current Malnutrition of Long Duration N	% Age at Risk	Ethnicity	N	% Ethnic Group
0-1 (N=224)	4	1.8	Mestizo (N=232)	5	2.2
1-2.5 (N=236)	20	8.5	Maya (N=145)	5	3.4
2.5-3.5 (N=128)	5	3.9	Creole (N=188)	8	4.3
3.5-5.5 (N=158)	5	3.2	Garifuna (N=181)	16	8.8
Chi Square = 10.56, df=3, P < .02			Chi Square = 11.13, df=3, P < .02		

These poorly growing children are contrasted with another set of children living in the same environments whose growth equals or exceeds the U.S. 75th centile on at least two out of three of the same measures. This category is labelled "better-than-average growth" and is unlikely to include children with clinical signs of PEM.

The poor growth class includes 208 or 28% of the children, while 67 or 9% are classified as having better-than-average growth. Sex differences within each class are not significant. Differences by age are reported in Table 21. As age increases, fewer children are classified in the better-than-average group, and an increasingly larger proportion of children at risk in each age group exhibit poor growth. These differences are highly significant (P < .001).

Differences in composite nutritional status by ethnic group are presented in Figure 22. Viewed in this way, ethnic patterns become quite clear and demonstrate a rank order of nutritional status by

Table 21. Children in Poor and Better-Than-Average Growth Classes by Age Group.

Age in Years	% Age at Risk	Poor Growth N	Poor Growth %	% Age at Risk	Better-Than-Average Growth N	Better-Than-Average Growth %
0-.5	2.4	5	4.6	2.8	31	46.3
.5-1	9.6	20	17.1	10.3	12	17.9
1-2.5	40.0	83	35.1	19.4	13	5.5
2.5-5.5	48.1	100	35.0	16.4	11	3.8

Chi Square = 45, df=3, P < .001.

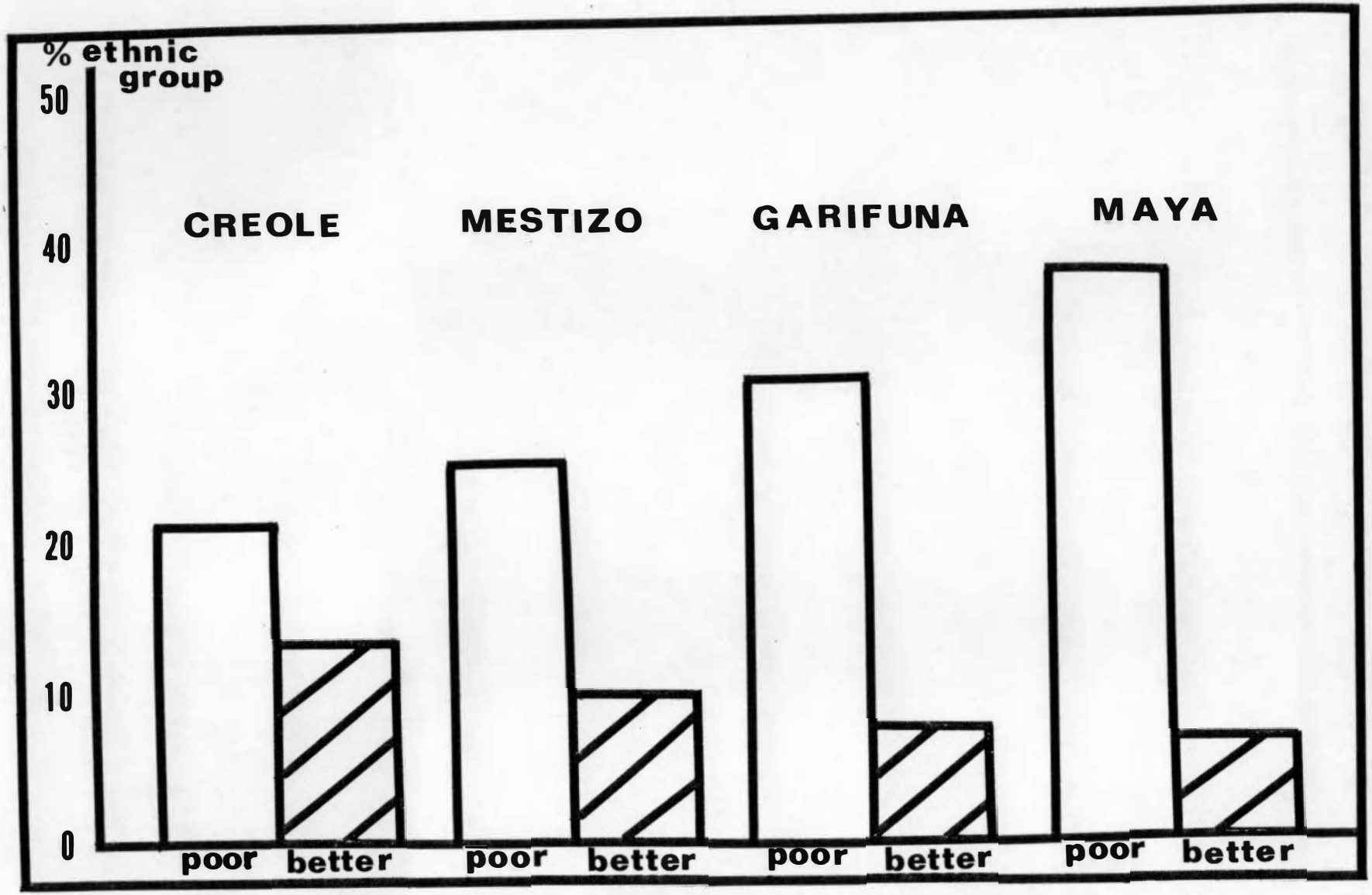

Figure 22. Poor and Better-Than-Average Growth by Ethnic Group.

ethnicity, with the Creole having the least malnutrition, followed by the Mestizo, the Garifuna, and lastly, the Maya. Both poor and better-than-average growth classes exhibit statistically significant ethnic patterns. Among poor growers compared to all others, ethnic differences are significant for all ages combined (Chi Square = 11.72, df=3, $P < .01$). Among the better-than-average growers, statistical significance is reached (Chi Square = 11.37, df-3, $P < .01$) only if children under 6 months old are omitted. This is consistent with the finding that, on average, Belizean children grow adequately on all measures up to about 6 months of age. An examination of those factors that significantly distinguish between poor and better-than-average growth classes will be presented in Chapter VI.

In this chapter several methods of assessing nutritional status are used and results presented. This series of measures indicates four major patterns. They are:

1) Among children from birth through 5.5 years of age, malnutrition increases in frequency with increasing age, especially after the first 6 months;

2) Creole children exhibit the least malnutrition in the two districts sampled;

3) Maya children exhibit the highest rates of retarded stature, indicating long-term, chronic undernutrition;

4) Both Mestizo and Garifuna children have similar rates of past, chronic malnutrition but the Garifuna are more likely to exhibit reduced weight-for-height as well as reduced height-for-age, indicating current, on-going episodes of nutritional stress.

CHAPTER VI

BIOCULTURAL FACTORS AND NUTRITIONAL STATUS

Results: Step-Wise Discriminant Function Analysis

Nine variables are compared for poor and better-than-average growing children using a step-wise discriminant function. These variables are the mother's age, the number of dead children (under 6 years old and excluding peri-natal deaths), the number of living children, the number of children residing in the household, the number of months breastfed, the age at introduction to semi-solids, the age at introduction to solid foods, and the severity and frequency of diarrhea. With an F to enter set at a probability of .01, only three variables meet significance levels. They are, in order of entry, the severity and frequency of diarrhea, the age at introduction to solid foods, and the number of children in the household. The jackknife classification method correctly classifies 70.8% of the children on the basis of these three factors, 68.1% of the poor growers and 76.9% of the better growers. With this method, however, it is difficult to discern which variables may be highly correlated or which, though rejected at a probability level of .01, may possess some significance. Therefore, a direct discriminant function analysis is performed and all factors entered (see Appendix, Table 32).

Results: Direct Discriminant Function Analysis

A summary of the results of the direct method is shown in Table 22. In this analysis several other factors emerge as significant.

Table 22. Summary of Direct Discriminant Function Analysis--Poor vs. Better Growth.[a]

Variable	Univariate F	Univariate Prob(F)	Poor Mean	Better Mean	Standardized Canonical Discriminant Function Coefficient
Child's age	39.34	0.0000	2.23	0.77	.5136
Number of months breastfed	10.95	0.0012	6.69	3.01	.4905
Age at introduction to solids	21.41	0.0000	1.82	0.80	.2674
Receiving no solids	17.82	0.0000	0.20	0.54	.0061
Receiving no semi-solids	21.41	0.0000	0.66	0.39	.3896
Skipped semi-solids	5.164	0.0245	0.36	0.17	.0139
Frequency and severity of diarrhea	21.43	0.0000	2.30	1.40	.2274
Mild colds	9.72	0.0022	0.68	0.92	.2388
Chronic colds	7.37	0.0075	0.20	0.02	.0684
Mild fevers	9.37	0.0026	0.65	0.90	.1284
Total living children	0.90	0.3439	3.97	3.51	.8224
Total resident children in household	1.14	0.2867	4.08	3.56	.3358
Child's rank among children in household	0.15	0.6989	3.67	3.48	.5918

[a]Eigenvalue = .70752; Canonical Correlation = 0.6437; Wilk's Lambda = 0.5856; Chi Square = 71.428; Degrees of Freedom = 21; Probability = 0.0000.

These include the number of months breastfed, the response category "receiving no solids," the category "receiving no semi-solids," mild colds, chronic colds, mild fevers, and the category "skipped semi-solids." In addition, the child's age and the frequency and severity of diarrhea are highly significant. The total number of children in the household does not appear important in this analysis. No other factors possess either significant F probabilities or relatively high canonical discriminant function coefficients.

Using the direct discriminant method, 82.9% of the children are correctly classified, 84.8% of the poor growers and 78% of the better growers. Figure 23 presents the histogram of classification.

Demographic Factors

Significant differences exist between the poor and better growth classes with regard to the total number of children residing in the household when tested with either a step-wise discriminant function or Chi Square contingency tables. Better growing children are more often living in households with less than 4 other children (Chi Square = 8.44, df=1, $P < .05$). The mean among poor growers is 4.4 children, while among better growers the mean is 3.3 children. No significant differences are found between average growers and poor growers in the number of resident children in the household.

Among children with poor growth, a 1-way ANOVA reveals no significant differences by ethnic group in the number of resident children in the household (F=.0253, df=3,199, n.s.). The means per ethnic group are as follows: Mestizo--4.5, Maya--4.0, Creole--4.6, and Garifuna--4.5.

```
   16  +                                                                  +
       .                                                                  .
       .                                                                  .
       .                                                                  .
   12  +                              1     2                             .
       .                              1     1                             +
       .                              11    1                             .
       .                              11  2 1 22                          .
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       .                             111 1221222 2                        +
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        .........+.........+.........+.........+.........+.........+.........+.........
                -6        -4        -2         0         2         4         6
          GROUP CENTROIDS                     1        2
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Frequency

Summary: Correct Classification: Poor = 84.8%, Better-Than Average = 78%,
Percent of "Grouped" Cases Correctly Classified = 82.88%.

Figure 23. Stacked Histogram of Canonical Discriminant Function Analysis Poor (1) vs. Better-Than-Average (2) Growth Classes.

There is a high correlation between the number of children residing in the household and the child's rank among these children, indicating that singletons and children of later birth orders constitute the majority measured. Nonetheless, the child's rank in the household does not significantly discriminate between poor and better growth.

No significant differences are found between poor and better growth classes with regard to the number of miscarriages and stillbirths, but poor growth is significantly associated with families which lost at least 1 live-born child during the first 5 years of life (Chi Square = 7.58, df=1, $P < .01$).

The influence of residence on reproduction is tested with a Scheffe's ANOVA. Table 23 presents these patterns. Despite significantly higher parities in rural women, the combined number of pre-natal and peri-natal deaths does not differ at the .05 probability level.

Table 23. Effective Reproduction by Residence.

Residence	Pre/Peri-Natal Dead		Post-Natal Dead		Total Living		Total Pregnancies	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Urban (N=473)	.16	.55	.35	.79	3.3	2.6	3.8	3.1
Rural (N=350)	.23	.69	.55	.95	4.5	3.2	5.3	3.9
F ratio	2.57		10.42		36.3		35.7	
F probability	0.109		0.0001		0.000		0.000	

Post-natally, residential differences have far greater effects. The number of children born live but who did not survive past 5 years old and the total number of survivors differ significantly by residence. Rural women have more pregnancies, more child deaths, and more surviving children.

Rural children are less often represented among the better growing children. Only 30 rural children are classed among the better growers while 130 exhibit poor growth. Urban children also are more often in the poor growth class (78) than in the better class (37), but the association between rural conditions and poor growth is greater (Chi Square = 6.65, df=1, $P < .01$).

Comparisons by district reveal that Stann Creek has a greater number of poorly growing children than does Cayo (Chi Square = 6.98, df=1, $P < .01$). In Cayo district there are significantly more children with either average or better-than-average growth living in towns than in villages (Chi Square = 6.8, df=1, $P < .01$). No significant association with urban or rural residence is found in Stann Creek district.

Ethnicity

Ethnic differences in growth are discussed in Chapter V. Ethnic differences in reproduction are shown in Table 24 for the entire sample. Only the total number of live-born children dying before 6 years of age differs significantly by ethnic group. Calculated as the proportion of post-natal dead per completed live-born pregnancies, the rates per ethnic group are as follows: Mestizo--7 per 100, Creole--8 per 100, Maya--13 per 100, and Garifuna--13.5 per 100.

Table 24. Effective Reproduction by Ethnic Group.

Ethnic Group	Mother's Age $\bar{X}$	Pre/Peri-Natal Dead $\bar{X}$	S.D.	Post-Natal Dead $\bar{X}$	S.D.	Total Living $\bar{X}$	S.D.	Pregnancies $\bar{X}$	S.D.
Mestizo (N=177)	26.9	.19	.59	.32	.66	3.95	2.8	4.46	3.3
Maya (N-114)	28.3	.13	.41	.61	.96	4.10	2.9	4.83	3.5
Creole (N-189)	26.4	.23	.60	.33	.81	3.73	3.0	4.27	3.6
Garifuna (N-337)	25.9	.19	.68	.50	.94	3.71	2.9	4.40	3.7
Total (N-817)	26.9	.19	.62	.44	.86	3.82	2.9	4.44	3.5
F ratio		0.606		4.254		0.675		0.624	
F probability		0.610		0.005		0.567		0.599	

Data on reproduction are tested with a 2-way ANOVA to determine whether ethnicity and residence interact in producing the patterns of association reported in Tables 23 and 24. The following table (Table 25) presents the results of this test.

Although residence has a greater over-all effect on reproductive success than ethnicity, there are no significant interactions of residence and ethnicity. Taken together, both factors account for only a small proportion of the variance in effective reproduction, i.e., for pre/peri-natal dead--1% (r^2 = .013), post-natal dead--4% (r^2 = .041), total living children--5% (r^2 = .049), and total pregnancies--5% (r^2 = .052).

Table 25. Effects of Ethnicity and Residence on Reproduction.

	Pre/Peri-Natal Dead	Post-Natal Dead	Total Living	Total Pregnancies
Ethnicity				
Sum of squares	0.09	17.20	26.43	83.39
F	0.08	7.95	1.08	2.31
F probability	0.97	0.0001	0.36	0.07
Residence				
Sum of squares	0.14	2.93	141.29	189.58
F	0.36	4.06	17.28	15.79
F probability	0.55	0.04	0.0001	0.0001
Ethnicity/residence				
Sum of squares	1.39	3.75	21.66	39.34
F	1.23	1.73	0.88	1.09
F probability	0.29	0.16	0.45	0.35

Dietary Patterns

The analysis of the effects of different feeding patterns on the growth of children through age 5 is confounded by a strong association of poor growth status with increasing age. While the average age of poorly growing children is 2.23 years, the average for better growing children is .77 years. Twenty-five percent (N=17) of the 67 children in the better-than-average growth class are under 6 months old. Therefore, a significant association between better growth and breast-feeding for less than 6 months is influenced by the children's ages (r=.4). By considering all children over 6 months old (in poor, average, and better-than-average growth classes), a clearer pattern emerges. Among these children, those who received up to 6 months of breastfeeding are significantly more often classified as having average or better-than-average growth. Those receiving no breast milk more often exhibit poor growth (Chi Square = 70.17, df=2, $P < .001$).

Extended breastfeeding, beyond 6 months, appears to offer no additional protection to the child's growth, although it may have importance in maintaining anovulation and adequate birth intervals (cf. Short 1976). Among breastfed children over 6 months old, those who received 7 months or more of breast milk are significantly more often among the poor growers (Chi Square = 32.4; df=2, P < .001). It is possible that the poorer health status of these children evoked extended breastfeeding from their mothers (cf. Muñoz et al. 1974) or that the mothers themselves are too poorly nourished to provide adequate breastfeeding.

Ethnic differences in the amount and pattern of breastfeeding exist. Maya women more often feed their children by breast alone (Chi Square = 43, df=6, P < .001). Breastfeeding continues for a median of 18 months among poorly growing Maya children. In this group of children, breastfeeding is extended beyond 7 months significantly more often than among poor growers in other ethnic groups (Chi Square = 20.86, df=3, P < .001). Among poorly growing Creole children, exclusive bottle feeding is most frequent (Chi Square = 43, df=3, P < .001). Ethnic differences among the average and better growing children with regard to breastfeeding patterns indicate that Garifuna and Creole women more often wean their children from the breast by 6 months of age than do Mestizo or Maya women (Chi Square = 23.73, df=3, P < .001).

Belizean mothers report a variety of feeding patterns. While 598 or 80% of the children in the entire sample receive some breastmilk, only 150 or 20% are breastfed exclusively. Another 150 or 20% are

bottle fed exclusively, leaving 448 or 60% receiving mixed feeds of breast and bottle. Commonly, Belizean women of all ethnic groups employ a pattern of bottle by day and breast by night. Many women mix breast and bottle for extended periods of time, up to 2 years, while others shift from exclusive breastfeeding to bottles after less than 1 month. Poor growth is significantly associated with those who move from either breast or mixed feeding to bottles (Chi Square = 7.29, df=1, $P < .01$). Better growth is associated with any type of early feeding which then shifts to the cup (Chi Square = 7.29, df=1, $P < .01$).

Considering that the type of milk in use may affect growth patterns, an analysis is carried out based on the last type of milk fed the child. No significant differences are found in the frequency of poor growth between those on breastmilk and those on proprietary formulas or between those receiving canned milk as opposed to powdered milk. However, formula-fed children are more often in the average or better-than-average growth classes than are those fed on other commercial milk preparations, such as powdered or canned whole milk, evaporated or condensed milk (Chi Square = 5.98; df=1, $P < .02$).

From the results of the direct discriminant function, weaning regimes associated with poor and better growth are detectable. Poor growers more often skip semi-solids and move directly on to solid foods, but at a later age than better growers. Mothers of better growing children more often respond that their children are not yet receiving either semi-solids or solids. This finding is related to

the average younger age of better growers compared to poor growers.

The age at introduction to semi-solids does not differ significantly by growth class, with an average age of 1.4 months. Nor are there marked differences in the type of semi-solids in use. The most frequent response in both growth classes is Ceralac, a packaged infant cereal. Poorly growing children are given custard and cornstarch lab slightly more often than better growing children.

The age at introduction to solid foods differs greatly between growth classes. Poor growers are first introduced to solids at an average age of 1.8 years, while better growing children receive solids by .8 years. This factor is correlated with the average age of children in each growth category (r=.45). It can be estimated that 20% (r^2 = .20) of the variance in age at introduction to solids is a function of the children's ages. Therefore, most of this variation is related to factors other than the ages of the children. Among poor growers receiving solids, the most frequent response regarding type of food is the family diet, followed by mashed Irish potatoes, and corn tortillas. Among better growing children on solids, family diet is also the most frequent response, followed by mashed potatoes combined with eggs. None of the better growing Maya children receive solids of any type while among better growing Creole children a wider variety of solids is in use than in any other ethnic group.

Ethnic patterns in the use of semi-solids and solids are analyzed for the entire sample. Table 26 shows the frequencies of the most commonly used semi-solid and solid foods. Table 27 presents

Table 26. Frequencies of Most Commonly Used Semi-Solid and Solid Weaning Foods.

Semi-Solids (294 Responses)	N	%	Solids (453 Responses)	N	%
Packaged infant cereals	145	49.3	Irish potatoes	130	29.0
Packaged custard	44	15.0	Eggs	83	18.0
Cassava starch lab	29	9.9	Rice	57	12.5
Cornstarch lab	23	7.8	Fish	57	12.5
Oats	18	6.1	Wheat flour products	38	8.0
Orange juice	11	3.7	Corn tortillas	28	6.0
Atole (corn lab)	9	3.1	Bananas (ripe)	23	5.0
Sugar or glucose	9	3.1	Plantain	8	2.0
Barley	4	1.4	Meat	7	1.5
Wheat flour porridge	2	0.7	Beans	7	1.5
			Fruits	6	1.0
			Soups	6	1.0
			Cheese	2	0.4
			Mashed vegetables	1	0.2

Table 27. Frequencies of First Semi-Solid Foods Arranged by Ethnic Group.

Food Item	Mestizo (N=92)		Maya (N=70)		Creole (N=119)		Garifuna (N=154)	
	N	%	N	%	N	%	N	%
Cornstarch lab (with water)	2	2.2	2	2.8	4	3.4	2	1.3
Cornstarch lab (with milk)	5	5.4	2	2.8	2	1.7	4	2.6
Cassava starch lab (with water)	0	0	1	1.4	0	0	15	9.7
Cassava starch lab (with milk)	0	0	0	0	0	0	13	8.4
Sugar or glucose	0	0	1	1.4	3	2.5	5	3.2
Atole (corn lab) (with water)	1	1.0	7	10.0	0	0	0	0
Atole (corn lab) (with milk)	0	0	1	1.4	0	0	0	0
Oats (with milk)	2	2.2	0	0	6	5.0	10	6.5
Packaged infant cereals	39	42.4	11	15.7	38	31.9	57	37.0
Custard (with water)	0	0	2	2.8	3	2.5	2	1.3
Custard (with milk)	5	5.4	1	1.4	11	9.2	20	13.0
Orange juice	5	5.4	0	0	2	1.7	4	2.6
Barley	0	0	0	0	3	2.5	1	0.6
Wheat flour porridge	0	0	0	0	2	1.7	0	0
Skipped to solids	33	36.0	42	60.0	45	37.8	21	13.6

the frequencies of semi-solids by ethnic group and Table 28 the frequencies of solids by ethnic group. Packaged infant cereals are the most common semi-solids in use among most Belizeans, reflecting a strong trend toward the consumption of imported items. A preference for these cereals is further predicated upon the adoption of the feeding bottle, which is used by 80% of the women in this sample. These patterns indicate that infant diets, for the most part, are highly acculturated. The residuals of traditional infant diets are in evidence as well. In Table 27 we see that 11% of the Maya children still receive atole, a gruel made of parched, ground corn. If we consider that, of the Maya children weaned onto solids without an intervening semi-solid phase (60%), the majority are receiving corn tortillas (family diet and corn in Table 28), it is apparent that corn remains the first food of choice for Maya babies. Among the Garifuna, approximately 18% are fed cassava lab, a gruel made of the starch expressed from bitter manioc. With the encouragement of public health nurses, approximately half of the cassava lab users are adding some amount of milk, usually of the sweetened canned variety, to the preparation. While this clearly improves nutrient quality, one wonders about the hygienic aspects of storing opened canned milk in the tropics. Informants frequently assert that cassava lab is an especially good food for infants due to its purity (white color) and fineness. Grated manioc may be strained through cheesecloth when starch (darara) is prepared for infants instead of through the traditional basketry equipment. An instant custard, made primarily of starch and

Table 28. Frequencies of First Solid Foods Arranged by Ethnic Group.

Food Item	Mestizo (N=139)		Maya (N=91)		Creole (N=192)		Garifuna (N=208)	
	N	%	N	%	N	%	N	%
Family diet	62	44.6	35	38.5	51	27.0	29	14.0
Corn	1	0.7	27	30.0	0	0	0	0
Wheat flour	10	7.2	9	10.0	12	6.3	7	3.4
Rice	8	5.8	5	5.5	21	11.0	23	11.0
Irish potato	27	19.4	1	1.0	47	24.5	65	31.0
Beans	2	1.4	1	1.0	2	1.0	2	1.0
Fish	4	2.9	1	1.0	18	9.4	34	16.3
Eggs	13	9.4	3	3.3	29	15.0	28	13.5
Soups	4	2.9	2	2.2	0	0	0	0
Meat	2	1.4	2	2.2	2	1.0	1	0.5
Cheese	0	0	0	0	0	0	2	1.0
Banana	2	1.4	1	1.0	5	2.6	15	17.2
Fruits (papaya, guava, mango, orange, etc.)	4	2.9	1	1.0	1	0.5	0	0
Plantain	0	0	3	3.3	3	1.6	2	1.0
Mashed vegetables	0	0	0	0	1	0.5	0	0

sugar, is also frequently served. Among both Creoles and Mestizos, no ethnic-specific semi-solid food patterns are evident.

Table 28 presents the frequencies of solid foods by ethnic group. Nearly half of the Mestizo children are fed their first solids from the family diet, which would be likely to include beans, flour tortillas, rice and various types of stews. In Maya families, the dietary preferences favor corn tortillas, bean soups, rice, meat, upon occasion, and other corn-based dishes in season. The most common daily dish in Creole households is rice and beans. Other favorite foods include "bile-up," a stew made of a variety of root vegetables and salted pigtails and homemade breads with fish or meat when available. Almost as many Creole children receive mashed potatoes for their first solids as receive food from the family diet. Frequently eggs are served along with mashed potatoes. Garifuna children are less frequently fed the family diet than are children of the other ethnic groups. The Garifuna diet is likely to include fish, plantains, coconuts, cassava bread, rice with scrambled eggs, and wheat breads. Mashed potatoes, often combined with eggs, and ripe mashed bananas are also commonly used solids for small Garifuna children. Most conspicuous is the far greater frequency of fish in the Garifuna diet. It should be noted, however, that children typically receive very small portions. For very young children, flesh is removed from a stewed or fried fish and cooked in a broth, locally called "fish tea." For somewhat older children, the typical portion is a fried fish tail. Among all ethnic groups, fresh meat is seldom fed to small children, allegedly because it is believed to

cause worms. Non-starchy vegetables are seldom consumed by children of any age. Many adults as well eat leafy or other non-starchy vegetables very seldom and in small quantities.

Table 29 lists the protein-calorie percentages for the most commonly eaten children's foods. These percentages are derived by dividing the caloric value of the protein in 100 gm of a particular food by the total calories in that food. It is apparent that the proportion of calories derived from protein is low in most of the traditional semi-solid gruels. Other foods usually eaten by children appear to have generally favorable protein-caloric ratios.

The following section reports the results of 50 24-hour recalls for diets of children 1 to 6 years of age. These diets were collected from women in their homes or at pre-natal clinics. The children whose diets are represented were not measured. This sample was collected in order to ascertain the range of dietary adequacy found in the communities surveyed and, if possible, in which nutrients deficiencies may exist. None of the children in this sample was breastfeeding or ill at the time of interview. Economic categories are assigned on the basis of the presence or absence of a professional or other wage earner in the nuclear family, or a primary dependency on extended kin, or subsistence farming. The sample is small, selected for maximum variance, and is not likely to represent accurate mean nutrient levels. As with all surveys based on single 24-hour recalls, highly skewed values are likely to result from seasonal and daily intake variability (Marr 1971; Garn et al. 1976). Furthermore, the perceived status of the investigator may

Table 29. Protein-Calorie Percentages of Common Belizean Children's Foods.[a]

Food Items	Protein-Calorie Percentages
Cornstarch lab with sugar	0.1
Cassava bread	1.1
Cassava starch lab with sugar	2.3
Mango	2.8
Plantain (raw)	2.8
Banana (ripe)	4.1
Guava (ripe)	4.4
Cocoyam (raw)	4.8
Atole (corn lab) with sugar	5.2
Johnny cake (with coconut milk)	5.5
Belize rice (cooked)	5.9
Sweet biscuit	6.4
Irish potato (raw)	6.8
Corn tortilla	7.3
Fry jack	7.5
Creole bread (with coconut milk)	8.0
Soda biscuit	8.5
Pan dulce (sweet roll)	9.6
Flour tortilla	10.3
Sweetened condensed milk	10.8
Oats (raw)	12.6
Pack bread (white, enriched flour)	13.1
Red or kidney beans (raw)	22.9
"Kraft" cheese	26.8
Fried egg	27.9
Boiled egg	34.5
Fish-jacks	44.9
Fish-mixed types	60.8
Fish-snapper	93.9

[a] $\frac{\text{Caloric value of protein (gm)}}{\text{Total caloric value of food (gm)}}$.

influence the mother's estimation of her child's intakes (Fidanza 1974).

Table 30 presents the medians and ranges of percent attained RDA's for 9 major nutrients, arranged by age level. With due recognition of the caution necessary in interpreting these results, it appears that a generally inadequate energy intake compromises what might otherwise appear to be an adequate intake of protein. If this situation is exacerbated by severe or chronic infection, greater deficits in energy and protein would result. Iron, riboflavin and niacin also appear to be inadequate at most ages. Calcium, thiamine, vitamin A, and vitamin C levels generally appear acceptable. Table 31 presents the data arranged by socio-economic rank, ethnicity, and residence for energy, protein, and iron. Energy and protein values decline as socio-economic status declines. Only in iron adequacy do the children of subsistence farmers compare favorably with the children of professionals, although both samples are quite small. Ethnic differences in energy and protein indicate highest intakes for Creoles, most of whom, in this sample, are urban residents as well. Maya children exhibit the lowest intakes in protein and energy but apparently acceptable levels of iron intake, derived perhaps from a frequent inclusion of beans in their diets. While the Mestizo sample is too small to reflect the wide variety of economic levels existing in this ethnic group, energy intakes appear quite low. Garifuna diets are low in energy and iron but apparently adequate in protein. It should be noted that the majority of Garifuna in this sample are urban residents.

Table 30. Median and Range of Percentage Attained Recommended Dietary Allowances for Selected Nutrients.[a]

Nutrients	Age Groups					
	1 Year Old (N=12)	2 Years Old (N=11)	3 Years Old (N=10)	4 Years Old (N=6)	5 Years Old (N=9)	6 Years Old (N=2)
Energy						
median	79	76	67	63	76	80
range	52-141	51-106	13-186	40-78	61-164	58-103
Protein						
median	160	121	113	93	145	146
range	89-284	71-190	15-202	45-177	95-163	138-155
Calcium						
median	124	110	85	97	101	120
range	67-289	13-175	6-183	72-110	65-250	104-137
Iron						
median	75	70	66	98	108	151
range	42-121	22-125	15-138	70-135	79-268	91-211
Vitamin A						
median	128	134	118	208	148	251
range	36-355	65-346	0-421	42-510	5-823	182-321
Thiamine						
median	118	146	129	188	118	381
range	72-302	51-482	18-260	69-490	69-398	100-662
Riboflavin						
median	148	88	92	76	77	91
range	60-405	41-177	13-190	34-110	45-149	85-98
Niacin						
median	75	66	55	51	68	72
range	30-113	18-96	12-82	28-75	40-172	57-88
Vitamin C						
median	117	105	110	246	150	447
range	12-939	0-1300	0-1325	0-1363	0-2820	85-810

[a]Recommended dietary allowances adopted from Recommended Dietary Allowances for the Caribbean (CFNI 1976).

Table 31. Mean, Median, and Range of Percentage Attained Recommended Dietary Allowances for Energy, Protein, and Iron Among 50 Belizean Children Arranged by Socio-Economic, Ethnic, and Residential Status.

	Percent Recommended Dietary Allowances								
	Energy			Protein			Iron		
Status	Mean	Median	Range	Mean	Median	Range	Mean	Median	Range
Professional (N=5)	96	103	61-141	175	157	95-284	110	86	73-211
Wage earner in nuclear family (N=25)	80	77	13-186	134	147	15-207	95	91	15-286
Extended family dependency (N=15)	72	54	43-124	125	144	45-234	87	62	42-202
Subsistence farming (N=5)	63	68	39-76	97	111	62-129	110	108	30-182
Mestizo (N=5)	73	66	51-109	132	117	74-202	102	86	55-182
Maya (N=4)	60	74	13-79	107	125	15-163	114	120	15-200
Creole (N=22)	87	78	40-186	141	145	62-284	103	95	51-286
Garifuna (N=19)	72	71	39-124	127	141	45-234	82	77	30-211
Urban (N=39)	81	76	39-186	134	144	45-284	90	87	22-286
Rural (N=11)	66	70	13-105	124	121	15-234	109	105	15-200

In general, urban diets appear to possess greater variety and larger portions which are reflected in higher protein and energy values. Lower values for iron in urban areas are somewhat unexpected and may reflect a higher proportion of beans in the diet of rural residents. However, the actual bioavailability of dietary iron in rural residents may be quite a bit lower, given higher levels of parasitism in the villages. Antagonists to iron absorption in the form of phytates in wheat or other dietary items are also likely to contribute to lower iron availability than is reflected in table values (Korte 1972; White 1975; Monsen 1980).

Among all children small additions of milk, either of the canned or powdered natural varieties or sweetened condensed types, to coffee, Milo, tea, cereals, breads, puddings, or in the form of ice cream add significantly to total protein intake. When cash is available, members of all ethnic groups add cheese with bread or soda biscuits (crackers) to their children's fare. In discussing diets with mothers, it is apparent that cultural patterns prescribing a well balanced meal do not preclude the use of high protein foods, whether of animal or vegetable origin. However, the lack of refrigeration for meat in homes with available cash, the lack of cash in many homes, and the scarcity of game or fish discourage greater use of flesh in meals. In addition, many women mention the belief that fresh meat, especially beef, may cause worms in children. It is unlikely, however, that this belief is a primary determinant of behavior.

Energy adequacy appears low for all groups. It was noted during the survey that very small portions of beans are added to rice,

soups or other dishes. Many mothers perceive beans as a scarce commodity. At the time of survey red beans sold for $.74 (BZE) per pound. By contrast, masa (ground corn dough) sold for $.25 (BZE) per pound while white sugar was $.18 (BZE) per pound. In many families, sugar consumption is quite high and a significant proportion of the energy intake in many children's diets is derived from sugar. Wheat flour, imported and fortified with iron, is a very important source of nutrients in most homes. Wheat flour is prepared according to different ethnic patterns into tortillas, bialy, Creole breads, fry jacks, durudia, powder buns, johnny cakes, and other recipes. Children consume numerous fruits in season. Figure 24 represents the seasonal distribution of major fruits and other farm produce in Belize as a whole. With only slight variation by district, a wide variety of fruits and vegetables is available from late March to October.

Although 24-hour recalls are inherently poor measures of average dietary intakes, this small sample of recalls serves to illustrate the major types of dietary problems in the districts surveyed. These are:

1. Energy adequacy is frequently so poor as to compromise what might otherwise be an adequate intake of protein.

2. For most nutrients, including energy and protein, socio-economic status is a major conditioning factor in dietary adequacy.

3. Intra-ethnic variation is great in all ethnic groups but less so among the Maya, whose rural residency, low socio-economic position, and traditional adaptations limit consumption.

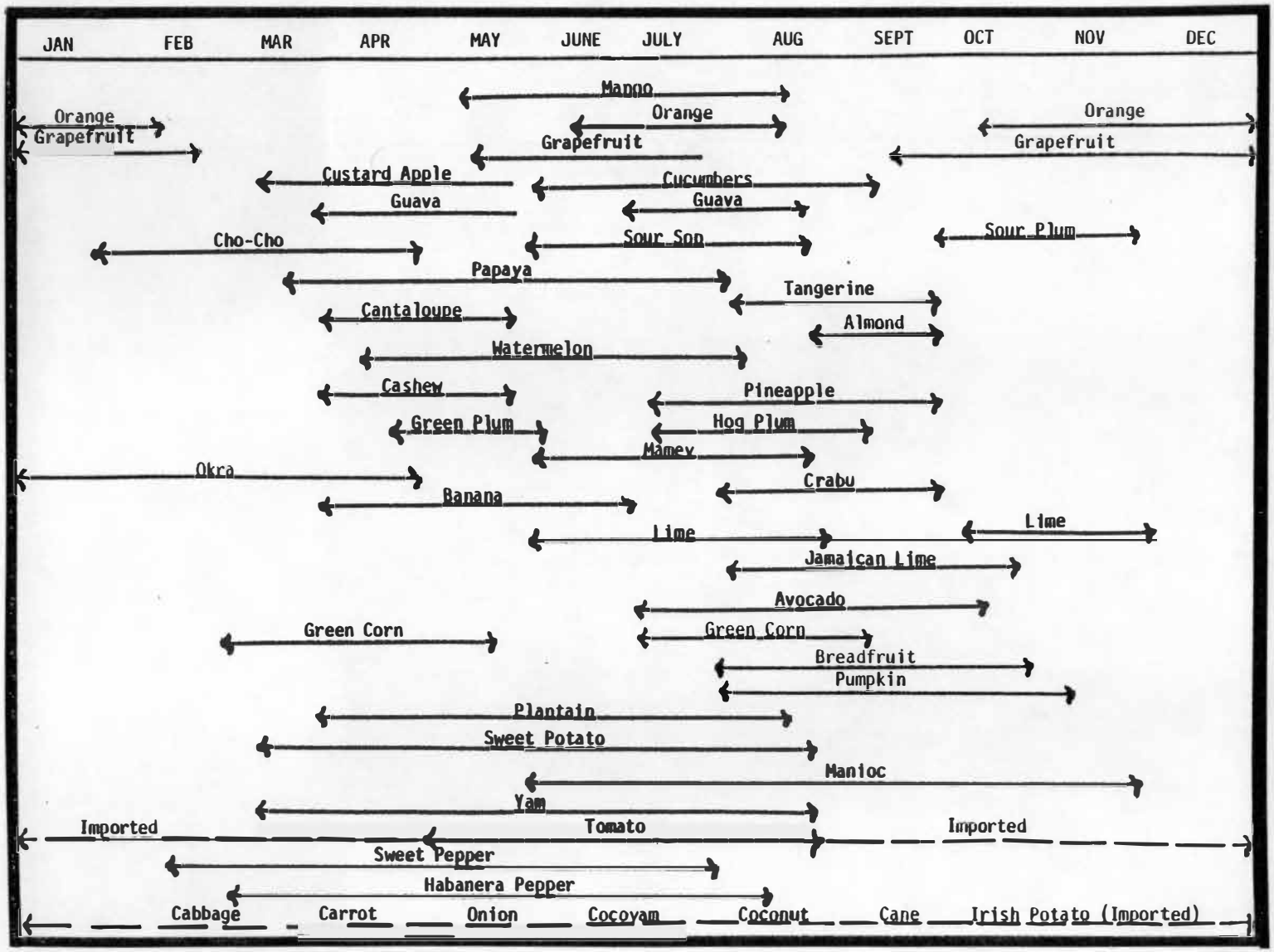

Figure 24. Main Market Seasons of Common Fruits and Vegetables.

4. Rural residents of all ethnic groups have greater limitations on dietary variety, accessibility, and quantity than urban residents.

Further research in each of these areas is indicated. In particular, clinical and biochemical assessment of individual nutritional status would help explain the observed patterns.

Health Status

The most significant difference between poor and better growth lies in the frequency and severity of infection, particularly with diarrheal diseases. By arranging categories of responses from mothers into a scale of increasing severity and frequency, levels of infection with diarrhea, colds, fevers (accompanied by no other symptoms), and parasites are estimated and entered into the discriminant function analysis. Results are highly significant for diarrhea in both the step-wise and direct discriminant methods. In addition to diarrhea, colds and fevers are more prevalent among poorly growing children. Frequencies of direct evidence of parasitism, for example, worms having been vomited or seen in stools, does not significantly differ between the growth classes.

These data demonstrate that poorly growing children more often experience chronic and severe episodes of diarrhea requiring hospitalization than do children with better growth (Chi Square = 22.9, df=2, P = .0001; gamma = .67). Considering the sample as a whole (N=658), the highest frequencies of chronic and hospitalized cases with diarrhea occur in children between 1 and 2.5 years old (Chi Square = 47.9, df=4, P = .0001; gamma = .26).

While there is little difference in the frequency of mild cases of diarrhea between rural and urban residents, rural children more often experience chronic diarrhea while urban children are more often hospitalized (Chi Square 28.6, df=2, P = .0001; gamma = .12). Clearly, the ease with which a child may be brought to hospital from different locations is reflected in this statistic.

Ethnic differences in the severity and frequency of diarrhea also exist and are highly significant (Chi Square = 53.75, df=6, P = .0001). Chronic diarrhea is most frequent among the Maya and Mestizo and least frequent among the Creole. Garifuna children are hospitalized with acute diarrhea far more often than any other group. Maya children are least often hospitalized. To some degree, patterns of residence and attitudes toward the national medical facilities may explain these differences, but other factors, such as differential rates of breastfeeding, environmental contamination, and standards of personal hygiene, are likely to be operating as well. Among poor growers, 64 or 31% experience chronic diarrhea and 24 or 11.5% have been hospitalized at least once with diarrhea. Higher rates of chronic diarrhea without doctor's care are found among the poorly growing Mestizo and Maya children while higher rates of hospitalization occur among poorly growing Garifuna children. Creole children with poor growth do not exhibit as high rates of chronic diarrhea as do the poorly growing Maya children, but are more often brought to the hospital (Chi Square = 42.43, df=6, P < .001). Ethnic differences in the severity and frequency of diarrhea are not apparent among better growing children.

Dietary patterns, especially with regard to breastfeeding, are associated with the frequency and severity of diarrhea. Severe diarrhea requiring hospitalization is significantly associated with exclusive bottle feeding as opposed to exclusive breastfeeding (Chi Square = 14.67, df=2, P < .001). Of those fed on either breast alone or a mixture of breast and bottle and who are weaned onto the bottle exclusively, 9% have been hospitalized and 34% have chronic diarrhea. Among children who received mixed feeding, followed by weaning onto the cup, only 4% have been hospitalized while 16% have chronic diarrhea. The greater likelihood of contamination in bottles as opposed to cups is implied.

The time at which semi-solids and solids are introduced is also associated with the frequency and severity of diarrhea. Among those in the total sample consuming semi-solids (N=213), severe diarrhea is reported in 5% of cases. Among those introduced to semi-solids during the first 6 months of life (N=184), severe diarrhea has a frequency of 14%, but among those introduced to semi-solids during the second half of the first year (N=20), severe diarrhea has a frequency of 20%. These differences are statistically significant (Chi Square = 57.87, df=4, P < .001). Chronic diarrhea in contrast to severe cases, exhibits similar patterns of association with introduction to solid foods (Chi Square = 15.4, df=6, P < .02), i.e., chronic cases increase when the age at first solids is greater than 12 months (gamma = .29).

The practice of pica, or the eating of sand, earth, and other non-edible items, also has a marked effect upon diarrhea frequency.

In those children for whom information on pica was systematically collected (N=429), 37 or 8.6% are sand or limestone-type soil eaters. Among these children, both chronic and severe diarrhea occur more frequently than among those with no pica (Chi Square = 36.78, df=2, P = .0001; gamma = .69).

Since exclusive breastfeeding has a protective effect on the frequency and severity of diarrhea, any social mechanism that supports the practice of breastfeeding should also have a positive effect, albeit, somewhat more indirect. Therefore, the type of birth attendant used by the mother is examined to ascertain if doctors, kin, or midwives (both trained and untrained) are differentially associated with exclusive breastfeeding. Results clearly indicate that women whose parturition is supported by traditional untrained midwives and/or kin are more often exclusive breastfeeders than those who consult trained midwives. Doctors are even less often among the birth attendants for exclusive breastfeeders than are trained midwives (Chi Square = 63.04, df=2, P < .001). The association between urban residence and doctors as birth attendants is expectedly quite high. Traditional untrained midwives, kin, and trained midwives more often serve as birth attendants among rural residents (Chi Square = 104.01; df=3, P = .0001).

The frequency and severity of colds also differentiates between children with poor and better-than-average growth. Mild, infrequent colds occur more often among the better growers while chronic and more complicated colds (with cough or fever) more often occur among poorly growing children (see Table 22, page 109). In addition, mild

and infrequent fevers without any other accompanying symptoms more often occur among better growing children while recurrent fevers are more frequent among poorly growing children (see Table 22, page 109).

Mothers were also asked to assess their children's appetites. Complaints of pickiness, loss of appetite, and a preference for liquids more often are reported by mothers of poorly growing children than by mothers of better growing children (Chi Square = 6.65, df=1, $P < .01$). It should be noted, however, that only 25% of the mothers of poorly growing children report that their children had poor appetites and only 10% of the mothers of children with better-than-average growth report poor appetites. Although this factor exhibits statistical significance, it is not likely to be a reliable indicator from a public health point of view.

Summary: Profiles of Children with Poor and Better-Than-Average Growth

This analysis delineates the demographic, dietary, and health factors related to the nutritional status of children in Stann Creek and Cayo districts, Belize. The child at risk of developing PEM is characterized by the following traits:

1. Living in a household with 5 or more children
2. Death of at least 1 other sibling under 6 years old
3. Resident in rural areas and/or of Maya ethnic group
4. Of Garifuna ethnic group, rural or urban
5. Not breastfed at all or receiving extended breastfeeding beyond 7 months
6. Introduced to solid foods at an age greater than 6 months

7. Frequent diarrhea or at least 1 episode of hospitalization with diarrhea
8. Chronic colds with coughs or fevers
9. Recurrent fevers with no other symptoms

Better-than-average growth is associated with the following traits:

1. Less than 5 children living in the household
2. Mother has lost no live-born children
3. Child is breastfed or fed a mixture of breast and bottle and is weaned onto the cup
4. Solid foods are introduced sometime during the first 6 months
5. If bottle fed, receives formulas as opposed to other milk preparations
6. Mother reports mild, infrequent episodes of diarrhea, colds and fevers
7. Child has not been hospitalized with diarrhea
8. Resident in urban areas, especially if also Creole

Two major issues related to these findings warrant discussion, unfortunately, neither of which can be resolved with the survey data. The first concerns the age differences between children with better-than-average growth and those with poor growth. It is possible that many of the younger children whose growth is assessed as better-than-average will decline, either to average or poor growth status with age. In the case of such an age effect, some of the statistically significant differences listed above may be spurious, a result of

cross-sectional sampling. A period or historical effect, i.e., one in which conditions have changed since the older children were born, is another possible interpretation for the age differences observed. This interpretation, however, is less likely as there is little evidence to indicate substantial improvement in health or dietary conditions in Belize over the years 1974 to 1979.

The other issue of concern relates to the mother's health status, both physical and emotional. Several studies have indicated that shorter mothers are more likely to bear small babies, who, under adverse post-natal conditions, are predisposed to poor growth and higher mortality (Morley 1973; Martorell and Delgado 1980). Other investigators have demonstrated a relationship between maternal malnutrition and morbidity during pregnancy and small birthweights (Zamenhof and Holzman 1973; Lechtig et al. 1976; Lechtig et al. 1977; Zamenhof and Marthens 1979). Furthermore, severe emotional problems, including those associated with mental retardation, alcoholism, and deprived socio-economic conditions may also contribute to poor growth status in the children of the family. During this survey many women were observed with markedly reduced stature, poor dental health, obesity, and other indicators of poor health. Should any of these factors be significantly associated with PEM in their children, it would indicate that greater attention must be paid to maternal health than has previously been the case.

In summary, given the cross-sectional nature of these data, clear causal inferences are not possible. Yet, this study reveals a number of important factors associated with PEM among preschoolers in

Belize. Since prevalence increases with age, the cumulative effect of certain factors, such as diarrhea and low energy intake, appear to have definite biological impact on children's growth. Behavioral differences in feeding patterns, reproduction, and health care operate indirectly by conditioning the likelihood of exposure to infection and poor diets. Ethnic and residential patterns evident in the anthropometric results presented in Chapter V reflect the geographical and cultural settings in which growth occurs. Better-than-average growth is attained more often in younger, urban children, and, perhaps, among those whose families possess relatively high incomes. It seems likely that many children classified in this cross-sectional survey as better growers will not remain in that category for the rest of their childhood.

CHAPTER VII

CONCLUSIONS

Discussion of Research Findings

In this study the prevalence of PEM among preschool age children in two districts of Belize is assessed with relevant anthropometric measures. Prevalence rates fall in the middle range by world-wide comparison. Several patterns emerge when internal comparisons are made along ethnic, residential, health status, dietary, and demographic lines.

Age, for example, is a highly important factor affecting the prevalence of PEM in Belize. Better-than-average growth is more likely to be exhibited by children under 1 year of age. Only a very few children maintain high levels of growth into their remaining childhood years. A large number of children grow normally during infancy, compared to U.S. standards. Yet, by the age of 2.5 years, a significant proportion have experienced frequent and debilitating infections, inadequate diets, and growth retardation. With continued nutritional stress, linear growth is affected and by 5.5 years of age, over a third of the children exhibit some degree of stunting. Weight-for-age is reduced in these children, as expected. This is reflected in the Gomez Scale analysis (see Chapter V). Low arm circumference is most frequent in children under 2.5 years old, indicating more wasting in muscle and fat during early childhood than at later ages. High rates of diarrhea during early childhood may be largely responsible. Measures of current malnutrition indicate that boys

may be more frequently affected than girls. Most patterns reveal less severe PEM and fewer weight deficits.

Because this analysis examines children at both ends of the growth spectrum in a cross-sectional design, several factors distinguishing one group of children from the other may actually be unimportant as discriminating characteristics. For example, a longitudinal study might reveal that there is no difference in family size between malnourished and non-malnourished children. Feeding regimes may be less important than hygienic practices, a factor not measured in this study. Maternal health status may also be a factor in understanding the etiology of childhood malnutrition in Belize.

Cross-sectional studies such as this one are carried out on survivors. Therefore, it is likely that a greater average age of children with growth retardation reflects a process of adaptation in which reduced body size allows children to survive where inadequate diets and high levels of infection are common. More susceptible children who die may be those whose growth rates are greater (Garrow and Pike 1967) or who have additional metabolic problems, such as sickle cell anemia or enzyme deficiencies. A follow-up, or prospective, longitudinal study is necessary in order to ascertain the characteristics of children who die as a result of PEM and to assess the nature of selective pressures, if any, that operate during early childhood.

The patterns of PEM in Belize illustrate the effect of ethnicity on health status. Although some children of all ethnic

groups develop signs of PEM, those in ethnic groups with greater access to the society's resources are less frequently malnourished. Ethnic groups which occupy a pariah status or which maintain cultural preferences limiting their access to changing economic and medical care opportunities are more likely to experience high rates of PEM. This is borne out in the present study.

Although urbanization is increasing in Belize, the majority of the population remains in rural areas. Village residents less often possess the water and sanitation facilities present in towns and cities. Dietary quality and quantity are more limited; health care facilities are more remote. Consequently, PEM and higher rates of mortality are more often found among rural than among urban children. In urban areas, PEM is more likely to develop in children who are bottle fed in homes where domestic hygiene is less than adequate. Diluted milk and other dietary factors, such as low energy intake, further contribute to poor nutritional status. Urban residents may bring a sick child to the hospital more rapidly, thus saving its life and protecting its growth.

This research documents the prevalence and distribution of PEM among preschoolers attending immunization clinics in Stann Creek and Cayo districts, Belize. The importance of diarrhea in the etiology of PEM is well established and is reiterated in the present study. Analysis of survey findings demonstrate that greater frequency and severity of diarrhea is significantly associated with growth retardation, ethnicity, pica, rural residence, bottle feeding, and late introduction to solid foods. Diarrheal episodes reach greatest

frequency and severity during the age range of 1 to 2.5 years, the same age at which current, on-going malnutrition, measured anthropometrically, reaches maximum frequency. Higher rates of chronic colds and fevers among malnourished children are also demonstrated. Further research is needed in order to evaluate the roles of maternal health status, education, family diets, low birthweights, health care practices, and income levels in the causation of childhood PEM in Belize. Specific areas of importance include breastmilk adequacy, birth intervals, ethomedicine, and the biochemical assessment of individual diets.

Breastfeeding has already declined in Belize. Only 20% of the women in this sample were breastfeeding their children without the addition of bottles. Among the few whose household finances allow for the purchase and full utilization of expensive formulas, children's growth is not compromised. But for the majority of women this is not possible. The financial cost of packaged milks, formulas, and baby foods, coupled with the cost of curing diarrhea and malnutrition, is high on both household and national levels. Most Belizean women of child-bearing age believe bottle feeding is superior to breast-feeding in terms of increased modernity, convenience, and other perceived needs and preferences. Few social supports remain for the breastfeeding woman. Medically trained midwives as well as physicians have not taken up the role of supporter once allocated to traditional birth attendants. Social scientists may find this a fertile area for research. Their results could contribute to future nutrition education programs.

Although the quantitative dietary data gathered in this study possess certain limitations, they corroborate the patterns of

malnutrition deduced through anthropometrics. Average energy intakes are low for all groups of children but are lower among the Maya, Garifuna, and rural residents. While protein intakes may appear adequate in most cases, bioavailability is markedly reduced by high levels of infection and low energy intakes. Iron nutrition also is poor for a large number of children. High consumption of fruit provides adequate levels of vitamins A and C in most children's diets. Since the predominant form of PEM is neither severe marasmus nor kwashiorkor, but one that results in nutritional dwarfing, the patterns of dietary adequacy revealed in 24-hour recalls may be considered reasonable estimates for the population segments sampled. Biochemical assessments are needed in order to clarify the patterns observed.

It is important to recognize that a study such as this one cannot indicate which factors associated with PEM are causal and which are consequential. For example, a significant association between poor growth and breastfeeding beyond 7 months may be interpreted in several different ways. Some mothers may continue to breastfeed poorly growing children longer than other children in an effort to give the unhealthy child extra nutritional support. Many of these women, however, may be unable to produce adequate breastmilk, either in quantity or quality, due to their own poor nutritional status. Their children may be poorly nourished on breastmilk even before 6 months of age. This is especially likely in the poorest families. Where income levels are extremely low, there may be little else besides breastmilk to feed the older infant. Yet, the substitution of

bottle feeding often is a serious mistake. Few are able to afford the maintenance of a full formula regime and sanitation standards are frequently low. When solids are introduced, poorly nourished children may not tolerate them, thus forcing their mothers to rely even more heavily on breastfeeding or bottles. When diarrhea and vomiting occur, many children refuse solid foods. Moreover, many mothers believe that it is necessary to withdraw all foods except sugar water or breastmilk when their children are sick. Ethnic and educational differences among mothers may contribute to differences in health-related beliefs and practices. Numerous observations attest to these relationships but time considerations during fieldwork precluded an adequate sampling of mothers. Changing ethnomedical beliefs and practices is another area requiring further research in Belize.

Even though the precise sequence of events leading to PEM in Belizean preschoolers is only roughly discernible, certain recommendations can be made.

Recommendations for Future Research and Action

Conditions which contribute to high rates of diarrheal diseases are manifold and include the prevalence of flies, the use of bucket latrines, household storage of water, and a host of other factors not easily changed without extensive resources. Since it is known that most of the deaths in cases of diarrheal diseases are due to dehydration or the loss of body water and salts in the stool, rehydration can save many lives and positively affect nutritional status. Common salt, baking soda, sugar, and coconut water as a source of potassium have been

suggested as sufficient ingredients for rehydration mixes. Although accurate measurements are necessary, the training of at least one or two key women in each village in proper measuring techniques may be a cost-effective method of reaching remote segments of the population with the care needed. The World Health Organization has produced several publications aimed at just such intervention (WHO 1976, 1978). Reserving the task of rehydration for the M.D. in the hospital, as is usually done in Belize, wastes time, lives, and the skills of other personnel. In towns, public health clinic personnel could also regularly administer rehydration mixes. The hospitalization of children who are being breastfed discourages the continuation of this practice and should be avoided whenever possible.

On the same note, it might be recommended that greater attention be paid to the needs of breastfeeding women. Minor infections, sore nipples, illness in the child, and psycho-social stress at home may provoke complaints indicating reluctance to continue breastfeeding. Since the medical indications for discontinuing breastfeeding are few, if any, it behooves the physician to recognize that the worry involved and constant effort necessary to feed a small baby artificially is likely to have a greater adverse effect on the mother's health than the possible ill effects of continued breastfeeding. Treatment, encouragement, and reassurance which stresses the overwhelming advantages of breastmilk for the child should be given at such time. All too often this has not been the case. When nurses and physicians, both of which are viewed as high status individuals, recommend or distribute a particular infant formula instead, the suggestion is implicit that

bottle feeding is superior to breastfeeding. This notion has already spread widely in Belize, but the trend is not irreversible. Eighty percent of the women sampled breastfed for at least a few weeks. This percentage and the duration of breastfeeding could be increased. Traditional midwives should be encouraged as well in their role of supporter to village mothers. Traditional midwives, healers, and herbalists are often consulted prior to the physician when the baby is ill. Some of these persons, most of whom possess considerable herbal knowledge, may be valuable extensions for public health personnel and could be taught the techniques of rehydration with comparative ease. These persons constitute a resource developing nations cannot afford to ignore.

Greater nutrition education is of utmost importance in Belize. Many women are wasting scarce cash on high protein, imported foods to the detriment of energy intake (cf. György 1975). An increased emphasis on bean production and consumption is warranted. If beans are resisted due to low prestige, newer, fancier preparations, such as bean salads, patties, beans prepared with fruits, or mounds of purée topped with onions, could be introduced and demonstrated. Local workers need to be able to advise the mother on the cost of feeding her child. Mothers need guidance and protection, otherwise they may buy the most expensive brands of milks only to find that as many as 16 teaspoons are required to make up one bottle. Consequently, they dilute the mixture, often excessively. Furthermore, hundreds of Belizean women believe their babies have milk allergies. It is unclear whether they received this information from health personnel or

through other persons. Nonetheless, they waste many precious dollars and unnecessarily stress themselves and their infants searching for the right milk or formula. The pattern was recounted repeatedly. With each new milk, an additional episode of diarrhea would signal the need to switch to another. This pattern and the belief that diarrhea normally accompanies teething are specific areas in which nutrition and hygiene education programs would greatly benefit the populace.

Sugar consumption should also be addressed. Although energy needs are scarcely met in many children's diets, the increasing consumption of sugar bodes ill for current and future health status. Dental disease among very young children is already a serious problem and diabetes appears to be increasing in Belizean adults. When sugar is used, local brown sugar is preferable as it is both cheaper and more nutritious than imported, white refined sugar. Many women believe that brown sugar is "dirty" and unsuitable for babies, and prefer it for baking. This issue should be included in any future nutrition education program. In addition, locally grown, but little used foods, such as sesame seeds and chaya (*Amaranthus* spp. or callaloo in Creole) should be stressed for greater iron intake. Increased consumption of non-starchy vegetables should also be encouraged. A wide range of these vegetables is available in Belize but seldom appears in weekly family diets. The retention of protective dietary patterns is equally important. Corn and bean or rice and bean combinations should be elevated to the status of national dishes through advertising and government policy. Ethnicity should be

utilized and not played down. Nutrition educators in the United States have recently begun to incorporate ethnic-specific menus into their programs, recognizing that most people welcome the opportunity to be proud of their traditions.

Ethnomedical beliefs and practices warrant greater attention in Belize. Several herbal preparations in widespread use may be effective and less expensive than pharmaceuticals. For example, apasote (Chenopodium spp.), a widely used vermifuge, possesses both clinical effectiveness and nutritional importance. Per 100 gm of apasote there are 2.7 gm of protein, 284 mg of calcium, 4.7 mg of iron and 158 retinal equivalent units of vitamin A (Ortiz de Montellano 1975; Hernandez et al. 1977). Another herb, locally known as pissabed or wild senna (Cassia occidentalis) contains cathartic acid and is an effective purgative. In some instances herbal remedies may contribute to disease processes (Ashcroft 1979). Professional health personnel need information concerning these herbs, not only because they may be effective alternatives to more expensive pharmaceuticals, but also because it is likely that the children they see are being treated at home with herbal preparations.

One ethnomedical practice deserves special attention and that is the practice of geophagy. In Belize certain women, especially when pregnant or ill, consume prepared clays containing calcium and magnesium. In some cases these are sun-baked tablets, imported from Honduras or Guatemala, known as kipula and bearing the imprint of a picture of Christ. Perhaps in imitation of their mothers, or for other reasons, approximately 10% of the children measured also ate various types of

soil. Children, however, are indiscriminant and may eat highly contaminated soils or sand, resulting in greater frequencies of diarrhea and parasitism. Several studies have shown that this form of pica may be effectively treated with multiple vitamin and mineral supplements (Prasad 1961; Gutelius 1963).

Family size in Belize affects the prevalence of malnutrition. Where there are 5 or more children in the household, PEM is more likely to occur. Although a longitudinal study could discount this finding, restricting family size through contraception is indicated for women experiencing poor health, low birthweights, and lactational difficulties. Further research is needed to ascertain the effects of closely spaced pregnancies and inadequate maternal diets on children's nutritional status. A more adequate study of birthweights is also warranted.

The Medical Department could provide birth control information and methods through public health clinics. Recent evidence from Jamaica (Brody 1978), Guatemala (Logan and Jenkins n.d.), Ecuador (Scrimshaw 1978), and Costa Rica (Low 1978) indicates that traditional values of fertility do not operate as barriers to family planning, as once commonly believed. Where birth control information is obtainable discretely and privately, even highly traditional Guatemalan Maya women seek its advantages.

Finally, greater communication about health and nutritional matters is needed in Belize. Schoolteachers should be encouraged to include units on food-related topics, hygiene, and the role of insects in disease, and other health issues in primary schools. Health workers

should not assume that the mothers they address completely understand their advice. Disease entities are not easily translatable from one ethnomedical system to another. Specific areas requiring greater attention include symptom recognition, knowledge of germs and hygiene, and appropriate treatment. Growth retardation is so common that many women are unable to recognize its signs in their children. While most women are very conscious of the dangers of intestinal parasites, few are alarmed when their children have diarrhea, unless it is quite severe. Considering the psychological importance of traditional treatments designed to assuage sickness-producing winds, ancestral spirits, or the ill will of other people, medical personnel should not discourage these ancient practices. Instead, simultaneous treatment with both traditional and modern medicine could be encouraged. Concerted effort to reach mothers with information concerning sanitation in the home, emphasizing simple concepts such as hand washing and fly protection, would be of great value. Social and professional distance, signaled by a variety of verbal and non-verbal messages, should be discouraged among all health personnel. Training and delegating responsibilities to more health care auxilliaries would allow the physician and nurse greater time to spend with each mother and child.

In summary, five major areas appear to require further research. These are maternal health status and lactation, birthweights, the characteristics of children who die, ethnomedical beliefs and practices, and basic research for nutrition education. Information on intra-familial food distribution, daily and ceremonial diet patterns, the allocation of the food dollar, and more detailed work on food

preparations is necessary. With this information, more effective, locally adapted nutrition education programs could be developed (Tonon 1978). However, large amounts of money can easily be spent pursuing greater understanding of the biocultural dynamics underlying protein-energy malnutrition without benefit to the children and families affected. Enough information is presently available on the situation in Belize to begin efforts to reduce the prevalence of PEM and its associated mortality. A formal nutrition policy in Belize is called for which takes ethnic, demographic, and socio-economic factors into account.

LIST OF REFERENCES

LIST OF REFERENCES

Acosta, Phyllis, Robert Aranda, Jane Lewis and Marsha Read
1974 Nutritional Status of Mexican-American Preschool Children in a Border Town. American Journal of Clinical Nutrition 27:1359-1368.

Adams, Catherine F.
1975 Nutritive Value of American Foods. Agricultural Handbook No. 456. Washington, D. C.: U.S. Department of Agriculture.

Adams, Richard N.
1965 Migraciones Internas en Guatemala Expansión Agraria de los Indígenas Kekchíes hacia El Petén. Estudios Centroamericanos No. 1. Guatemala: Seminario de Integracion Social Guatemalteca y Instituto de Estudios Latinoamericanos. Austin: Universidad de Texas.

Alleyne, George
1975 Mineral Metabolism in Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 202-212. New York: Academic Press.

Andelman, M. B. and B. R. Sered
1966 Utilization of Dietary Iron by Term Infants. A Study of 1,048 Infants from a Low Socio-Economic Population. American Journal of Disease in Childhood 111:45.

Anderson, Mary Ann
1979 Comparison of Anthropometric Measures of Nutritional Status in Preschool Children in Five Developing Countries. American Journal of Clinical Nutrition 32:2339-2345.

Antrobus, A.C.K.
1971 Child Growth and Related Factors in a Rural Community in St. Vincent. Environmental Child Health December: 187-209.

Ariza-Macías, Jaime, Helberto Luna-Jaspe, Roberto Rueda-Williamson, Jose Mora-Parra and Franz Pardo-Tellez
1973 A Cross-Sectional Study of Growth of Colombian Children from Two Socioeconomic Classes, During Their First Six Years of Life. Ecology of Food and Nutrition 2:61-67.

Arroyo, Pedro, Sara E. Q. DeArroyo, Sara E. Pérez Gil and Adolfo Chávez
1972 Correlation Between Family and Infant Food Habits by Scalogram Analysis. Ecology of Food and Nutrition 1:127-130.

Ashcraft, Norman
1972 Economic Opportunities and Patterns of Work: The Case of British Honduras. Human Organization 31(4):425-433.

Ashcroft, M. T.
1979 Some Non-Infective Diseases Endemic in the West Indies. Cajanus 12(3):155-164.

Ashcroft, M. T., P. Heneage and H. A. Lovell
1966 Heights and Weights of Jamaican School Children of Various Ethnic Groups. American Journal of Physical Anthropology 24:35-44.

Aykroyd, W. R.
1965 Nutrition in the Caribbean. Journal of Hygiene, Cambridge 63:137-153.

Battaglia, Frederick and Michael Simmons
1978 The Low-Birth-Weight Infant. In Human Growth. Volume 2. Postnatal Growth, Frank Falkner and J. M. Tanner, eds., pp. 507-555. New York: Plenum.

Beghin, I. D.
1969 Assessment of the Effectiveness of a Nutritional Rehabilitation Centre at Fond-Parisien, Haiti. Journal of Tropical Pediatrics 15:248.

Beisel, W. R.
1977 Malnutrition as a Consequence of Stress. In Malnutrition and the Immune Response, R. M. Suskind, ed. New York: Raven Press.

Belizean Independence Secretariat
1972 Belize: New Nation in Central America. Belize: The Government Printer.

Bengoa, J. M.
1974 The Problem of Malnutrition. World Health Organization Chronicle 28:3-7.

1975 Prevention of Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 435-452. New York: Academic Press.

Berman, M. L.
1972 Effect of Breastfeeding on Post-Partum Menstruation, Ovulation and Pregnancy in Alaskan Eskimos. American Journal of Obstetrics and Gynecology 114:524-534.

Bibera, Sibilina B., Hermenegilda G. Lopez, Lucila B. Rabuco, Zenaida C. Sakdalan, Carmencita B. Salvosa and George R. Wadsworth
1976 The Origins of Malnutrition During Childhood: A Study of Two Cases in Manila, Philippines. Philippine Journal of Nutrition July-September: 105-110.

Birch, Herbert, C. Pinero, E. Alcalde, T. Toca and J. Cravioto
1971 Relation of Kwashiorkor in Early Childhood and Intelligence at School Age. Pediatric Research 5:579.

Blades, Hayden
1979 Some Economical and Nutritional Factors in Devising a Food and Nutrition Plan in Belize. Paper presented at Caribbean Agroeconomics Society Meeting, April, San Ignacio, Belize.

Briscoe, John
1978 The Role of Water Supply in Improving Health in Poor Countries (with Special Reference to Bangladesh). American Journal of Clinical Nutrition 31:2101-2113.

1979 The Quantitative Effect of Infection on the Use of Food by Young Children in Poor Countries. American Journal of Clinical Nutrition 32:648-676.

Brock, J. F. and M. Autret
1952 Kwashiorkor in Africa. World Health Organization Monograph. Series No. 8. Geneva: WHO.

Brockmann, C. Thomas
1977 Ethnic and Racial Relations in Northern Belize. Ethnicity 4:246-262.

Brody, Eugene
1978 The Meaning of the First Pregnancy for Working Class Jamaican Women. In The First Child and Family Formation, Warren Miller and Lucile Newman, eds., pp. 92-107. Chapel Hill: University of North Carolina Press.

Brown, Roy
1978 Weaning Foods in Developing Countries. American Journal of Clinical Nutrition 31:2066-2072.

Buchanan, Robert
1975 Breast-feeding--Aid to Infant Health and Fertility Control. Population Reports. Series J. No. 4. Washington, D. C.: George Washington University Medical Center.

Burgess, Anne and R.F.A. Dean
1962 The Social Psychology of Food Habits. In Malnutrition and Food Habits, Anne Burgess and R.F.A. Dean, eds., pp. 76-84. New York: Macmillan.

Burgess, H. J. and Ann P. Burgess
1969 The Arm Circumference as a Public Health Index of Protein-Calorie Malnutrition of Early Childhood (II). A Modified Standard for Mid-Upper Arm Circumference in Young Children. Journal of Tropical Pediatrics 15:189-192.

Burgess, H. J. and E. Wheeler
1970 Lower Shire Nutrition Survey. A Report of a Nutritional Status and Dietary Survey Carried Out in Ngaba Area April/May 1970. Ministry of Health, Blantyre, Malawi. Mimeo. Cited in Development and the Problems of Village Nutrition, Sue Schofield, 1979. Montclair, N. J.: Allanheld, Osmun and Company.

Buzina, R. and K. Uemura
1973 Selection of the Minimum Anthropometric Characteristics to Assess Nutritional Status. In Nutrition and Malnutrition, Identification and Measurement, Alexander Roche and Frank Falkner, eds., pp. 271-281. New York: Plenum.

Calder, Ritchie
1966 Food Supplementation for Prevention of Malnutrition in the Pre-School Child. In Pre-School Child Malnutrition, National Academy of Sciences--National Research Council, Publication 1281, pp. 251-257. Washington, D. C.: NAS-NRC.

Cameron, Noël
1978 The Methods of Auxological Anthropometry. In Human Growth. Volume 2. Postnatal Growth, Frank Falkner and J. M. Tanner, eds., pp. 35-90. New York: Plenum.

Carballo, M.
1977 Social and Behavioral Aspects of Breastfeeding. In Fertility Regulation During Human Lactation, Alan Parkes, Agnes Thomson, Malcolm Potts and Margaret Herbertson, eds., pp. 57-68. Cambridge, England: Galton Foundation.

Caribbean Agroeconomics Society
1979 Salient Features of the Belizean Economy Resource Base. Paper presented at Caribbean Agroeconomics Society Meeting, April, San Ignacio, Belize.

Caribbean Food and Nutrition Institute
1974 Food Composition Tables for Use in the English-Speaking Caribbean. Kingston: CFNI.

1975 An Assessment of the Food and Nutrition Situation in Belize. Kingston: CFNI

1976 Recommended Dietary Allowances for the Caribbean. Kingston: CFNI.

Caribbean Food and Nutrition Institute
1979 Programmes and Projects for Improving the Belize Food and Nutrition Situation with Particular Reference to the Agricultural Sector. Draft prepared for the Government of Belize: CFNI.

Central Planning Unit
1978 Belize Abstract of Statistics 1976. Belmopan: The Government Printer.

1979 Population Statistics 1977. Unpublished data, Statistical Section, Central Planning Unit, Belmopan, Belize.

Chávez, Adolfo and Celia Martinez
1979 Consequences of Insufficient Nutrition on Child Character and Behavior. In Malnutrition, Environment and Behavior, David Levitsky, ed., pp. 238-255. Ithaca: Cornell University Press.

Chen, Lincoln
1978 Control of Diarrheal Disease Morbidity and Mortality: Some Strategic Issues. American Journal of Clinical Nutrition 31: 2284-2291.

Chibnik, Michael
1975 Economic Strategies of Small Farmers in Stann Creek District, British Honduras. Ph.D. Dissertation, Columbia University.

Chow, Bacon F.
1973 Effect of Maternal Dietary Protein on Anthropometric and Behavioral Development of the Offspring. In Nutrition and Malnutrition, Identification and Measurement, Alexander Roche and Frank Falkner, eds., pp. 183-219. New York: Plenum.

Committee on Nutritional Anthropometry of the Food and Nutrition Board of the National Research Council
1956 Recommendations Concerning Body Measurements for the Characterization of Nutritional Status. Human Biology 28:111-288.

Condon-Paoloni, Deanne, Joaquin Cravioto, Francis E. Johnston, Elsa R. DeLicardie and Theresa O. Scholl
1977 Morbidity and Growth of Infants and Young Children in a Rural Mexican Village. American Journal of Public Health 67(7): 651-656.

Correa, Hector and John Jacoby
1978 Nutrition and Fertility: Some Iconoclastic Results. American Journal of Clinical Nutrition 31:1431-1436.

Cosminsky, Sheila
1976 Carib-Creole Relations in a Belizean Community. In Frontier Adaptations in Lower Central America, Mary Helms and F. Loveland, eds., pp. 95-114. Philadelphia: Institute for the Study of Human Issues.

1977 Interethnic Relations in a Southern Belizean Community. Ethnicity 4:226-245.

Cravioto, Joaquin
1979 Malnutrition, Environment and Child Development. In Malnutrition, Environment and Behavior, David Levitsky, ed., pp. 28-39. Ithaca: Cornell University Press.

Cravioto, Joaquin, H. G. Birch, E. DeLicardie, L. Rosales and L. Vega
1969 The Ecology of Growth and Development in a Mexican Pre-industrial Community. Report 1: Method and Findings from Birth to One Month of Age. Monographs of the Society for Research in Child Development. Serial No. 129. 34(5).

Cravioto, Joaquin and Elsa R. DeLicardie
1973 The Relation Between Size at Birth and Preschool Clinical Severe Malnutrition. In Nutrition and Malnutrition Identification and Measurement, Alexander Roche and Frank Falkner, eds., pp. 321-327. New York: Plenum.

1976 Malnutrition in Early Childhood. Food and Nutrition 2(4): 2-11.

Currier, R. L.
1966 The Hot-Cold Syndrome and Symbolic Balance in Mexican and Spanish American Folk Medicine. Ethnology 5:251-263.

Davidson, William V.
1976 Black Carib (Garífuna) Habitats in Central America. In Frontier Adaptations in Lower Central America, Mary Helms and F. Loveland, eds., pp. 85-94. Philadelphia: Institute for the Study of Human Issues.

DeGwynne, Eunice and Diva Sanjur
1974 Nutritional Anthropometry: Diet and Health-Related Correlates Among Preschool Children in Bogotá, Colombia. Ecology of Food and Nutrition 3:273-282.

DeLicardie, Elsa and Joaquin Cravioto
1974 Behavioral Responsiveness of Survivors of Clinical Severe Malnutrition to Cognitive Demands. In Early Malnutrition and Mental Development, J. Cravioto, L. Hambraeus and B. Vahlquist, eds., pp. 134-154. Uppsala: Almqvist and Wiksell.

DeMaeyer, E. M.
1976 Early Signs of Protein-Calorie Malnutrition. In Early Signs of Nutritional Deficiencies, J. C. Somogyi and T. Tashev, eds., pp. 1-8. Basel: Karger.

DeMorales, Alina and Frances Larkin
1972 Influence of the Availability of Commercial Infant Foods on Feeding Practices in Jamaica. Ecology of Food and Nutrition 1:131-135.

Department of Health, Education and Welfare
1972 Nutritional Evaluation of the Population of Central America and Panama. Regional Summary. DHEW Publication No. (HSM) 72-8120. Washington, D. C.: Institute of Nutrition of Central America and Panama and the Interdepartmental Committee on Nutrition for National Defense.

DeWalt, K. M., P. B. Kelly and G. Pelto
1980 Nutritional Correlates of Economic Microdifferentiation in a Highland Mexican Community. In Nutritional Anthropology, N. Jerome, G. Pelto and R. Kandel, eds., pp. 205-222. Pleasantville: Redgrave.

Dewey, Kathryn G.
1979 Agricultural Development, Diet and Nutrition. Ecology of Food and Nutrition 8:265-273.

Dingle, J. H., G. F. Badger and W. S. Jordon
1964 Illness in the Home: Study of 25,000 Illnesses in a Group of Cleveland Families. Cleveland: Western Reserve University Press.

Dobbing, John
1979 Malnutrition and the Developing Brain: A Critical Review. In Malnutrition, Environment and Behavior, David Levitsky, ed., pp. 41-55. Ithaca: Cornell University Press.

Drillien, Cecil M.
1958 Growth and Development in a Group of Children of Very Low Birth Weight. Archives of Disease in Childhood 33:10-18.

Dubos, Rene
1961 Mirage of Health. Garden City: Doubleday-Anchor.

Etkin, Nina
1979 Biomedical Evaluation of Indigenous Medical Practices. Medical Anthropology 3(4):393-400.

Eveleth, Phyliss and J. M. Tanner
1976 Worldwide Variation in Human Growth. New York: Cambridge University Press.

Fernandez, Renate
1979 The Decline of Breastfeeding: Interplay of Images and Policies. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 65-75. New York: Academic Press.

Fidanza, F.
1974 Sources of Error in Dietary Surveys. In Assessment of Nutritional Status and Food Consumption Surveys, R. J. Somogyi and A. Szczygiel, eds., pp. 105-113. Basel: Karger.

Finch, Clement A.
1975 Erythropoiesis in Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 247-256. New York: Academic Press.

Fortuine, R.
1966 Acute Purulent Meningitis in Alaska Natives: Epidemiology, Diagnosis and Prognosis. Canadian Medical Association Journal 94:19.

Foster, George M.
1966 Social Anthropology and Nutrition of the Pre-School Child Especially as Related to Latin America. In Pre-School Child Malnutrition, National Academy of Sciences--National Research Council, Publication 1281, pp. 258-266. Washington, D. C.: NAS-NRC.

1972 The Anatomy of Envy: A Study in Symbolic Behavior. Current Anthropology 13(2):165-202.

Frisancho, A. Roberto
1974 Triceps Skin Fold and Upper Arm Muscle Size Norms for Assessment of Nutritional Status. American Journal of Clinical Nutrition 27:1052-1058.

Frisancho, A. Roberto, Stanley Garn and Werner Ascoli
1970 Childhood Retardation Resulting in Reduction of Adult Body Size Due to Lesser Adolescent Skeletal Delay. American Journal of Physical Anthropology 33:325-326.

Garcia, Frederick
1977 A Survey for Intestinal Parasites in Five Maya Indian Villages of Belize, C.A. Unpublished manuscript, Central Medical Laboratory, Belize City.

Garn, Stanley, Frances Larkin and Patricia Cole
1976 The Problem with One-Day Dietary Intakes. Ecology of Food and Nutrition 5:245-247.

Garn, Stanley, G. M. Owen and D. C. Clark
1974 The Question of Race Differences in Stature Norms. Ecology of Food and Nutrition 3:319-320.

Garn, Stanley, Helen Shaw and K. D. McCabe
1978 Effect of Socioeconomic Status on Early Growth as Measured by Three Different Indicators. Ecology of Food and Nutrition 7:51-55.

Garrow, J. S. and M. C. Pike
1967 The Long-Term Prognosis of Severe Infantile Malnutrition. Lancet I:1-4.

Gerlach, L. P.
1964 Socio-Cultural Factors Affecting the Diet of Northeast Coastal Bantu. Journal of the American Dietetic Association 45:420-424.

Gomez, F., R. Ramos-Galvan, J. Cravioto and S. Frenk
1955 Malnutrition in Infancy and Childhood with Special Reference to Kwashiorkor. In Advances in Pediatrics, Vol. VII, S. Z. Levine, ed. Chicago: Yearbook Publishers.

Gonzalez, Nancie and Moises Behar
1966 Child-Rearing Practices, Nutrition and Health Status. Milbank Memorial Foundation Quarterly 44:77-97.

Gopalan, C.
1968 Kwashiorkor and Marasmus: Evolution and Distinguishing Features. In Calorie Deficiencies and Protein Deficiencies, R. A. McCance and E. M. Widdowson, eds., pp. 49-62. Boston: Little Brown.

1975 Protein vs. Calories in PCM Treatment. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 329-351. New York: Academic Press.

Gordon, J. E., W. Ascoli, L. J. Mata, M. A. Guzmán and N. S. Scrimshaw
1968 Nutrition and Infection Field Study in Guatemalan Villages, 1959-1964. VI. Acute Diarrheal Disease and Nutritional Disorders in General Disease Incidence. Archives of Environmental Health 16:424.

Gordon, J. E., I. D. Chitkara and J. B. Wyon
1963 Weanling Diarrhea. American Journal of Medical Sciences 245:345.

Government of Belize
1976 Belize: New Nation in Central America. Belmopan: The Government Printer.

Graham, George G.
1968 The Later Growth of Malnourished Infants: Effects of Age, Severity and Subsequent Diet. In Calorie Deficiencies and Protein Deficiencies, R. A. McCance and E. M. Widdowson, eds., pp. 301-314. Boston: Little Brown.

Graham, George G. and Blanca Adrianzen
1971 Growth, Inheritance and Environment. Pediatric Research 5:691-697.

Greenberg, Idaz
1977 Guide to Corals and Fishes of Florida, the Bahamas and the Caribbean. Miami: Seahawk Press.

Gregory, James P.
1976 The Modification of an Interethnic Boundary in Belize. American Ethnologist 3:683-708.

1978 The Mopan: Socioeconomic Development and Ethnic Change. Paper presented at the 77th Meeting of the American Anthropological Association, Los Angeles.

Gross, Daniel and B. Underwood
1971 Technological Change and Calorie Costs: Sisal Agriculture in Northeastern Brazil. American Anthropologist 73:725-740.

Gutelius, M. F., F. Millican, E. Layman, G. Cohen and C. Dublin
1963 Treatment of Pica with a Vitamin and Mineral Supplement. American Journal of Clinical Nutrition 12:388-393.

György, Paul
1971 Biochemical Aspects. American Journal of Clinical Nutrition 24:970-975.

1975 Calories in the Treatment of Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 311-322. New York: Academic Press.

Habicht, Jean-Pierre, Reynaldo Martorell, Charles Yarbrough, Robert Malina and Robert E. Klein
1974 Height and Weight Standards for Preschool Children. How Relevant Are Ethnic Differences in Growth Potential? Lancet (April 6): 611-614.

Hamill, Peter, Terence Drizd, Clifford Johnson, Robert Reed and Alex Roche
1977 NCHS Growth Curves for Children Birth-18 Years, United States. Vital and Health Statistics, Series 11, No. 165. Hyattsville: USDHEW.

Hammond, Neil
1975 School Entrants Survey. In An Assessment of the Food and Nutrition Situation in Belize, Caribbean Food and Nutrition Institute, pp. 63-67. Kingston: CFNI.

Harfouche, Jamal Karam
1966 Growth and Illness Patterns of Lebanese Infants (Birth-18 Months). Beirut: Khayats.

Haviland, W. A.
1967 Stature at Tikal, Guatemala: Implications for Ancient Maya Demography and Social Organization. American Anthropologist 32:316-325.

Henderson, Peta H.
1972 A Sugar Usina in British Honduras. In Technology and Social Change, H. Russell Bernard and Pertti Pelto, eds., pp. 136-163. New York: Macmillan.

Hernandez, Mercedes, Adolfo Chávez and Hector Bourges
1977 Valor Nutritivo de Los Alimentos Mexicanos. Mexico: Instituto Nacional de La Nutricion.

Hernandez, Mercedes, Carlos Pérez Hidalgo, Juan Ramirez Hernandez, Herlinda Madrigal and Adolfo Chávez
1974 Effect of Economic Growth on Nutrition in a Tropical Community. Ecology of Food and Nutrition 3:283-291.

Hofvander, Y. and R. Eksmyr
1969 Changes in Upper Arm Circumference and Body Weight in a Two-Year Follow-Up of Children on Applied Nutrition Programme in a Representative Ethiopian Highland Village. Journal of Tropical Pediatrics 15:251.

Hoorweg, Jan and J. Paget Stanfield
1976 The Effects of Protein Energy Malnutrition in Early Childhood on Intellectual and Motor Abilities in Later Childhood and Adolescence. Developmental Medicine and Child Neurology 18:330-350.

Howard, Michael C.
1975 Ethnicity in Southern Belize, The Kekchi and the Mopan. Museum Brief No. 21. Colombia: University of Missouri-Colombia, Museum of Anthropology.

James, M. D.
1970 The Effect of Social Class in the Physical Growth of Nigerian Yoruba Children. Bulletin of the International Epidemiological Association 20:127-136.

Jelliffe, Derrick B.
1959 Protein-Calorie Malnutrition in Tropical Preschool Children. Journal of Pediatrics 54:227-256.

1962 Culture, Social Change and Infant Feeding. Current Trends in Tropical Regions. American Journal of Clinical Nutrition 10:19-43.

1966 The Assessment of the Nutritional Status of the Community. World Health Organization Monograph Series No. 53. Geneva: WHO.

1967 Parallel Food Classifications in Developing and Industrialized Countries. American Journal of Clinical Nutrition 20:279-281.

1968 Infant Nutrition in the Subtropics and Tropics. Second Edition. World Health Organization Monograph Series No. 29. Geneva: WHO.

Jelliffe, Derrick B., G. Bras and K. L. Short
1954 Kwashiorkor and Marasmus in Jamaican Infants. West Indian Medical Journal 3:43.

Jelliffe, Derrick B. and E. F. Patrice Jelliffe
1971 An Overview. American Journal of Clinical Nutrition 24: 1013-1024.

1978a National Policy and Young Child Nutrition. American Journal of Clinical Nutrition 31:1421-1424.

1978b The Volume and Composition of Human Milk in Poorly Nourished Communities, A Review. American Journal of Clinical Nutrition 31:492-515.

Jelliffe, Derrick B. and Hebe F. Welbourn
1963 Clinical Signs of Mild-Moderate Protein-Calorie Malnutrition of Early Childhood. In Mild-Moderate Forms of Protein-Calorie Malnutrition, Gunnar Blix, ed., Symposia of the Swedish Nutrition Foundation, pp. 12-30. Uppsala: Almqvist and Wiksells.

Jelliffe, E. F. Patrice and Derrick Jelliffe
1969a The Arm Circumference as a Public Health Index of Protein-Calorie Malnutrition of Early Childhood. Journal of Tropical Pediatrics, December: 179-188.

1969b The Arm Circumference as a Public Health Index of Protein-Calorie Malnutrition of Early Childhood. IX. Experience in the Caribbean. Journal of Tropical Pediatrics, December: 209-212.

Johnston, Francis E.
1978 Somatic Growth of the Infant and Preschool Child. In Human Growth. Volume 2. Postnatal Growth, Frank Falkner and J. M. Tanner, eds., pp. 91-116. New York: Plenum.

Joint FAO/WHO Expert Committee on Nutrition
1962 Sixth Report. World Health Organization Technical Report Series No. 245. Geneva: WHO.

1971 Eighth Report. Food Fortification-Protein Calorie Malnutrition. World Health Organization Technical Report Series No. 477. Geneva: WHO.

Katz, Solomon, Heidelise Rivinus and William Barker
1972 Physical Anthropology and the Biobehavioral Approach to Child Growth and Development. American Journal of Physical Anthropology 38:105-118.

Kawata, Kazuyoshi
1978 Water and Other Environmental Interventions--The Minimum Investment Concept. American Journal of Clinical Nutrition 31:2114-2123.

Kay, Margarita
1978 Clinical Anthropology. In The Anthropology of Health, Eleanor E. Bauwens, ed., pp. 3-11. St. Louis: C. V. Mosby.

Keller, W., G. Donoso and E. M. DeMaeyer
1976 Anthropometry in Nutritional Surveillance: A Review Based on Results of the WHO Collaborative Study on Nutritional Anthropometry. Nutrition Abstracts Review 46:591.

Kennell, John and Marshall Klaus
1979 Early Mother-Infant Contact: Effects on Breastfeeding. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 199-210. New York: Academic Press.

Kerns, Virginia
1977 Daughters Bring In: Ceremonial and Social Organization of the Black Carib of Belize. Ph.D. Dissertation. University of Illinois, Urbana-Champaign.

Klein, Robert E.
1979 Malnutrition and Human Behavior: A Backward Glance at an On-Going Longitudinal Study. In Malnutrition, Environment and Behavior, David Levitsky, ed., pp. 219-237. Ithaca: Cornell University Press.

Kleinman, David
1980 Human Adaptation and Population Growth. Montclair, N. J.: Allanheld, Osmun and Company.

Korte, R.
1972 Heat Resistance of Phytohemagglutinins in Weaning Food Mixtures Containing Beans (Phaseolus Vulgaris). Ecology of Food and Nutrition 1:303-307.

Kourany, M., M. A. Vasquez and L. J. Mata
1971 Prevalence of Pathogenic Enteric Bacteria in Children in 31 Panamanian Communities. American Journal of Tropical Medicine and Hygiene 20:608-621.

Lancet (no author)
1970 Classification of Infantile Malnutrition. Lancet (August 8): 302-303.

Latham, Michael
1978 Strategies to Control Infections in Malnourished Populations--Holistic Approach or Narrowly Targeted Interventions? American Journal of Clinical Nutrition 31:2292-2300.

1979 International Perspectives on Weaning Foods: The Economic and Other Implications of Bottle Feeding and the Use of Manufactured Weaning Foods. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 119-127. New York: Academic Press.

Lechtig, Aaron, Reynaldo Martorell, Hernan Delgado, Charles Yarbrough and Robert Klein
1976 Effect of Morbidity During Pregnancy on Birth Weight in a Rural Guatemalan Population.. Ecology of Food and Nutrition 5:225-233.

Lechtig, Aaron, Pedro Rosso, Hernan Delgado, Jorge Bassi, Reynaldo Martorell, Charles Yarbrough, Myron Winick and Robert Klein
1977 Effect of Moderate Maternal Malnutrition on the Levels of Alkaline Ribonuclease Activity in the Human Placenta. Ecology of Food and Nutrition 6:88-90.

Lindenbaum, J., J. Harmon and C. Gerson
1972 Subclinical Malabsorption in Developing Countries. American Journal of Clinical Nutrition 25:1056.

Logan, Michael H. and Carol Jenkins
n.d. Ethnicity and Family Planning at a Guatemalan Clinic. Unpublished manuscript.

Low, Setha
1978 Family Formation in Costa Rica. In The First Child and Family Formation, Warren Miller and Lucile Newman, eds., pp. 128-144. Chapel Hill: University of North Carolina Press.

Lowenstein, Frank
1963 The Vicious-Circle Mechanism in Production of Protein-Calorie Malnutrition. In Mild-Moderate Forms of Protein-Calorie Malnutrition, Gunnar Blix, ed., pp. 107-114. Uppsala: Almqvist and Wiksells.

Lowenstein, Matthew and James Phillips
1973 Evaluation of Arm Circumference Measurement for Determining Nutritional Status of Children and Its Use in an Acute Epidemic of Malnutrition: Owerri, Nigeria, Following the Nigerian Civil War. American Journal of Clinical Nutrition 26:226-233.

Lu, K. H. and B. S. Savara
1962 A Statistical Analysis of Relative Importance in Factors Affecting Weight Changes in Children from Three to Eight Years Old. Human Biology 3:1-19.

MacMahon, B., T. M. Lin, C. R. Lowe, A. P. Mirra, B. Kavnihar, E. J. Salber, D. Trichnopoulos, V. G. Valaaras and S. Yuasa
1970 Lactation and Cancer of the Breast. Bulletin of the World Health Organization 42:185.

Malcolm, L. A.
1973 Ecological Factors Relating to Child Growth and Nutritional Status. In Nutrition and Malnutrition, Identification and Measurement, Alexander Roche and Fran Falkner, eds., pp. 329-353. New York: Plenum.

1975 Some Biosocial Determinants of the Growth, Health and Nutritional Status of Papua New Guinean Preschool Children. In Biosocial Interrelations in Population Adaptation, E. Watts, F. Johnston and G. Lasker, eds., pp. 367-375. The Hague: Mouton.

Marchione, Thomas
1980 Factors Associated with Malnutrition in the Children of Western Jamaica. In Nutritional Anthropology, N. Jerome, G. Pelto and R. Kandel, eds., pp. 223-274. Pleasantville: Redgrave.

Marr, J. W.
1971 Individual Dietary Surveys--Purposes and Methods. World Review of Nutrition and Dietetics 13:105-164.

Martorell, Reynaldo and H. Delgado
1980 Maternal Size and Childhood Mortality in Malnourished Communities. Paper presented at the 49th Annual Meeting of the American Association of Physical Anthropologists, Niagara Falls.

Martorell, Reynaldo, A. Lechtig, C. Yarbrough, H. Delgado and R. Klein
1978 Energy Intake and Growth in an Energy Deficient Population. Ecology of Food and Nutrition 7:147-154.

Mata, Leonardo
1978 Breast-feeding: Main Promoter of Infant Health. American Journal of Clinical Nutrition 31:2058-2065.

Mata, Leonardo and Moises Behar
1975 Malnutrition and Infection in a Typical Rural Guatemalan Village: Lessons for the Planning of Preventive Measures. Ecology of Food and Nutrition 4:41-47.

Mata, Leonardo and J. J. Urrutia
1971 Intestinal Colonization of Breast-fed Children in a Rural Area of Low Socio-economic Level. Annals of the New York Academy of Sciences 176:93.

Mata, Leonardo, J. J. Urrutia and A. Lechtig
1971 Infection and Nutrition of Children of a Low Socio-Economic Rural Community. American Journal of Clinical Nutrition 24:249-259.

Mata, Leonardo and Richard Wyatt
1971 Host Resistance to Infection. American Journal of Clinical Nutrition 24:977-985.

Mathias, Elizabeth
1979 Modernization and Changing Patterns of Breastfeeding: The Sardinian Case. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 75-80. New York: Academic Press.

May, Jacques and Donna McLellan
1972 The Crown Colony of British Honduras. In The Ecology of Malnutrition in Mexico and Central America, pp. 123-158. New York: Hafner.

Mazzarelli, Marcella
1967 Intercommunity Relations in British Honduras. Human Organization 26(4):222-229.

Medical Department Reports
1979 Gomez Grades of 0-36 Months Old Children Attending Child Health Clinics, 1975-1978 by District. Unpublished mimeo. Medical Department of Belize.

Metcoff, Jack
1975 Cellular Energy Metabolism in Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 65-85. New York: Academic Press.

Miall, W. E., Patricia Desai and K. Standard
1970 Malnutrition, Infection and Child Growth in Jamaica. Journal of Biosocial Science 2:13-44.

Middleton, John
1967 Magic, Witchcraft and Curing. Austin: University of Texas Press.

Mondot-Bernard, Jacqueline M.
1977 Relationships Between Fertility, Child Mortality and Nutrition in Africa. Paris: Development Centre of the Organization for Economic Co-operation and Development.

Monsen, Elaine
1980 Simplified Method for Calculating Available Dietary Iron. Food and Nutrition News 51(4):1-4.

Montgomery, Edward
1977 Social Structuring of Nutrition in Southern India. In Malnutrition, Behavior and Social Organization, Lawrence Greene, ed., pp. 143-170. New York: Academic Press.

Moodie, A. D., M. P. Keet, D. E. Evans, W. Wittmann and J. D. Hansen
1972 Environmental Stress and the Underprivileged Child. Kwashiorkor in Perspective. Ecology of Food and Nutrition 1:95-101.

Moore, H. A., E. DeLaCruz and O. Vargas
1966 Diarrheal Disease Studies in Costa Rica: IV. The Influence of Sanitation upon the Prevalence of Intestinal Infection and Diarrheal Disease. American Journal of Epidemiology 82:162.

Morley, David
1973 Paediatric Priorities in the Developing World. London: Butterworths.

Morley, David, Joan Bicknell and Margaret Woodland
1968 Factors Influencing the Growth and Nutritional Status of Infants and Young Children in a Nigerian Village. Transactions of the Royal Society of Tropical Medicine and Hygiene 62(2):164.

Muñoz deChavez, Miriam, Pedro Arroyo, Sara Elena Pérez Gil, Mercedes Hernandez, Sara Eugenia Quiroz, Marina Rodriquez, Mirta P. DeHermelo and Adolfo Chávez
1974 The Epidemiology of Good Nutrition in a Population with a High Prevalence of Malnutrition. Ecology of Food and Nutrition 3:223-230.

McIntosh, Curtis
1980 Food and Nutrition Problems Associated with Natural Disasters. Cajanus 13(1):18-27.

McKay, D. A.
1969 Experience with the Mid-Arm Circumference as a Nutritional Indicator in Field Surveys in Malaysia. Journal of Tropical Pediatrics 15:205.

McKeown, Thomas, R. G. Brown and R. G. Record
1972 An Interpretation of the Modern Rise of Population in Europe. Population Studies 26(3):345-370.

McKigney, John
1971 Economic Aspects. American Journal of Clinical Nutrition 24:1005-1012.

McLaren, Donald S.
1974 The Great Protein Fiasco. Lancet II (July): 93-96.

1975 The Fat-Soluble Vitamins and Protein-Calorie (Energy) Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 181-200. New York: Academic Press.

McLaren, Donald S. and P. L. Pellett
1970 Nutrition in the Middle East. World Review of Nutrition and Dietetics 12:43.

McLaren, Donald S., Umayma Yaktin, Abdullah Kanawati, Sanaa Sabbagh and Zeina Kadi
1975 The Relationship of Severe Marasmic Protein-Energy Malnutrition and Rehabilitation in Infancy to Subsequent Mental Development. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 107-112. New York: Academic Press.

Newman, James
1970 The Ecological Basis for Subsistence Change among the Sandawe of Tanzania. Washington, D. C.: National Academy of Sciences.

Newman, Marshall T.
1975 Nutritional Adaptation in Man. In Physiological Anthropology, Albert Damon, ed., pp. 210-259. New York: Oxford University Press.

Newton, Niles
1971 Psychologic Differences Between Breast and Bottle Feeding. American Journal of Clinical Nutrition 24:993-1004.

Nickens, Paul
1976 Stature Reduction as an Adaptive Response to Food Production in Mesoamerica. Journal of Archaeological Science 3:31-41.

Nietschmann, Bernard
1973 Between Land and Water. New York: Seminar Press.

Niswander, Kenneth and Myron Gordon, editors
1972 The Women and Their Pregnancies. Department of Health, Education and Welfare Publication No. (NIH) 73-379. Washington, D. C.: U.S. Government Printing Office.

Nocks, Barry N.
1967 Nutrition Study in British Honduras. American Journal of Clinical Nutrition 20:661-671.

Ortiz deMontellano, Bernard
1975 Empirical Aztec Medicine. Science 188:215-220.

Pellett, P. L.
1977 Marasmus in a Newly Rich Urbanized Society. Ecology of Food and Nutrition 6:53-56.

Pigott, Jeralyn and Kathryn Kolasa
1979 Prevalence of Malnutrition and Dietary Habits of Preschoolers in a Rural Guatemalan Village. Ecology of Food and Nutrition 8:71-78.

Prasad, A. S., J. A. Halsted and M. Nadimi
1961 Syndrome of Iron Deficiency Anemia, Hepatosplenomegaly, Hypogonadism, Dwarfism and Geophagia. American Journal of Medicine 31:532-541.

Puffer, Ruth, C. V. Serrano and Ann Dillon
1971 The Inter-American Investigation of Mortality in Childhood. Washington, D. C.: PAHO/WHO.

Puffer, Ruth and C. V. Serrano
1973 Patterns of Mortality in Childhood. Washington, D. C.: PAHO.

Puffer, Ruth
1979 Breastfeeding in Latin American Projects. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 163-176. New York: Academic Press.

Puri, R. K., G. Asok Kumar, K. K. Khanna and D. C. Prasada Rao
1976 Infant Feeding and Its Effect on Growth and Development of Children. Indian Journal of Pediatrics 43(347):361-367.

Purohit, Mira, N. N. Purohit, S. Saxena and J. B. Mehta
1977 Effect of Various Factors Influencing Physical Growth of Indian Infants from Birth to Six Months: A Longitudinal Study. Indian Journal of Pediatrics 44:328-341.

Rajalakshmi, R.
1979 Lactation Performance as a Function of Nutrition and Social Class. In Breastfeeding and Food Policy in a Hungry World, Dana Raphael, ed., pp. 183-188. New York: Academic Press.

Rao, T.M.V. Prasada, J. Gowrinath Sastry and K. Vijayaraghaban
1974 Nutritional Status of Children in Urban Slums Around Hyderabad City. Indian Journal of Medical Research 10: 1492-1498.

Rao, Visweswara and C. Gopalan
1969 Nutrition and Family Size. Indian Journal of Nutrition and Dietetics 6:258-266.

Rao, Visweswara and N. Pralhad Rao
1975 Association of Growth Status and the Incidence of Nutritional Deficiency Signs. American Journal of Clinical Nutrition 28:209-215.

Rao, Visweswara and Darshan Singh
1970 An Evaluation of the Relationship Between Nutritional Status and Anthropometric Measurements. American Journal of Clinical Nutrition 23:83-93.

Raphael, Dana
1973 The Role of Breastfeeding in a Bottle-Oriented World. Ecology of Food and Nutrition 2:121-126.

Raphael, Dana, editor
1979 Breastfeeding and Food Policy in a Hungry World. New York: Academic Press.

Rea, J. N.
1971 Social and Economic Influences on the Growth of Pre-School Children in Lagos. Human Biology 43:46-63.

Robson, John R. K.
1974 The Ecology of Malnutrition in a Rural Community in Tanzania. Ecology of Food and Nutrition 3:61-72.

Roche, Alexander and Frank Falkner, editors
1973 Nutrition and Malnutrition, Identification and Measurement. Advances in Experimental Medicine and Biology, Volume 49. New York: Plenum.

Rosa, F. W. and M. Turshen
1970 Fetal Nutrition. Bulletin of the World Health Organization 43:785-795.

Rowland, M.G.M., T. J. Cole and R. G. Whitehead
1977 A Quantitative Study into the Role of Infection in Determining Nutritional Status in Gambian Children. British Journal of Nutrition 37:441.

Rubenstein, A., J. Boyle, C. Doroff and S. Kunitz
1969 Effect of Improved Sanitary Facilities on Infant Diarrhea in a Hopi Village. Public Health Reports 84:1093.

Russell, Stephen M.
1964 A Distributional Study of the Birds of British Honduras. Ornithological Monograph No. 1. American Ornithologists' Union. Baton Rouge: Louisiana State University Press.

Rutstein, Shea and Vilma Medica
1978 The Latin American Experience. In The Effects of Infant and Child Mortality on Fertility, Samuel Preston, ed., pp. 93-112. New York: Academic Press.

Sanford, Margaret
1974a A Socialization in Ambiguity: Child-Lending in a British West Indian Society. Ethnology 13(4):393-414.

1974b Revitalization Movements as Indicators of Completed Acculturation. Comparative Studies in Society and History 16(4):504-518.

1976 Child Lending in Belize. Belizean Studies 4(2):26-36.

Sanjur, D. M., J. Cravioto, L. Rosales and A. Van Veen
1970 Infant Feeding and Weaning Practices in a Rural Pre-industrial Setting. A Sociocultural Approach. Acta Paediatrica Scandinavia, Supplement 200, Stockholm.

Sanstead, Harold H.
1975 Mineral Metabolism in Protein Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 213-220. New York: Academic Press.

Saul, Frank P.
1972 The Human Skeletal Remains of Altar De Sacrificios. Cambridge: Peabody Museum.

Schneider, R. E., M. Shiffman and J. Faigenblum
1978 The Potential Effect of Water on Gastrointestinal Infections Prevalent in Developing Countries. American Journal of Clinical Nutrition 31:2089-2099.

Scholl, Theresa O., Francis E. Johnston, Joaquin Cravioto, Elsa DeLicardie and Deborah Lurie
1979 The Relationship of Growth Failure (Chronic Undernutrition) to the Prevalence of Clinically Severe Protein-Energy Malnutrition and to Growth Retardation in Protein-Energy Malnutrition. American Journal of Clinical Nutrition 32:872-878.

Scrimshaw, Nevin
1975 Interactions of Malnutrition and Infection: Advances in Understanding. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 354-368. New York: Academic Press.

Scrimshaw, Nevin, Carl Taylor and John Gordon
1968 Interactions of Nutrition and Infection. World Health Organization Monograph Series No. 57. Geneva: WHO.

Scrimshaw, Susan
1978 Stages in Women's Lives and Reproductive Decision-Making in Latin America. Medical Anthropology 2(3):41-58.

Segal, Aaron
1975 Population Policies and the Caribbean Crisis. In Population Policies in the Caribbean, Aaron Segal, ed., pp. 1-24. Lexington: Lexington Books.

Seone, N. and M. C. Latham
1971 Nutritional Anthropometry in the Identification of Malnutrition in Childhood. Journal of Tropical Pediatrics and African Child Health 17:98-104.

Short, R. V.
1976 Lactation--The Central Control of Reproduction. In Breast-Feeding and the Mother. Ciba Foundation Symposium, pp. 73-86. London: Elsevier.

Sims, Laura, Beatrice Paolucci and Portia Morris
1972 A Theoretical Model for the Study of Nutritional Status. An Ecosystem Approach. Ecology of Food and Nutrition 1: 197-205.

Sims, Laura and Helen Smiciklas-Wright
1978 An Ecological Systems Perspective: Its Application to Nutrition Policy, Program Design and Evaluation. Ecology of Food and Nutrition 7:173-179.

Sinha, Dinesh P.
1979 Oral Rehydration in Diarrheal Diseases: A Simple Solution to a Complex Problem. Cajanus 12(3):138-149.

Solien deGonzalez, Nancie
1963 Breast-Feeding, Weaning and Acculturation. Tropical Pediatrics 62(4):577-581.

Stavrakis, Olga and Omawale
1978 Sugarcane Development and Child Nutrition in Belize, Central America. Paper presented at the Southern States Anthropology Association Meetings, Kentucky.

Stewart, W. H., L. J. McCabe, E. C. Hemphill and T. DeCapito
1955 Diarrheal Disease Control Studies: IV. The Relationship of Certain Environmental Factors to the Prevalence of Shigella Infection. American Journal of Tropical Medicine and Hygiene 4:718.

Stini, William A.
1972 Malnutrition, Body Size and Proportion. Ecology of Food and Nutrition 1:121-126.

1975 Adaptive Strategies of Human Populations under Nutritional Stress. In Biosocial Interrelations in Population Adaptation, E. Watts, F. Johnston and G. Lasker, eds., pp. 19-41. The Hague: Mouton.

Teller, Charles, Ricardo Sibrian, Cesar Talavera, Vernon Bent, Juan Del Canto and Lenin Saenz
1979 Population and Nutrition: Implications of Sociodemographic Trends and Differentials for Food and Nutrition Policy in Central America and Panama. Ecology of Food and Nutrition 8:95-109.

Tonon, Marilyn
1978 Models for Educational Interventions in Malnourished Populations. American Journal of Clinical Nutrition 31:2279-2283.

Trivedi, B. K., H. S. Gandhi and N. K. Shukla
1971 Bacteriological Water Quality and Incidence of Water-Borne Diseases in a Rural Population. Indian Journal of Medical Sciences 25(11):795.

Valverde, Victor, Reynaldo Martorell, Victor Mejia-Pivaral, Hernan Delgado, Aaron Lechtig, Charles Teller and Robert E. Klein
1977 Relationship Between Family Land Availability and Nutritional Status. Ecology of Food and Nutrition 6:1-7.

Vamoer, A. P.
1969 Report on Nutrition in Zambia. In Proceedings of the Eastern African Conference on Nutrition and Child Feeding, pp. 152-173. Nairobi.

Vasquez, Maria
1975 Improving Feeding Patterns of Infants in Belize. Unpublished manuscript.

Waddell, D.A.G.
1961 British Honduras: A Historical and Contemporary Survey. Oxford: Oxford University Press.

Waldmann, E.
1975 The Ecology of the Nutrition of the Bapedi, Sekhukuniland. Ecology of Food and Nutrition 4:139-151.

1976 Early Bapedi Growth in Sekhukuniland, Transvaal, South Africa. Ecology of Food and Nutrition 5:133-141.

Walker, Alexander
1967 Interpretation of Biological Data on One Ethnic or Regional Group May Not Be Equally Applicable to Other Groups. American Journal of Clinical Nutrition 20(9):1025-1039.

Waterlow, J. C.
1948 Fatty-Liver Disease in Infants in the British West Indies. Special Reports of the Medical Research Council (London). No. 263. London.

1963 Metabolic Disturbances in Protein-Calorie Malnutrition. In Mild-Moderate Forms of Protein-Calorie Malnutrition, Gunnar Blix, ed., pp. 47-59. Upssala: Almqvist and Wiksells.

1972 Classification and Definition of Protein-Calorie Malnutrition. British Medical Journal 3:566-569.

1973 Note on the Assessment and Classification of Protein-Energy Malnutrition in Children. Lancet II: 87.

1975 Adaptation to Low-Protein Intakes. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 23-35. New York: Academic Press.

Waterlow, J. C. and G.A.O. Alleyne
1971 Protein Malnutrition in Children: Advances in Knowledge in the Last Ten Years. Advances in Protein Chemistry 25:117.

Waterlow, J. C., R. Buzina, W. Keller, J. M. Lane, M. Z. Nichaman and J. M. Tanner
1977 The Presentation and Use of Height and Weight Data for Comparing the Nutritional Status of Groups of Children Under the Age of 10 Years. Bulletin of the World Health Organization 55(4):489-498.

Waterlow, J. C. and I. H. Rutishauer
1974 Malnutrition in Man. In Early Malnutrition and Mental Development. Symposia of the Swedish Nutrition Foundation XII, pp. 13-26. Uppsala: Almqvist and Wiksells.

Watt, J., M. D. Hollister, M. Beck and E. Hemphill
1955 Diarrheal Disease in Fresno County, California. American Journal of Public Health 45:354.

Weir, J. M., I. M. Wasif, F. R. Hassan, S. M. Attia and M. A. Kader
1952 An Evaluation of Health and Sanitation in Egyptian Villages. Journal of Egyptian Public Health Association 27:55-76.

Wellin, Edward
1955 Water Boiling in a Peruvian Town. In Health, Culture and Community, Benjamin Paul, ed., pp. 71-103. New York: Russell Sage Foundation.

White, G. F., T. J. Bradley and A. White
1972 Drawers of Water: Domestic Water Use in East Africa. Chicago: University of Chicago Press.

White, Hilda
1975 Dietary Iron and Anemia. Nutrition and the M.D. 2(1):1-2.

Williams, Cicely
1933 A Nutritional Disease of Children Associated with a Maize Diet. Archives of Disease in Childhood 8:434.

1935 Kwashiorkor. A Nutritional Disease of Children Associated with a Maize Diet. Lancet 2:1151.

1978 Cultural and Other Barriers in the Implementation of Health Programs. American Journal of Clinical Nutrition 31:2037-2039.

Winick, Myron and Pedro Rosso
1969 Head Circumference and Cellular Growth of the Brain in Normal and Marasmic Children. Journal of Pediatrics 74:774.

1975 Brain DNA Synthesis in Protein-Calorie Malnutrition. In Protein-Calorie Malnutrition, Robert Olson, ed., pp. 93-102. New York: Academic Press.

Wolman, A.
1975 Environmental Sanitation in Urban and Rural Areas: Its Importance in the Control of Enteric Infections. Bulletin of the Pan American Health Organization 9(2):157.

World Health Organization Expert Committee
1965 Nutrition and Infection. Technical Report Series No. 314. Geneva: WHO.

World Health Organization
1976 Treatment and Prevention of Dehydration in Diarrhoeal Diseases--A Guide for Use at the Primary Level. Geneva: WHO.

World Health Organization Report of Advisory Group
1978 Development of a Programme for Diarrhoeal Disease Control. WHO/DDC/78.1. Geneva: WHO.

Wray, Joe D. and A. Aguirre
1969 Protein Calorie Malnutrition in Candelaria, Colombia. I. Prevalence; Social and Demographic Causal Factors. Journal of Tropical Pediatrics 15(3):76-98.

Wray, Joe D.
1971 Population Pressure on Families. Family Size and Child Spacing. In Rapid Population Growth: Consequences and Policy Implications. Volume 2. Baltimore: Johns Hopkins University Press.

1978 Direct Nutrition Intervention and the Control of Diarrheal Diseases in Preschool Children. American Journal of Clinical Nutrition 31:2073-2082.

Yarbrough, Charles, Jean-Pierre Habicht, Reynaldo Martorell and Robert Klein
1973 Anthropometry as an Index of Nutritional Status. In Nutrition and Malnutrition, Identification and Measurement, Alexander Roche and Frank Falkner, eds., pp. 15-26. New York: Plenum.

Yerushalmy, J., M. D. Bierman, D. H. Kemp, A. Connor and F. E. French
1956 Longitudinal Studies of Pregnancy on the Island of Kauai, Territory of Hawaii. American Journal of Obstetrics and Gynecology 71:80.

Zamenhof, Stephen and G. B. Holzman
1973 Study of Correlations Between Head Circumferences, Placental Parameters and Neonatal Body Weights. Obstetrics and Gynecology 41:855.

Zamenhof, Stephen and Edith Van Marthens
1979 Study of Some Nutritional and Regulatory Factors Affecting Prenatal Brain Development. In Malnutrition, Environment and Behavior, David Levitsky, ed., pp. 56-77. Ithaca: Cornell University Press.

APPENDIX

APPENDIX

SUPPLEMENTARY INFORMATION

Table 32. Clinic Interview Schedule.

Items
1. Mother's married name, maiden name, and age
2. Father's name and age
3. Home villages of each parent
4. Present residence
5. Number of years at present residence
6. The ethnic identity of each parent
7. The number of living children and number of children in household
8. The number of miscarriages and stillbirths
9. The number and sex of deceased children
10. The name and ethnic affiliation of the child to be measured
11. The child's birthdate
12. The child's birth order
13. When the child was not living with its own nuclear family, the number of children in the household and the child's order among them
14. The child's birthweight
15. The type of birth attendant used and place of birth
16. Feeding pattern since birth:relative amounts of breast to bottle
17. Duration, in months, of breastfeeding
18. The type of bottle feeds used
19. The present type of milk (or formula) drunk
20. The age at introduction to first semi-solid foods
21. The type of semi-solids used
22. The age at introduction to first solid foods
23. The type of solids used
24. The frequency and severity of diarrhea
25. The frequency and severity of colds
26. The frequency and severity of fevers unaccompanied by other obvious symptoms
27. Known episodes of parasitic infections; frequency of worming; methods used
28. Foods withdrawn and methods used for the treatment of diarrhea
29. The frequency and severity of pica
30. The child's present appetite
31. Observations noted on obvious symptoms, e.g., swollen belly, conjunctivitis, depigmentation of hair or skin, skin sores, herniated umbilicus, etc.

Table 33. Plant Foods.

Common Name	Scientific Name	Spanish Name	Garifuna Name	Creole Name	Maya Name
Almond	Prunus dulcis	almendras	hammond	hammond	hammond
Annatto	Bixa orellana	achiote	guseue	rucu, natto	kusub
Avocado	Persea americana	aguacate	uagadi	butter pear, alligator pear	on
Banana	Musa sapientum	gineo	bimina	banana	gineo, sak haas
Black beans	Phaseolus vulgaris	frijoles negros	aife woorit	black beans	bux bool
Breadfruit	Artocarpus altilis	mazapan	fei faruda	breadfruit	mazapan
Bucut	?	bucut	bucut	bucut	bucut
Cabbage	Brassica oleracea	repoyo	cabbage	cabbage	repoyo
Callaloo	Amaranthus spp.	chaya	callaloo	callaloo, jackatoo	chayok, chai
Cantaloupe	Cucumis melo	cantalupo	cantalope	melon	cantalupo
Carrot	Daucus carota	zanahoria	carrot	carrot	carrot
Cashew	Anacardium occidentale	marañon	úrui	caju	marañon
Chestnut	Castanea spp.	castaña	chestnut	lee breadfruit	castaña
Christophine, Custard Marrow	Sechium edule	chayote	cho cho	cho cho	ch'um, huiskil
Coconut	Cocos nucifera	coco	faluma	coconut	coco
Cocoyam, Taro, Dasheen	Colocasia spp.	makal	uahu, simuruna	taya, coco, tannia	makal, škukut makal
Corn	Zea mays	maiz (if green, elote)	auasi	corn	ixim
Cucumber	Cucumis sativus	pepino	cucumber	cucumber	pepino
Custard Apple	Annona reticulata	anona	gusu	custard apple, anona	oop
Eggplant	Solanum melongena	berenjena	--	garden egg	--

Table 33 (Continued)

Common Name	Scientific Name	Spanish Name	Garifuna Name	Creole Name	Maya Name
Garlic	Allium sativa	ajo	lai	garlic	ajo
Ginger	Zangiber officianale	jengibre	chichamber	ginger	ginger
Guava	Psidium guajava	guayaba	uariuf	guava	pitši, guayaba
Grapefruit	Citrus paradisi	toronja	čarigi	grapefruit	toronja
Hogplum	Spondias purpurea	jocote	hogplum	hogplum	abil
Irish potato	Solanum tuberosum	papa	mabi	potato	papa
Jicama	Pachyrhizus erosus	jicama	jicama	jicama	tšikam
Lime, sweet	Citrus aurantifolia	limón	sinduri	sweet lime	limón
Lime, sour, Jamaican lime	Citrus aurantifolia	lima	sinduri	sour lime, Jamaican lime	lima
Mamey	Lucuma mammosa	zapote	sabudi	mamey apple	tšakal haas
Mango	Mangifera indica	mango	mangu	mango	mango
Manioc	Manihot esculenta Crantz	yuca			
sweet		yuca dulce	gumánana	casaba	tzin
bitter		yuca agria	gai	casaba	tzin
Nance	Byrsonima crassifolia	nance	murei	crabu	tši
Okra	Abelmoschus esculentus	okro	inehu	okro	okro
Onion	Allium cepa	cebollo	sibuia	onion	cebollo
Orange	Citrus sinensis	naranja	oranshu	orange	china, paqal
Palm hearts	Oreodoxa oleracea	palmetto	harada	cabbage palm	koxang
Papaya	Carica papaya	papaya	ababou	pawpaw	put
Peanut	Arachis hypogaea	cacahuate	mali, pinda (sing) gagawadi (pl)	pinda	cacahuate
Peppers	Capsicum spp.	chile (chile dulce, habanera, pequin, etc.)	ati	pepper	xuk ik

Table 33 (Continued)

Common Name	Scientific Name	Spanish Name	Garifuna Name	Creole Name	Maya Name
Pineapple	Ananas comosus	piña	ieieua	pineapple	piña
Plantain	Musa paradisiaca	platano	baruru	plaan	ixik
Pumpkin	Curcubita maxima	calabaza	ueíama	calabash	k'um
Pumpkin seeds	Curcubita maxima	pepitos	tili ueíama	pepitos, calabash seeds	sik
Red (or kidney) Beans	Phaseolus vulgaris	frijoles rojos	aife	red beans	tšuk bool
Rice	Oryza sativa	arroz	ri	rice	arroz
Sapodilla	Sapota zapotilla	chicozapote	sapodilly	sapodilly	ya, chicozapote
Sea Grape	Coccoloba uvifera	uva de la playa	baibai	sea grape	--
Sesame seeds	Sesamum indicum	ajonjoli	uóngula	wonglo	wonglo
Soursop	Annona muricata	guanabana	gurusuru	soursop	guanabana
Squash	Cucurbito pepo	calabaza	calabash	marrow, calabash	gum, štšum
Star Apple	Chrysophyllum cainito	caimito	--	star apple	sikiya
Sugar Cane	Saccharum officiarum	caña	uirígiru gaña	cane	to
Sweet Potato	Ipomaea batatas	camote	mabi	sweet potato	is
Tangerine	Citrus reticulata	mandarina	--	--	--
Tomato	Lycopersicon esculentum	tomate	dumadi	tomato	p'ak
Watermelon	Citrullus lanatus	sandia	badia	watermelon	sandia
Wild Pineapple	Ananas sativa	piña de monte	garaua	wild pineapple	piña de monte
Yam	Dioscorea trifedi	llame	guču	yampie	payak

Table 34. Game Animals.*

Common Name	Scientific Name	Spanish Name	Garifuna Name	Creole Name	Maya Name
Agouti	Dasyprocta punctata	agouti	aguri	kiaki	?
Armadillo	Dasypus sp.	armadillo	gasígamu	hammadilly	vetch
Brocket Deer	Mazama americana	venado colorado	--	antelope	yuk
Chachalaka	Ortalis vetula	chachalaka	--	crawkicraw, cockrico	batch
Collared Peccary	Pecari tajacu	kekeo	gigeu	pecari	kek'entše
Crested Guan	Penelope purpurascens	quam	quam	quam	kox
Crocodile	Crocodylus sp.	crocodillo	agari	alligator	ayin
Curassow	Crax rubra	faisan, cojolito (m.)	faisan	pheasant	kambool
Iguana	Iguana sp.	iguana gorobo (m.)	uaiamugu	bamboo chicken	iguana
Manatee, Dugong	Trichechus sp.	manati	manadi	manantee	tek
Paca	Cuniculus paca	tepesquinte	gibinadu	gibnut	haleb
Rabbit	Sylvilagus sp.	conejo	masaraga	coney	serek
Spotted Wood Quail	Odontophorus guttatus	?	?	partridge	bale
Tapir	Tapirella bairdi	danda	dandai	mountain cow	tsiminche
White-lipped Peccary	Tayussu pecari	jabali	howia	warri	kitam
White-tailed Deer	Odocoileus virginiana	venado	usari	deer	keh
Wild Turkey	Agriocharis ocellata	pavo de monte	figaga wait	wild turkey	yax kutz

*Birds were identified with the aid of Russell 1964.

Table 35. Domestic Animals and Their Products.

Common Name	Spanish Name	Garifuna Name	Creole Name	Maya Name
Beef	res	uiandu	beef	res
Butter	mantequilla	beru	buttah	mantequilla
Cheese	queso	furumas	cheese	queso
Chicken	pollo	gaiu	chicken	pollo
Duck	pato	ganaru	duck	pato
Eggs	huevos	gaiye	eggs	huevos, eggs
Goose	ganso	wanana	goose	--
Honey	miel	maba	honey	caab
Lard	manteca	agule buiruhu	lard	manteca
Milk	leche	miligi	milk	leche
Pork	cerco, puerco	buiruhu	pork	cerco, puerco
Sheep	carnero	mudu	mutton	sheep, mutton
Turkey	pavo	figaga	turkey	pavo

Table 36. Seafoods.[a]

Common Name	Scientific Name	Garifuna Name	Creole Name
Angelfish	Holocanthus spp. and Pomocanthus spp.	uagaua	
Balao	Hemiramphus balao	barou	
Ballyhoo	Hemiramphus brasiliensis	barou	
Bermuda chub	Kyphosus sectatrix	cockabelly	cockabelly
Blue Crab	Cardisoma guanhumi	harauru	rotti
Bonefish	Albula vulpes	masímasi	boneyfish
Bonita	Thunnus spp.	bunigi	tunny
Catfish	Bagre marinus	bagu	cattó
Coney	Epinephelus fulvis	butterfish	butterfish
Coral Crab	Carpilius corallinus	maguiama	
Crayfish (river)	?	isuru	crayfish
Great Barracuda	Sphyraena barracuda	iamúra	barrow
Greenback Turtle (also called Yellowfin)	Chelonia mydas	gadáru	
Grouper	Diplectrum spp.	carupa	
Grunt	Haemulon spp.	guweguru	
Hairy Crab	?	gusa	
Hammerhead Shark	Sphyrna mokarran	baiara	
Hawksbill Turtle	Eretmochelys imbricata	gáraru	
Hickatee Turtle (freshwater)	Pseudomys sp.	higidi	bocatora
Hogfish	Lachnolaimus maximus	portana	
Horse conch	Strombus spp.	uadabu	conk
Horse-eye Jack	Caranx latus	uenamutagu	
Houndfish	Tylosurus crocodilus	gonbiri	
Jack	Caranx spp.	biliwar	
Jewfish	Epinephelus itajara	inegu	
Kingfish	Scomber cavalla	auaui	
Land Crab	Ocypode spp.?	horo	crab, sirik
Leatherback Turtle	Dermochelys coriacea	abaradaru	

Table 36 (Continued)

Common Name	Scientific Name	Garifuna Name	Creole Name
Little conch	Strombus spp.	paigu	
Loggerhead Turtle	Caretta caretta	gauamu	
Mackeral	Scombermorus spp.	uarubi	
Marbled Grouper	Epinephelus inermus	pampana (from Spanish)	
Nurse Shark	Ginglymostroma cirratum	alaidi	
Octopus	Octopus spp.	arari	
Orange Filefish	Cantherhines pullus	gasoedere	
Oyster	Crassastrea rhizophora	suindiri	
Peacock Flounder	Bathus lunatus	pejacarte (from Spanish	
Reef Catfish	Cynoscion jamaicensis?	buganshaw	woolgai
Red Grouper	Epinephelus morio	guchalali	rockfish
Reef Croaker	Odontoscion dentex	drummer	drummer
Rock Hind	Epinephelus adscensionis	Jimmy Hine	Jimmy Hine
Sand Drum	Umbrina coroides	drummer	drummer
Shrimp	Penaeus spp.	isu, gemarou	
Smalltooth Sawfish	Pristis pectinata	gasiara	
Snapper	Lutjanus spp.	galali	
Snook	Centropomus undecimalis	burutoba	tuba
Southern Sennet	Sphyraena picudilla	uouangu	
Southern Stingray	Dasyatis americana	sibari	
Spiney Lobster	Panulirus argus	hagauaru	
Spotted Eagle Ray	Aetobatus narinari	uagaua	
Squid		arari	
Tarpon	Megalops atlantica	haba	
Tiger Shark	Galeocerdo cuvieri	weibayuwa	
Turbot	Balistis vetula	hanau	Old Wife
Whiting	Sillago silama	hasulali	
Yellow Jack	Caranx bartholomaei	iauaridi	cobali
Yellow Stingray	Urolophus jamaicensis	surudunot	

Table 36 (Continued)

[a]The Garifuna possess an extensive knowledge of sea animal life. Generally, people living inland have very limited knowledge of varieties of fish. Hence, Garifuna is the principal language reported here. Where distinct Creole terms are known, they too are reported. Identifications were verified using the fine illustrations in Greenberg (1977). This list represents most of the commonly eaten varieties but is not exhaustive.

Table 37. Weight Data--Total Sample by Age and Sex.

Age and Sample Size			Weight in Kilograms		
Age in Months	Midpoint	Number	Mean	S.D.	Median
		Males			
0-3	1.5	24	4.92	1.06	4.84
3-6	4.5	34	6.58	0.99	6.45
6-9	7.5	39	7.88	1.33	8.04
9-12	10.5	21	8.77	1.22	9.09
12-18	15.0	45	9.09	1.81	9.49
18-30	24.0	60	10.97	1.49	11.14
30-42	36.0	49	12.85	1.93	12.93
42-54	48.0	61	14.34	2.27	14.77
54-66	60.0	27	15.31	2.10	15.63
		Females			
0-3	1.5	28	4.36	0.88	4.45
3-6	4.5	31	6.40	0.80	6.44
6-9	7.5	21	7.73	0.94	7.73
9-12	10.5	23	8.31	1.39	8.35
12-18	15.0	51	8.82	1.48	8.96
18-30	24.0	75	10.71	1.75	10.57
30-42	36.0	75	12.53	1.81	12.27
42-55	48.0	41	13.67	1.89	13.47
54-66	60.0	26	14.67	1.98	14.77

Table 38. Stature Data--Total Sample by Age and Sex.

Age and Sample Size			Stature in Centimeters		
Age in Months	Midpoint	Number	Mean	S.D.	Median
			Males		
0-3	1.5	24	57.08	3.29	57.30
3-6	4.5	32	63.54	3.35	63.30
6-9	7.5	39	67.65	3.61	68.00
9-12	10.5	21	72.07	3.03	72.50
12-18	15.0	46	74.55	6.05	75.00
18-30	24.0	61	81.08	5.60	82.00
30-42	36.0	50	89.01	5.81	88.00
42-54	48.0	62	95.38	5.95	97.20
54-66	60.0	28	100.46	5.60	101.00
			Females		
0-3	1.5	29	55.14	3.98	56.00
3-6	4.5	31	63.24	2.92	63.30
6-9	7.5	24	65.75	4.21	66.00
9-12	10.5	23	70.17	4.30	70.50
12-18	15.0	52	73.40	5.97	74.10
18-30	24.0	74	81.05	4.67	80.85
30-42	36.0	77	88.50	5.39	88.45
42-54	48.0	43	93.94	5.37	94.00
54-66	60.0	26	97.91	6.30	98.50

Table 39. Weight (in Kilograms) by Stature (in Centimeters)--Sexes Combined.

Stature in Centimeters	Sample Size	Weight in Kilograms		
		Mean	S.D.	Median
46-50 cms.	4	3.09	0.62	3.18
50-54 cms.	11	4.25	1.47	3.95
54-58 cms.	24	4.72	0.82	4.63
58-62 cms.	37	5.62	0.72	5.36
62-66 cms.	57	6.85	0.99	6.82
66-70 cms.	62	7.54	0.76	7.57
70-74 cms.	63	8.52	1.09	8.64
74-78 cms.	75	9.67	0.88	9.55
78-82 cms.	68	10.38	0.96	10.40
82-86 cms.	65	11.61	1.26	11.48
86-90 cms.	78	12.32	1.18	12.30
90-94 cms.	60	13.15	1.51	13.18
94-98 cms.	57	14.35	1.96	14.60
98-102 cms.	44	15.04	1.42	15.14
102-106 cms.	28	16.42	0.94	16.39
106-110 cms.	11	16.35	2.68	16.96
110-114 cms.	1	18.18	--	--
114-118 cms.	1	20.23	--	--

Table 40. Head Circumference Data--Total Sample by Age and Sex.

Age and Sample Size			Circumference in Centimeters		
Age in Months	Midpoint	Number	Mean	S.D.	Median
		Males			
0-3	1.5	20	37.76	2.14	37.75
3-6	4.5	32	41.00	1.57	41.00
6-9	7.5	38	43.26	2.12	43.00
9-12	10.5	21	44.50	1.36	45.00
12-18	15.0	46	45.43	2.08	46.00
18-30	24.0	61	47.36	1.99	47.35
30-42	36.0	49	48.30	2.67	48.00
42-54	48.0	62	48.49	2.08	49.00
54-66	60.0	28	49.29	1.52	49.00
		Females			
0-3	1.5	25	37.43	2.34	38.00
3-6	4.5	30	40.63	1.44	40.35
6-9	7.5	23	41.48	3.22	42.00
9-12	10.5	21	43.79	1.65	43.50
12-18	15.0	51	44.64	2.24	45.00
18-30	24.0	75	46.39	1.58	46.50
30-42	36.0	77	47.72	2.80	47.40
42-54	48.0	43	47.96	1.56	48.00
54-66	60.0	27	48.46	1.90	48.50

Table 41. Arm Circumference Data--Total Sample by Age and Sex.

Age and Sample Size			Circumference in Centimeters		
Age in Months	Midpoint	Number	Mean	S.D.	Median
			Males		
0-3	1.5	22	12.01	1.68	12.00
3-6	4.5	31	13.79	1.18	14.00
6-9	7.5	37	14.43	1.59	14.50
9-12	10.5	21	14.86	1.04	15.00
12-18	15.0	46	14.73	1.56	15.00
18-30	24.0	60	15.15	1.07	15.00
30-42	36.0	49	15.51	1.24	15.50
42-54	48.0	61	15.84	1.23	16.00
54-66	60.0	28	15.65	0.98	15.50
			Females		
0-3	1.5	21	12.33	1.46	12.20
3-6	4.5	28	13.58	1.18	13.50
6-9	7.5	24	14.36	1.27	14.00
9-12	10.5	23	14.63	1.33	14.50
12-18	15.0	52	14.32	1.36	14.50
18-30	24.0	75	15.18	1.17	15.00
30-42	36.0	77	15.37	1.22	15.50
42-54	48.0	43	15.60	1.19	15.50
54-66	60.0	26	15.48	1.09	16.00

Table 42. Triceps Skinfold Data--Total Sample by Age and Sex.

Age and Sample Size			Skinfold in Millimeters		
Age in Months	Midpoint	Number	Mean	S.D.	Median
			Males		
0-3	1.5	16	6.84	2.63	7.00
3-6	4.5	28	9.32	2.56	9.25
6-9	7.5	36	9.40	2.98	10.00
9-12	10.5	18	9.64	3.16	10.00
12-18	15.0	44	8.83	3.23	9.50
18-30	24.0	54	9.28	2.56	10.00
30-42	36.0	46	9.83	2.60	10.00
42-54	48.0	57	10.34	2.62	10.00
54-66	60.0	26	8.98	2.29	9.00
			Females		
0-3	1.5	19	6.77	2.59	6.50
3-6	4.5	26	8.94	1.99	9.00
6-9	7.5	23	9.63	2.76	10.00
9-12	10.5	22	8.89	2.31	9.00
12-18	15.0	49	8.45	2.59	8.75
18-30	24.0	68	9.73	2.58	10.00
30-42	36.0	70	10.33	2.43	10.00
42-54	48.0	42	9.54	2.72	10.00
54-66	60.0	26	9.56	1.82	10.00

Table 43. Median Arm Muscle Diameter Circumference and Area--Total Sample by Age and Sex.

Age Group--Midpoint Months		Muscle Diameter mm	Muscle Circumference mm	Muscle Area mm^2
		Males		
0-3	1.5	31.2	98	780
3-6	4.5	35.3	111	990
6-9	7.5	36.2	114	1050
9-12	10.5	37.7	119	1140
12-18	15.0	38.3	120	1150
18-30	24.0	37.7	119	1140
30-42	36.0	39.3	124	1220
42-54	48.0	40.9	129	1350
54-66	60.0	40.3	127	1310
66-78	72.0	44.3	139	1520
		Females		
0-3	1.5	32.3	102	830
3-6	4.5	33.9	107	940
6-9	7.5	34.6	109	1050
9-12	10.5	37.2	117	1100
12-18	15.0	37.4	118	1130
18-30	24.0	37.8	119	1140
30-42	36.0	39.3	124	1220
42-54	48.0	39.3	124	1220
54-66	60.0	49.9	129	1350
66-78	72.0	42.6	134	1420

Table 44. Weight, Stature, Head Circumference: Anthropometric Means by Age and Ethnic Group.

	Weight (kg)			Stature (cm)			Head Circumference (cm)		
	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.
0-3 months									
Mestizo	19	4.42	1.07	19	55.71	4.33	13	37.40	1.81
Maya	6	4.85	0.99	6	55.87	2.23	6	37.80	2.16
Creole	12	4.86	1.04	13	57.44	3.58	11	38.15	2.32
Garifuna	13	4.80	0.76	13	55.88	3.29	13	37.78	2.34
3-6 months									
Mestizo	22	6.39	0.83	21	63.57	3.29	20	40.75	1.41
Maya	12	6.17	0.88	11	62.36	3.35	11	40.41	1.46
Creole	12	7.33	0.82	12	64.98	2.15	12	41.75	1.03
Garifuna	19	6.33	0.78	19	62.80	3.10	19	40.55	1.70
6-9 months									
Mestizo	13	7.99	1.02	13	67.35	3.23	11	43.27	1.97
Maya	17	8.28	1.21	17	66.17	5.23	17	41.89	3.01
Creole	14	7.80	0.83	14	68.35	1.93	13	42.67	4.17
Garifuna	19	7.32	1.39	19	66.26	4.13	19	43.08	3.10
9-12 months									
Mestizo	17	8.69	1.61	17	71.71	4.01	17	44.29	1.58
Maya	8	8.37	1.00	8	68.94	2.41	8	44.44	1.54
Creole	14	8.03	2.33	14	69.29	8.58	14	43.66	2.64
Garifuna	7	7.80	0.88	7	69.86	4.44	6	43.08	1.99
12-18 months									
Mestizo	24	9.88	1.25	23	76.81	4.37	24	45.55	1.25
Maya	27	8.39	1.55	28	72.11	6.04	28	44.68	1.89
Creole	19	9.44	1.61	21	75.80	5.02	20	45.95	1.54
Garifuna	26	8.31	1.61	26	71.87	5.20	25	44.13	3.16
18-30 months									
Mestizo	43	10.99	1.67	43	79.98	5.28	43	46.67	2.62
Maya	22	10.63	1.27	22	79.64	4.40	22	46.23	1.67
Creole	35	10.77	1.71	34	82.85	4.42	35	46.55	1.73
Garifuna	35	10.81	1.70	36	81.54	4.52	36	47.37	1.43
30-42 months									
Mestizo	42	12.29	2.16	42	87.47	5.05	42	47.77	2.39
Maya	21	12.17	1.52	21	85.39	5.05	20	46.60	1.47
Creole	35	13.29	1.72	38	91.03	5.43	38	48.70	3.19
Garifuna	26	12.78	1.45	26	89.97	5.11	26	49.13	2.90
42-54 months									
Mestizo	31	14.10	2.21	31	94.13	4.49	31	48.31	1.57
Maya	16	12.80	1.19	16	90.58	4.94	16	46.90	2.01
Creole	28	14.15	3.22	31	96.55	5.95	31	48.66	1.81
Garifuna	27	14.01	1.94	27	96.02	4.95	27	48.61	1.86
54-66 months									
Mestizo	16	14.69	2.24	16	100.20	5.18	16	48.93	2.21
Maya	13	14.77	1.65	13	96.67	6.54	13	48.39	1.24
Creole	15	15.82	2.04	16	99.95	6.48	16	49.22	1.71
Garifuna	9	14.48	2.29	9	99.89	5.98	9	48.99	1.72

Table 45. Arm Circumference and Triceps Skinfold: Anthropometric Means and Medians by Age and Ethnic Group.

	Arm Circumference (am)				Triceps Skinfold (mm)			
	N	$\bar{X}$	S.D.	Median	N	$\bar{X}$	S.D.	Median
0-3 months								
Mestizo	12	12.08	1.66	12.10	10	5.62	2.45	4.75
Maya	6	12.17	2.21	12.25	3	6.50	3.28	7.00
Creole	12	11.92	1.53	12.00	9	6.61	2.18	7.00
Garifuna	13	12.48	1.29	13.00	13	7.92	2.58	8.00
3-6 months								
Mestizo	19	13.46	0.86	13.00	15	8.73	2.40	8.00
Maya	11	13.36	1.16	13.50	9	7.72	2.31	8.50
Creole	10	14.62	1.53	14.25	11	9.64	2.49	9.50
Garifuna	19	13.61	1.10	13.50	19	9.84	1.82	10.00
6-9 months								
Mestizo	12	15.08	1.72	15.00	10	9.40	4.11	8.75
Maya	17	14.82	1.09	15.00	16	10.31	2.52	10.50
Creole	13	14.26	1.19	14.00	14	9.14	2.89	9.50
Garifuna	19	13.70	1.56	14.00	19	9.11	2.45	9.00
9-12 months								
Mestizo	17	14.51	1.29	14.50	14	8.07	2.67	8.50
Maya	8	14.63	1.06	14.50	7	9.57	2.51	10.00
Creole	12	15.23	1.26	15.50	12	10.75	2.52	10.50
Garifuna	7	14.60	0.47	14.50	7	8.57	1.48	8.00
12-18 months								
Mestizo	23	15.07	1.26	15.00	20	9.23	3.27	9.25
Maya	28	14.35	1.19	14.00	26	8.71	2.64	9.50
Creole	21	14.75	1.23	15.00	21	9.09	2.72	10.00
Garifuna	26	14.01	1.99	14.00	26	7.71	3.34	7.75
18-30 months								
Mestizo	43	15.19	0.99	15.00	32	10.03	2.36	10.00
Maya	21	15.08	1.08	15.00	20	10.28	2.16	10.00
Creole	35	15.35	1.17	15.50	34	9.31	2.77	9.00
Garifuna	36	15.01	1.33	15.00	36	8.88	2.76	8.75
30-42 months								
Mestizo	42	15.53	1.29	15.50	32	10.05	2.24	10.00
Maya	20	15.24	1.51	15.35	20	9.79	2.59	10.00
Creole	38	15.52	1.16	14.00	38	10.37	2.76	7.25
Garifuna	26	15.27	0.93	15.50	26	10.15	2.33	10.00
42-54 months								
Mestizo	30	16.21	0.96	16.25	26	10.40	1.83	10.75
Maya	16	15.34	1.04	15.35	15	9.43	3.35	10.00
Creole	31	15.91	1.39	16.00	31	9.77	2.54	10.00
Garifuna	27	15.29	1.27	15.20	27	10.20	3.26	10.00
54-66 months								
Mestizo	16	15.36	1.09	15.50	15	9.47	2.54	10.00
Maya	13	15.69	1.01	15.50	12	10.17	1.53	10.50
Creole	16	15.92	0.99	16.00	16	8.81	1.64	9.00
Garifuna	9	15.15	0.86	15.50	9	8.55	2.36	8.00

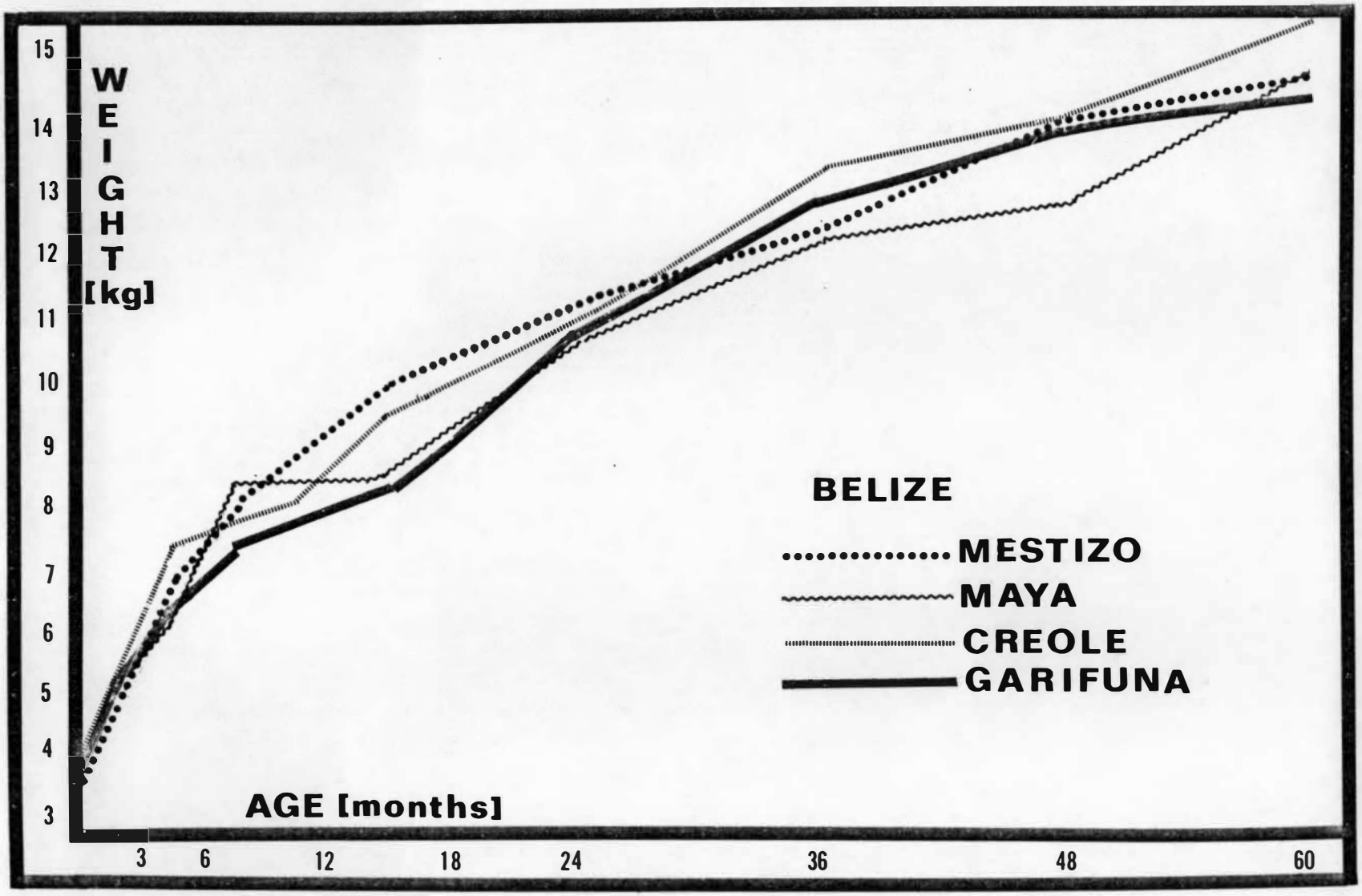

Figure 25. Weight by Age and Ethnic Group, Belize.

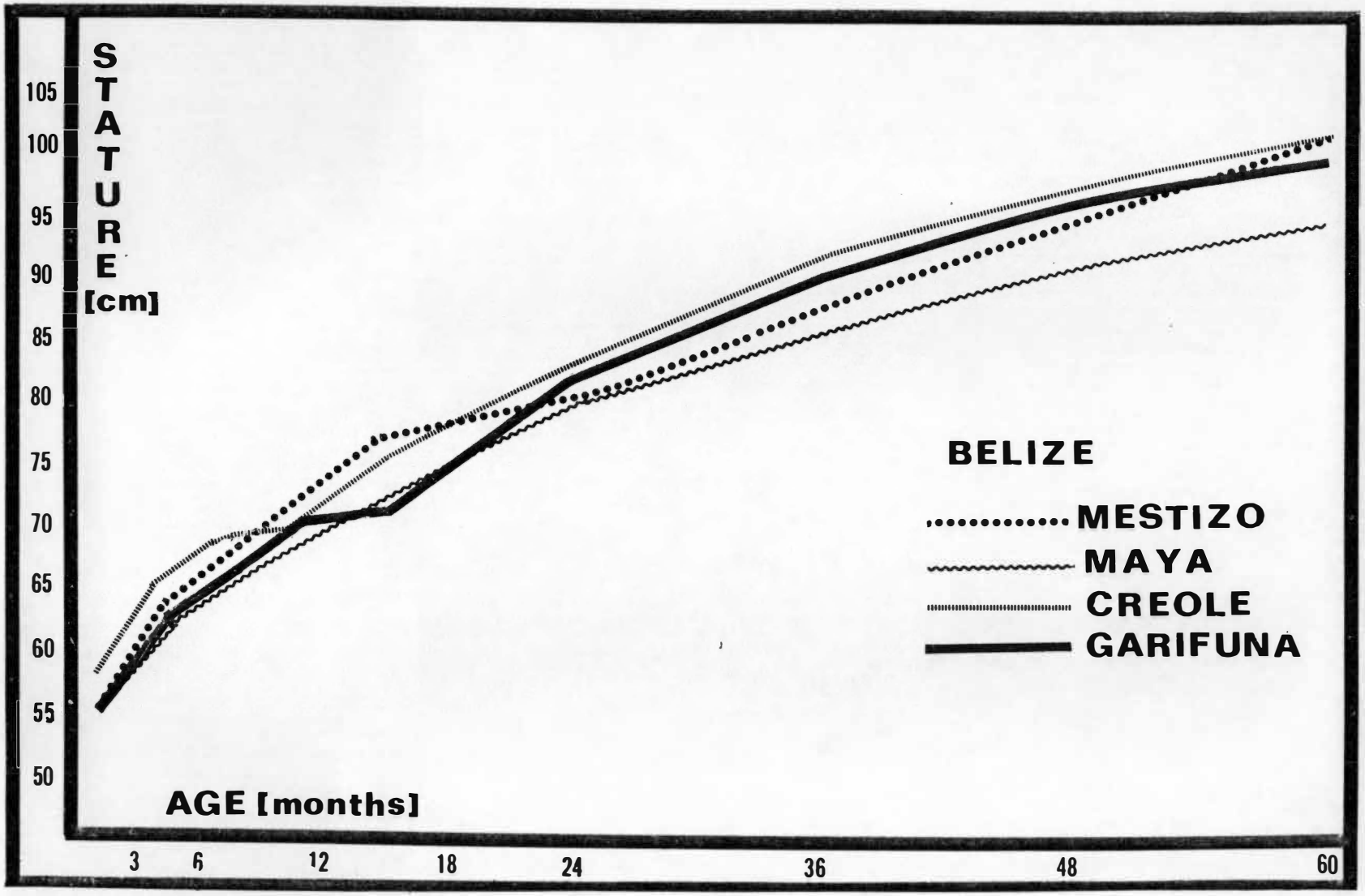

Figure 26. Stature by Age and Ethnic Group, Belize.

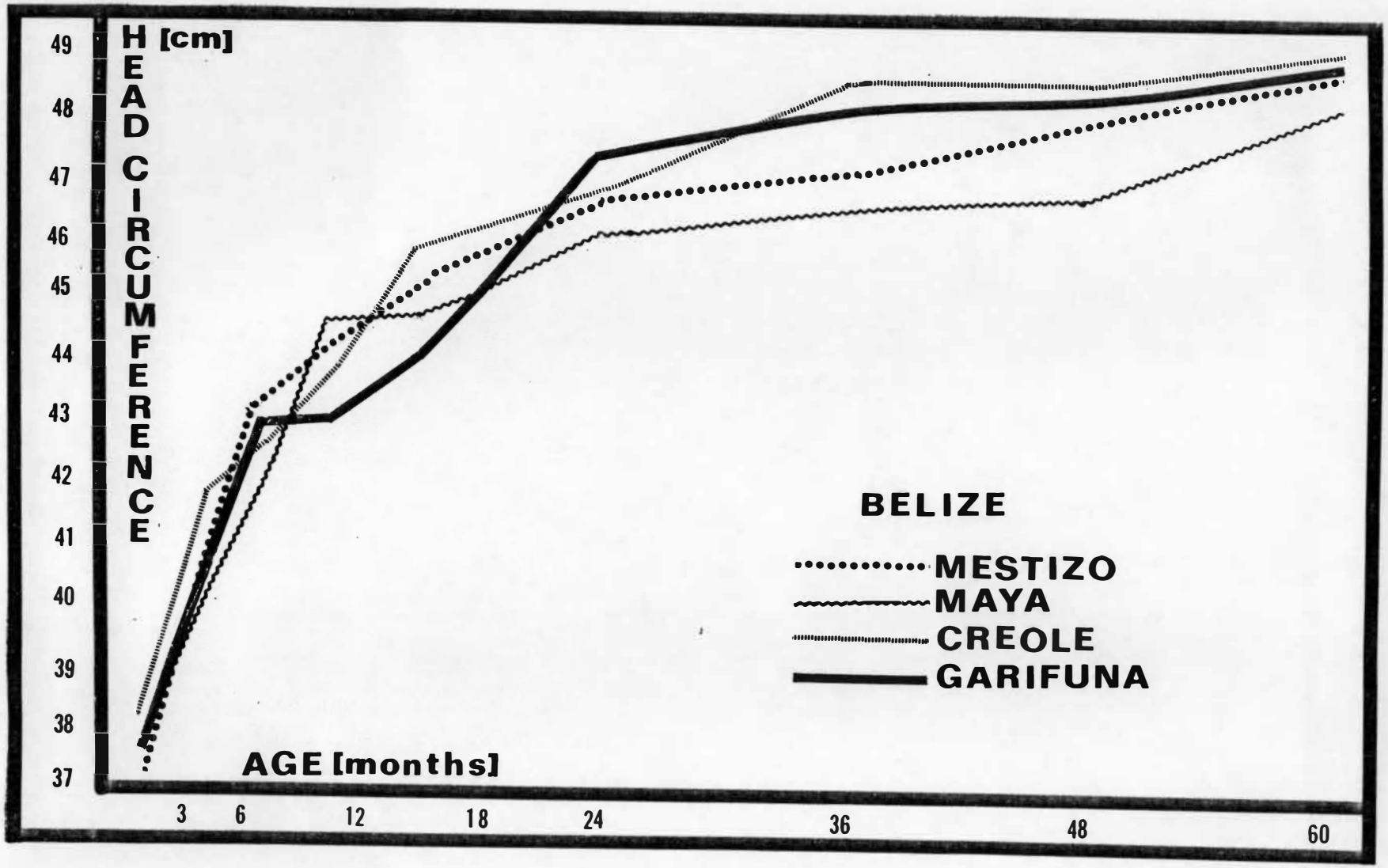

Figure 27. Head Circumference by Age and Ethnic Group, Belize.

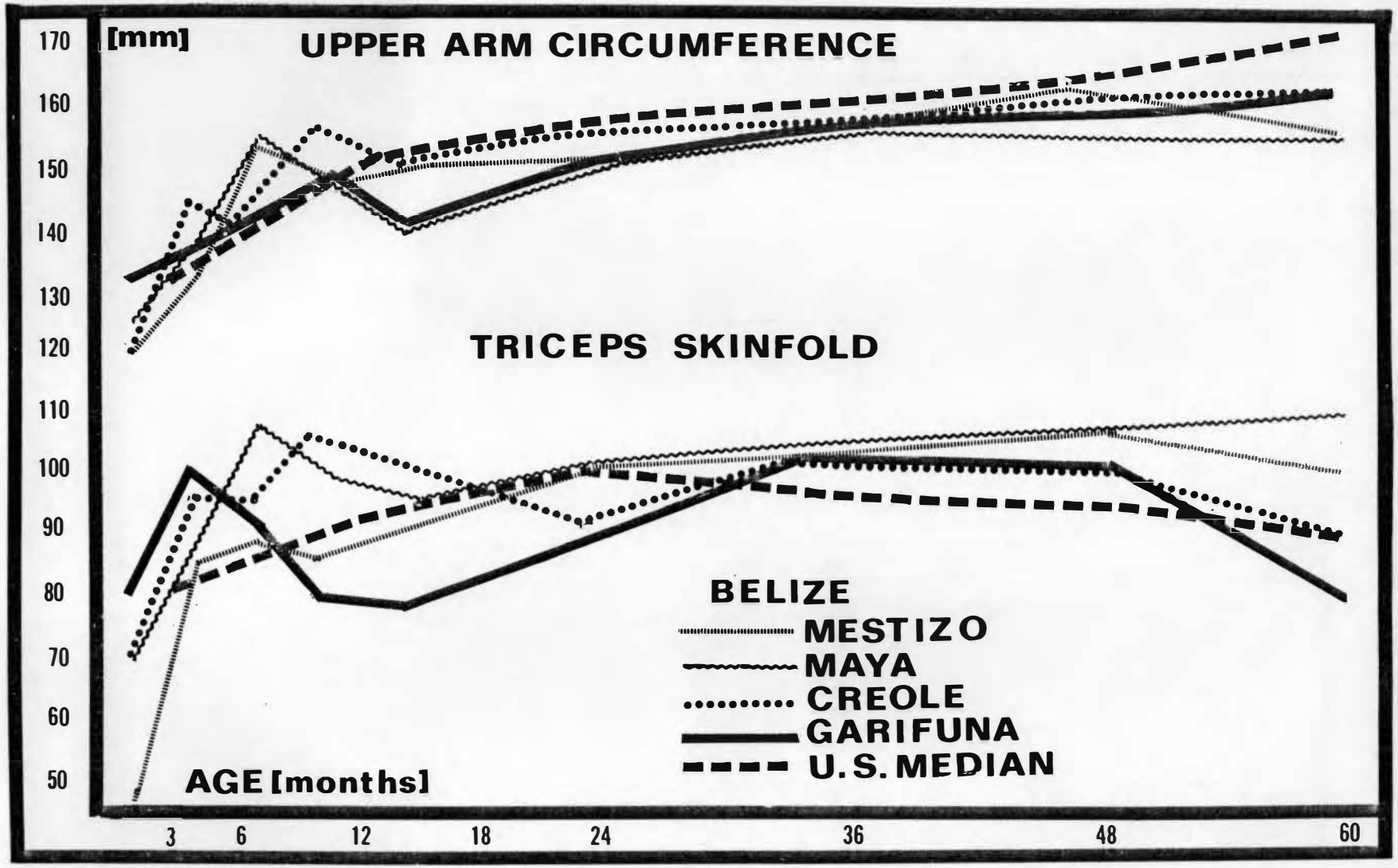

Figure 28. Upper Arm Circumference and Triceps Skinfold by Age and Ethnic Group, Belize and U.S. Compared.

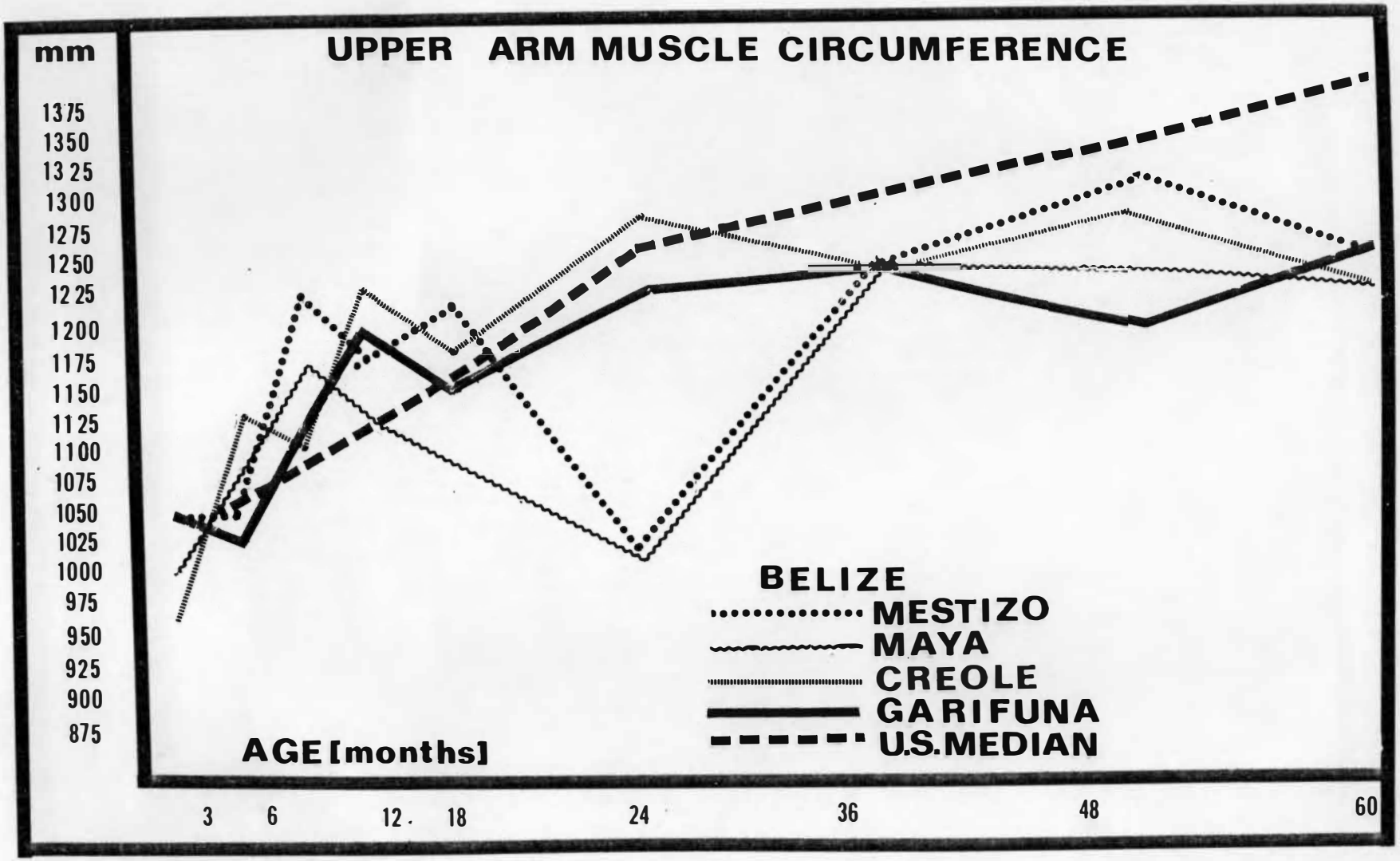

Figure 29. Median Upper Arm Muscle Circumference by Age and Ethnic Group, Belize and U.S. Compared.

VITA

Carol Lynn Jenkins was born as Carol Lynn Feldman in Philadelphia, Pennsylvania in 1945. Her high school education was completed at Atlantic City Friends School in New Jersey, after which she entered Barnard College of Columbia University. There she was first introduced to the study of Anthropology. She completed a Bachelor's degree, specializing in Physical Anthropology, at the University of Pennsylvania in 1967. During her undergraduate years, she worked as a research assistant to Dr. Francis Johnston and Dr. Wilton Krogman at the Children's Growth Center. After graduating, she spent several years as a social worker for the Welfare Departments of Harlem, New York and Memphis, Tennessee. Returning to graduate school at Memphis State University, she received a Master's of Science degree in Geography, with a minor in Applied Anthropology in 1974. From 1972 to 1977 she taught both Anthropology and Geography at Shelby State Community College in Memphis. Her doctoral studies, begun in 1977 at The University of Tennessee, Knoxville, focused on Medical Anthropology, with a collateral minor in Public Health. After receiving the Ph.D. she will join the faculty at Illinois State University in Anthropology. Her future plans include a follow-up study of maternal malnutrition and ethnomedicine in Belize.