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LIBERIA NATIONAL NUTRITION SURVEY

(December 4, 1975 to March 25, 1976)

Prepared by

The UCLA Nutrition Assessment Unit
Division of Population, Family and International Health
School of Public Health, University of California, Los Angeles

In Cooperation with

The Ministry of Health and Social Welfare
Republic of Liberia

and

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INTRODUCTION

The main purpose of the survey is to provide a statistically valid assessment of the prevalence of acute, chronic protein-calorie malnutrition (PCM) and anemia in children 0-5 years old, in the rural areas of Liberia. In addition, certain larger counties and ecological areas, (e.g. traditional agriculture) are described separately. Comparisons within the country are essential to identify priorities for areas as well as certain population groups for remedial programs.

Prior to the present survey, a few reports on the nutritional status of the Liberian population were restricted to certain parts of the country or were not fully representative of the population. The most recent and extensive of these was a 1971 survey which included several sites in Bong and Lofa counties (1). Sites selected were villages with health clinics. The survey provided important, and at times, unique information on nutritional status

The results indicated that "Liberian children were understatured and underweight when compared with various standards...children appeared to do well until 6-8 months of age, if breast fed, but thereafter growth began to plateau due to lack of sufficient calories and protein in the diet."

Approximate prevalence estimates of malnutrition for 600 Kpelle and Loma children from this survey revealed the following:

1 15% of infants and 30% of children 1-5 years had long term chronic protein-calorie malnutrition, (PCM).

2. 10% of infants and 25% of children 1-5 years were underweight for age, and

3) At least 50% of children 0-5 years were anemic.

All these estimates were based on reference data from the USA referred to later in the report.

Chronic PCM (also termed chronic undernutrition or stunting) indicates that a malnutrition of both calories and protein has been present for at least 6 months and often much longer. Retarded skeletal growth is a valuable indicator of this condition, particularly in young children (2,3,4).

Acute PCM indicates the deficiency is of recent onset, in terms of weeks to a few months, and is estimated by comparing the weight of a child with that expected for the same height. The highest prevalences of acute PCM occur in conditions of acute food shortage such as famines (5).

PCM may also be assessed by comparing the weight of a child with that expected for the same age or by using arm measurements which include muscle and fat. A child with chronic PCM may or may not be underweight or have arm, muscle or fat wasting (6).

The problem of undernutrition in Liberia was demonstrated as early as 1948 (7) and discussed at various conferences (8,9). The association with food-availability, practices and taboos, morbidity and socio economic status was apparent, but not clearly quantified. The high mortality rates of infants (approximately 137 per 1000 live births) and 1-4 year old children (approximately 16 per 1000 per year) (10), indicate that malnutrition may be an important contributory factor (11).

In 1975, the Ministry of Health and Social Welfare, Government of Liberia,

(GOL) required rapid national information to determine the extent of malnutrition and where this existed within the country. Such information could be used as a guideline for developing appropriate programs, where required (12).

As a result of a request from the Government of Liberia, a representative from the Center for Disease Control (CDC), Atlanta, Georgia, USA made a brief site visit in June 1975 and the concept of the "simplified assessment" approach was presented. In August 1975, the UCLA Nutrition Assessment Unit was given the responsibility of assisting the GOL to do the survey. A Liberia Nutrition Status Survey protocol was prepared by UCLA using the Nepal experience by CDC as a guideline. A site visit to Liberia by UCLA from September 20 to October 19, 1975 was required to clarify the Government of Liberia request, assess survey content and logistic and budgetary needs. With the assistance of the GOL, USAID and UCLA, the training was done from December 4-20, 1975 and January 8-19, 1976 and the field survey from January 20 to March 25, 1976.

The Ministry of Health and Social Welfare, Government of Liberia, after consultation with Liberian and other experts, decided to use the concept of "simplified assessment of nutrition status" (13) as the basic methodology to satisfy the Government's request. This relies primarily on anthropometry, selected clinical signs and hemoglobin estimation of target groups, such as young children and mothers, who represent the greatest "at risk" groups for malnutrition (14). It also relies on adequate sampling procedures and sample sizes for valid descriptions.

A detailed food consumption or biochemical survey would be inappropriate as an initial step to supply the information required, because of expense,

curation, validity and feasibility for a representative adequate sample of the whole country.

In view of the recommendations from the Ministry of Health and Social Welfare, Government of Liberia, and Africa Bureau/AID, certain other indicators were included in the survey on a limited random subsample.* These included socio-economic status, sanitation, qualitative food consumption, methods of feeding, health attendance, mortality and prevalence of parasites. The nature of the information collected was more subjective, the numbers much fewer and standardization more difficult than the "simplified assessment". The data, nevertheless, may provide clues regarding some of the factors associated with the development of protein-calorie malnutrition.

* The subsample description and analysis will be presented in a separate report.

BACKGROUND INFORMATION

The Republic of Liberia has a land area of 43,000 sq. miles and is geographically divided into three zones: coastal, tropical rain forest and inner Guinea Highlands.

The country has nine counties; of these, five are coastal: Cape Mount, Grand Bassa, Montserrado, Sinoe and Maryland; and four inland: Bong, Lofa, Nimba and Grand Gedeh. They are divided into districts, and districts in turn, are divided by clans/townships.

The total population from the 1974 Census of Population and Housing is 1.5 million of which, about 12% reside in Monrovia proper and Buchanan. The natural increase has been estimated at 3.9% for the whole country; 1.7% rural and 7.0% for major urban, the latter figure due to urban-rural migration (15).

The overall population density is about 35 persons per sq. mile. This varies greatly throughout the country in that large sections of the forest in Lofa County and southeastern parts of Liberia are practically uninhabited.

There are numerous tribes throughout Liberia; nine of these: Kpelle, Bassa, Gio, Kru, Mano, Gola, Grebo, Loma and Krahn comprise 83% of the total population. The Kpelle and Bassa Tribes are the most numerous, comprising 23% and 16% respectively (15).

Most of the population works by subsistence agriculture. Although half of the land area has been farmed, only a small portion (5%) is farmed each year due to shifting cultivation techniques (16). Rice is by far the most important staple, being grown in over 90% of the agricultural areas of the country. It is usually harvested late in the year. Almost half the country production occurs in Bong and Nimba Counties (17). Despite this, production

is inadequate to satisfy demand, so approximately one-quarter of all rice consumed is imported.

Heavy rainfall and high humidity favor insect vectors of disease, water-borne and other intestinal parasites (18). The major causes of death are malaria and gastro-intestinal disease. Other significant causes of death and morbidity in infants and young children include prematurity, measles, respiratory infection and tetanus. Poor sanitation may be the major environmental factor affecting health in Liberia.

Protein-calorie malnutrition and anemia are reported to be very common, particularly in young children. Both calorie and protein food intake may be at times, as little as 50% of the expected intakes for proper nourishment (1). Although breastfeeding usually continues well into the second year, weaning foods may be limited to rice water or pounded rice (19). Rice water may be contaminated, leading to gastro-intestinal disease. Children are often not fed when they have diarrhea or fever (7). This further compounds the problem. Various taboos involving eggs and certain meats may contribute to the problem although, more significantly, the amount of available animal protein is limited due to the small livestock population and underutilization of inland fish potential. There is no local production of milk.

It is suspected that even if sufficient food were produced or imported in Liberia, inadequate distribution and use of resources may still perpetuate PCM, particularly in small children (16).

Even in the capital city of Monrovia, there may be certain populations with serious nutritional problems. In Maternal and Child Health Clinics

throughout the city, the appearance of kwashiorkor and marasmus is not uncommon, particularly in very young children who are bottle-fed well before the child reaches six months of age (19). Inadequate amounts of milk powder are mixed with nonsterile water resulting in undernutrition and diarrhea.

Finally, superimposed upon the already mentioned problems in production and consumption of food, constraints of transportation and communication outside Monrovia seriously hinder agricultural, health and other services.

III. INDICES OF MALNUTRITION

The main objective of the survey is to assess nutritional status according to geopolitical units in Liberia and in a manner which quantifies the number of malnourished. The indices for children up to five years of age, include:

1. Height-for-Age (H/A)
2. Weight-for-Height (W/H)
3. Weight-for-Age (W/A)
4. Arm Circumference-for-Age (AC/A)
5. Arm Circumference-for-Height (AC/H)
6. Fatfold (Triceps)-for-Age (FF/A)

Indices are based on international reference median values. A list of these sources is presented in Appendix D and the actual values in Appendix E. This reference data does not necessarily mean a specific "standard" of ideal nutrition; it simply compares the results from populations with reasonable health and nutrition backgrounds (20). No reference information was available for Liberia, thus outside sources were required.

However, it has been shown that the best nourished groups of young children in Africa, drawn from so-called "elite populations", have similar anthropometric values to those in more industrialized areas of the world (21).

In order to present a malnutrition prevalence estimate according to each reference value, a single cut-off point was predetermined. This point was based on a percentage of the reference median according to age (or height) and in general, corresponds to the 1st to 3rd percentile level of reference

distribution. This means that any result below the cut-off point is equivalent to the lowest 1-3 % of the reference population. Both the reference values and the percentage cut-off points have been used in large surveys in Africa (eg. Sahel) and elsewhere (Nepal, Sri Lanka) particularly by the Center for Disease Control (5, 22). Past experience enables this survey to present a clearer picture of the significance of malnutrition prevalence estimates based on anthropometry.

The cut-off points according to the percentage of medians and percentiles, with their meanings are listed in Table 1.

TABLE 1

ANTHROPOMETRIC INDICES IN YOUNG CHILDREN

INDEX	CUT-OFF POINT REFERENCE VALUE % MEDIAN	PERCENTILE*	SIGNIFICANCE**
1. H/A	90%	1st	Chronic Protein-Calorie Malnutrition (PCM)
2. W/H	80%	1st	Acute PCM
3. W/A	80%	3rd	Combination Acute/Chronic PCM
4. AC/A	82.5%	1-3rd	Arm Soft Tissue Wasting
5. AC/H	85%	3rd	Arm Soft Tissue Wasting
6. FF/A	60%	3rd	Fat Wasting-Low Calorie Reserve

*Approximate percentile, due to some variation according to age.

**Interpretation of a value below the cut-off point % median of reference; i.e. a child with under 90% of the reference median for Height for Age (H/A) has chronic PCM.

The selection of a single numerical estimate of malnutrition prevalence allows meaningful comparisons between areas of the country and selected groups It also permits investigation of associated factors, such as occupation, with PCM. More complete distribution tables are presented in Appendix J to give a fuller description of the data.

ANTHROPOMETRIC INDICES

Height-for-Age (H/A)

This is the only index used in the survey which identifies chronic PCM or "stunting" of growth. Stunting may be considered as an end result of cumulative episodes of nutritional insults (eg. due to infection, inadequate food) with failure of "catch up" in linear growth of bones (23). Even in the multi-tribal situation in Liberia, where differences in adult height occur, the effect of undernutrition and poor health is most likely the strongest factor which determines stature in young children (21).

Weight-for-Height (W/H)

This estimates acute PCM, that is recent body wasting, based on the principle that the taller the child, the heavier he or she should be. Nutritionally labile tissues, mainly muscle and fat are compared with the more stable skeletal measure of stature. Because this relationship is unaffected by differences in age, the W/H index is particularly useful when correct ages are often difficult to determine accurately.

Height-for-age and weight-for-height indicate different durations of PCM and their results may be linked for each individual child in a useful classification (24) :

Weight-for-height (% of median)		Height-for-Age (% of median reference): Normal 95+	Mild 90-94	Moderate 85-89	Severe 85-
Normal	90+	Normal to Mild		Stunting	
Mild	80-89				
Moderate	70-79	Wasting		Stunting Wasting	
Severe	70-				

The following categories of nutritional status may thus be selected:

Nutritional Status	Height-for-Age	Weight-for-Height
Normal Nutrition	Normal	Normal
Acute Undernutrition (Wasting)	Normal	Low*
Chronic Undernutrition (Stunting)	Low**	Normal
Concurrent Acute and Chronic Undernutrition (Wasting & Stunting)	Low**	Low*

*Defined as less than 80% of reference median weight-for-height (24)

**Defined as less than 90% of reference median height-for-age (24)

Where the prevalence percentage of low weight-for-height is very small, this form of presentation may not always be required.

Weight-for-Age (W/A)

This measure does not distinguish between the relative contributions of skeleton and soft tissue bulk to weight. A child with low W/A thus may be short and well-proportioned, or be taller, but wasted. W/A however, is the usual anthropometric measure for growth charts and routine clinical

assessment, so that comparisons may be made, where required, between clinic attenders and the general population.

Arm Measurements

These measures are useful additions to weight and height for a fuller description of nutritional status. It must be noted that they relate to the mid-upper arm and hence describe a somewhat different aspect of soft tissue than weight alone,ie. that of muscle and fat on a single site of the body. A key clinical sign for undernutrition is thin limbs; arm measures simply quantify arm bulk.

The triceps fatfold measure goes one step further and enables estimates of the relative contribution of fat and muscle to be made. Fatfold is difficult to measure correctly and results should be interpreted cautiously due to the known problems in quality control. Frequent training exercises are required to ensure reliability.

Arm circumference-for-height (AC/H), like weight-for-height (W/H), is "age-independent." The measurement of arm circumference alone has a special value for children aged 1-5 years. Knowledge of precise age is not essential to estimate nutritional status as the referece values vary little over this age range. Arm circumference for-age (AC/A) was used on this survey because ages were carefully determined and children under one year were also measured.

Arm muscle and arm fat area may be calculated using a simple formula incorporating arm circumference and triceps fatfold (25). The same caution must be exercised for the arm fat area as discussed under fatfold measurement reliability. However, arm muscle area calculation is far less affected by

variations in triceps fatfold measure than by variations in arm circumference.

Results are presented in the report as nutrition profiles. The first two columns indicate prevalence rates for chronic and acute PCM, i.e. height-for-age and weight-for-height. Further columns give rates for underweight (weight-for-age) arm wasting (arm circumference-for-age) and fat wasting (fatfold-for-age).

ANEMIA

The percentage of anemia in young children used an international reference for hemoglobin below which a child was considered anemic: 10.0 Gm/100 ml for children aged 6-24 months and 11.0 Gm/100 ml for those aged 2 to 5 years (26).

CLINICAL DIAGNOSIS OF NUTRITIONAL STATUS

Kwashiorkor was diagnosed according to the presence of bilateral pedal edema. The survey did not include a clinical assessment of marasmus because of the great difficulty of adequate standardization. Both kwashiorkor and marasmus relate to the most severe forms of PCM and do not indicate the less severe, but still important types as defined anthropometrically.

MATERNAL NUTRITIONAL INDICES

These include,with cut-off points:

Height	150	cm (or 5 ft.)
Arm Circumference	23	cm
Fatfold (Triceps)	7.5	mm

The choice of such points was based on the following:

A woman less than 5 feet tall may be considered sufficiently short to be associated at least to some degree with short stature in her child. This level is often used in parts of Africa (27). The measure is not as good as mean parental stature, but is acceptable when only one parent is available. Correlation between mother and child may suggest important genetic factors or that the environment affects the growth of both. The nutritional significance of short stature in women is not nearly as clear as for young children.

The 5 foot choice has an added value in obstetric interpretations, in that a shorter woman is decidely at risk for obstructed labor, because of a possible small pelvis.

An arm circumference of 23 cm represents 80% of the reference value for adult women, and has been used in other parts of the world (e.g. India) to provide an estimate of undernutrition.

The triceps fatfold point of 7.5 mm is more arbitrary than the others and represents approximately 40% of the values of adult women in more industrialized countries.* A value below this, does not necessarily mean undernutrition, although it suggests a lack of caloric reserve and low fat stores in the body. Results for adult fatfold in this survey should be treated with

*Third to fifth percentile for adult black women in the USA (30).

the utmost in caution, as it was the measurement which was most difficult to standardize.

The survey categorized maternal age into three groups: under 20 years; 20-40 years, and over 40 years. This took into account the variation of expected anthropometric results of adolescent women according to age. This group comprised some 22% of all mothers measured and at times were considered separately.

Pregnant women of all ages (20% were under 20 years) were considered as a special group. Mothers over 40 years were not included as an individual group, as there were relatively few.

IV. SURVEY DESIGN - METHODS

A valid estimate of the prevalence of malnutrition requires:

1. A survey universe or population which is the total population for the area described;

2. A sample which is statistically reliable and representative of the population;

3. An objective, quantifiable definition of malnutrition.

A. SURVEY UNIVERSE

The present survey examined the nutritional status of the rural areas of Liberia. This universe, therefore, was defined as the whole of Liberia, excluding Monrovia proper and Buchanan. It comprised of two parts:

1. Traditional Agricultural Areas (72.6% of Universe Population).

This includes all the "traditional" agricultural areas (except very remote) included in the 1975 National Rice Survey. These areas essentially represent the more rural parts of Liberia, where almost all the rice in the country is produced.

2. Large Rural, Urban and Concession Areas (27.4% of Universe Population).

These areas were not included in the Rice Survey. They are listed in Appendix K, and are termed non-agricultural areas in this report.*

Large rural areas (e.g. Voinjamma, Tchien) comprise more densely populated rural towns in a rice producing area, usually above 2,000 people. Urban areas (e.g. Bong Town, Harper, Congo Town) rely far less on subsistence agriculture and goods; food is usually purchased. Concession areas comprise certain large rubber plantation and mining industries, where health and nutrition care is primarily the responsibility of the owners. Firestone accounts

*It should be noted they are still part of the rural universe.

TABLE 2

NUMBER AND PERCENT OF COUNTRY SURVEY POPULATION BY COUNTY AND ECOLOGICAL AREA

	Ecological Area									
	TRAD. AGRICULTURE		LARGE RURAL		URBAN		CONCESSIONS		TOTAL	
COUNTY	POP.	% *	POP.	% *	POP.	% *	POP.	% *	POP.	% *
Bong	133,294	17.0	6,115	5.9	7,537	7.5	4,203	4.6	151,149	14.0
Grand Bassa	62,238	8.0	11,420	11.1	3,582	3.6	7,637	8.3	84,877	7.9
Cape Mount	37,126	4.8	2,597	2.5	7,897	7.9	3,089	3.3	50,709	4.7
Grand Gedeh	58,151	7.4	5,685	5.5					63,836	5.9
Lofa	126,129	16.1	11,933	11.6			2,056	2.2	140,118	13.0
Maryland	61,632	7.9	3,528	3.4	11,531	11.5			76,691	7.1
Montserrado	86,251	11.0	46,098	44.8	53,198	53.1	63,094	68.2	248,641	23.1
Nimba	181,075	23.2	6,349	6.2	16,429	16.4	10,576	11.4	214,429	19.9
Sinoe	35,928	4.6	9,135	8.9			1,822	2.0	46,885	4.4
TOTAL	781,824	100.0	102,860	100.0	100,174	100.0	92,477	100.0	1,077,335	100

Percentages according to the ecological area for the country.

for almost 2/3 of these.

The combination of these ecological areas equals the total universe for the nutrition survey, which in the text is referred to as Country or Liberia, and pertains to rural Liberia.

It should be noted from the following tables that all counties but Montserrado have predominantly traditional agricultural populations. Montserrado has the largest total population and contributes at least half of all the non-agricultural survey universe for the country.

TABLE 5

PERCENT COUNTY POPULATION ACCORDING TO ECOLOGICAL AREAS

	Ecological Area				
COUNTY	TRADITIONAL AGRICULTURE	LARGE RURAL	URBAN	CONCESSION	TOTAL %
Bong	88.2	4.0	5.0	2.8	100
Grand Bassa	73.3	13.5	4.2	9.0	100
Cape Mount	73.2	5.1	15.6	6.1	100
Grand Gedeh	91.1	8.9			100
Lofa	90.0	8.5		1.5	100
Maryland	80.4	4.6	15.0		100
Montserrado	34.7	18.5	21.4	25.4	100
Nimba	84.5	2.9	7.7	4.9	100
Sinoe	76.6	19.5		3.9	100
TOTAL	72.6	9.5	9.3	8.6	100
TOTAL SAMPLE SITES	85.0	11.0	11.0	10.0	117
percent of total	72.6	9.4	9.4	8.6	100

All population estimates were obtained from the 1974 provisional census data following the procedure of the rice survey. At the time of this survey, the final census results were not yet available. The provisional data used was an underestimate compared with the final census report. This influenced all areas of the country in an almost equal proportion, however, validating the present survey universe.

3. Other Ecological Areas.

a) MONROVIA PROPER. In consultation with the Ministry of Health and Social Welfare and the Ministry of Planning and Economic Affairs, a population of approximately 40,000 was identified within urban Monrovia (Monrovia Proper). Within this were certain areas where housing and living conditions appeared sufficiently poor to suspect nutritional problems. For convenience, this area is termed "Monrovia", but in fact represents a fraction of the total population of the city. For this reason, the Monrovia results are not included in the national estimates, but are presented separately.

b) SPECIAL GROUP. This group consists of about 300 children up to five years of age born and raised at LAMCO, a large mining concession in Nimba County. These children have rural origins, yet also have a reasonable degree of nutrition and health care. In other words, comparisons could be made between this special group and other areas in Liberia. This would give some indication of the potential growth and tissue bulk of the children in rural areas of Liberia.

B. SAMPLING

The number and distribution of sample sites within Liberia are presented in Table 4 and Figure 1.

TABLE 4

NUMBER AND PERCENT OF SAMPLE SITES BY COUNTY ACCORDING TO ECOLOGICAL AREA

	Ecological Area									
	TRADITIONAL AGRICULTURE		LARGE RURAL		URBAN		CONCESSION		TOTAL	
COUNTY	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Bong	18	21.2	1	9.1	1	9.1	1	10.0	21	17.9
Grand Bassa	8	9.4	1	9.1	1	9.1	1	10.0	11	9.4
Cape Mount	6	7.0	-	-	-	-	-		6	5.1
Grand Gedeh	5	5.9	1	9.1	-	-	-		6	5.1
Lofa	12	14.1	1	9.1	-	-	-		13	11.1
Maryland	6	7.0	1	9.1	2	18.2	-		9	7.7
Montserrado	6	7.0	5	45.4	6	54.5	7	70.0	24	20.5
Nimba	18	21.2	-	-	1	9.1	1	10.0	20	17.2
Sinoe	6	7.0	1	9.1	-	-	-		7	6.0
TOTAL	85	99.8	11	100.0	11	100.0	10	100.0	177	100.0

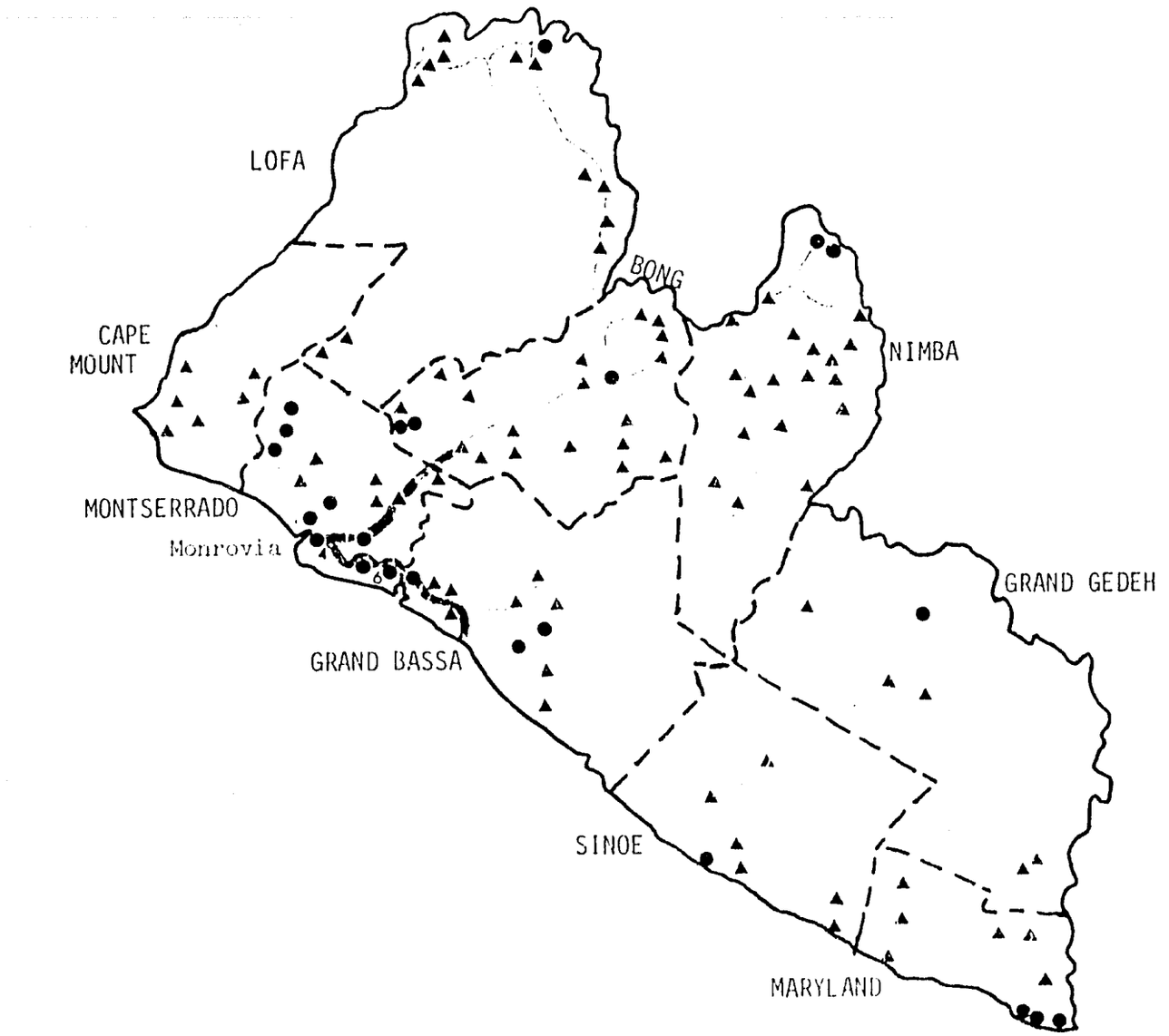
* Percentage according to the ecological area for the country.

Random sampling techniques were employed so that every subject in the universe described had a known probability of being selected.

The subjects in the survey were children under five years of age and their mothers. For simple or stratified random sampling, it would have been necessary to enumerate all subjects, then identify sampled individuals throughout scattered areas, a clearly impossible task in Liberia, where

FIGURE 1

DISTRIBUTION OF SAMPLE SITES - LIBERIA COUNTIES



0 25 50 75 100 kilometres

▲ Traditional Agricultural Sites

● Others

County Boundaries

Tarmac Roads

Major Unpaved Roads

populations are often sparse and constraints of transportation, communication, personnel and time were present.

Accordingly, a stratified multi-stage method was used. In this way a convenient number of relatively compact geographic areas were randomly selected and more than one individual sampled in each of these areas. With this method, it was possible to increase the total sample size to use available resources more efficiently (28,29).

The compact geographic areas (enumeration areas or EA's) were listed in the 1974 Population Census, with each EA of approximately 400 people. The basic sampling frame was this list and a sample site a selected EA.

1. Agricultural Areas.

For the agricultural areas the same EA's were chosen as those in the 1975 National Rice Survey. This offered a very important advantage in that these EA's had been visited within two months by the Rice Survey enumerators and a reasonably accurate description of the area was available.

A comparison of the sampling procedures for the Rice and Nutrition Surveys indicates that within the sampling unit different methods were used to identify the target populations studied.

SAMPLING IN TRADITIONAL AGRICULTURAL AREAS

	1975/1976 Rice Survey	1976 Nutrition Survey
Stage I	Counties	Counties
Stage II	Geographic areas within counties	Geographic areas within counties
Stage III	2 EA's within Stage II (systematic sample)	2 EA's within Stage II (systematic sample)
Sampling unit/site	Selected EA	Selected EA
Sampling within the unit/site	i Enumeration all rice-producing households ii Systematic sample 6 of these households	i Enumeration of total population ii Random start and random direction until 50 children under 5 years measured

This survey used a cluster sampling technique in that thirty children under 5 years were found and measured after a random start and direction. The locality (village) lists of the Rice Survey for the selected EA's were used for this purpose, and survey members took particular care to revisit the same localities where Rice Survey enumerators had previously marked the houses visited, which assisted in identification during the nutritional survey.

2. Non-Agricultural Areas.

These areas were not visited in the rice survey. In this survey it was then possible to sample purely by population proportionality using a random start and fixed interval. Thus no intrinsic weighting was required. The same provisional population line listing of EA's and localities was used. The procedure involved:

a) Cumulation of the total population of all non-agricultural areas;

b) Using the same sampling interval based on the whole of the agricultural universe (i.e. population divided by the number of sites);

c) A random selection of a starting number within the range of the sampling interval;

d) Inclusion of the first EA according to this starting number in the cumulative total to determine the initial sample site;

e) Adding the interval size consecutively to the starting number to identify further EA's as sites until all sites were selected to the end of the cumulative population total.

The method of sampling allows the following inferences to be made with reasonable statistical assurance that normal distribution holds:

1. Total Country (1)

2. Major ecological areas (2)

   Agricultural
   Non-Agricultural

3. County Groupings

   a) By agricultural population (3)

      Bong, Montserrado and Grand Bassa
      Nimba and Lofa
      Cape Mount, Sinoe, Maryland and Grand Gedeh

   b) By total population (3)

      Bong and Montserrado
      Nimba and Lofa
      Cape Mount, Sinoe, Maryland, Grand Bassa and Grand Gedeh

   Total Sets of Valid Inferences (9)

Each area required at least 30 sampling units in order to calculate estimates. By using binomial theory an area sample size total of 900 children 0-59 months of age was determined to be the minimum number required for adequate precision; the individual sample unit was accordingly 30 children. (Appendix A).

The rationale for grouping certain counties in the general description, apart from the requirements of sample size, is based on certain key factors, such as geographic proximity and tribe representation. Sample sites were located through maps supplied by the Ministry of Planning and Economic Affairs and USAID. For agricultural areas, direct interviews with the Rice Survey enumerators enabled further detailed mapping.

Within County Comparisons

These concern particular counties and ecological areas, the Monrovia sample and the special group population at LAMCO. Comparisons including Monrovia require to be age-group specific due to the different age distribution.

The criteria for determining differences include:

1. Percentage prevalence rate variations,
2. Statistical testing such as the z test,
3. Sample size (See Appendix A).

It should be noted that even when the sample size may be less than 900 for a particular county or area, large differences in prevalence rates may be sufficiently reliable for comparative purposes, providing the variation of the result from site to site within the county described was low. For this reason some of the tables include totals less than a sample size of 900. Results, however, must be interpreted with due caution.

When the overall prevalence of a result was less than 5%, statistically significant variation could not be confidently evaluated between groups or regions.

3. Sampling in Monrovia

Selected populations were broadly identified in the poorer housing and more crowded areas of Monrovia. Using aerial maps and a grid method of sampling, random numbers identified the parts to be selected. Teams used a cluster sampling technique with a predetermined start and direction.

Ten children were measured in almost all clusters to increase the total number and enable a more uniform distribution of sites. The sites selected and the number of children up to 24 months of age were as follows: West Point (50), Sonowein (60), Buzzi Quarter (40), Logan Town (10), New Kru Town and Fanti Town (15), Lakplasse (20), Plumkor (20) and Point Four (10).

In view of the difficulty in defining the total universe of poorer sections within each area, sampling by population proportionality cannot be assured, although the households were randomly visited. The final results, therefore, must be interpreted with caution.

Approximately half of the houses visited were of a very temporary nature. Almost all household heads were employed. Jobs ranged from taxi driver to engineer. It was not possible to ascertain their incomes.

4. Semi-Remote Areas

Semi-remote areas were selected during the analysis. These were more than two hours walk from the nearest road and distant from the county capital. The sites are listed in Appendix K. This procedure was required because remote areas of the country, representing about 5% of the total rural population, were not visited.

It must be noted that semi-remote areas were not sampled per se, but simply selected from the total agricultural sample after the survey was

completed. No valid statistical comparisons were thus possible, but consistent differences in PCM prevalence estimates between the semi-remote and the rest of the agricultural sample for the country may indicate that the degree of remoteness may be an important factor in nutritional status. In no other way were these semi-remote areas meant to represent the remote areas not visited; in fact almost half the population of the latter live in the River Cess Territory in Grand Bassa County with a rather unique isolation.

V FIELD METHODS

A. PERSONNEL

The Government of Liberia provided three senior nutritionists: the Project Co-Director from the National Food Assistance Unit, and two supervisors, one from the University of Liberia and the other from the Peace Corps program within the Ministry of Health and Social Welfare (MHSW). The survey logistics officer was provided by the same Ministry. These personnel were available full-time during the field phase of the survey, and their efforts under difficult circumstances enabled the quality of work to remain at a high standard and the schedules to be met.

The closest liaison was maintained throughout all phases of the survey with the Assistant Minister for Preventive Services, MHSW.

AID/Liberia supplied the part-time services of the Health Development Officer, Monrovia.

The MHSW provided 24 trainees and the National Food Assistance Unit provided 2. The trainees consisted of Liberian physician-assistants and home economists, as well as health educators or teachers from the Peace Corps in the MHSW Preventive Services Program. In order to participate in the survey, the nutritionists and trainees became temporarily absent from important and at times essential roles within their regular Ministry programs. This indicates the high priority given by the Government of Liberia for the survey.

During the training phase, 22 trainees were selected as survey members to comprise 10 teams and one reserve team. The basis for selection included primarily competence in interviewing and measurement. Almost all

trainees were well-motivated and had prior health or nutrition experience in the Liberian hinterland.

B. TRAINING

The training period was divided into two phases, separated by Christmas and the President's Inauguration over the New Year.

The first phase, from December 4-20, 1975, included procedures outlined in the training manual prepared previously by the UCLA Nutrition Unit with Liberian consultation. Basic items in the training included: survey aims and definitions; understanding of and practice with questionnaire content, modified where required to suit local conditions and field testing; age determination using local calendar of events; measuring techniques, eliciting of physical signs, blood-taking; practical procedures on the survey such as the approach to local leaders, survey subjects and their families; and sampling at the site level.

During the interim, some of the sites selected for the survey were identified at the local level by several of the trainees.

The second phase, from January 8-20, 1976, involved training revision, as well as frequent practice sessions in the field. Standardization sessions for each measurement were performed 2-3 times.

During the training period, preparation was also required to clarify the sample sites in more detail using census information, interviewing the enumerators for the National Rice Survey, drawing local maps, local purchase and distribution of equipment, revising the measuring board and checking on vehicle and logistic requirements.

There were two major training sites. Initially, JFK Hospital, Monrovia, provided the facilities of a training room and outside annex.

Frequent practice sessions on interviewing and measurement were done in the hospital pediatric outpatient department and measurement at the inpatient department. The National Food and Assistance Unit provided a large hall and storeroom for training and equipment storage.

Facilities for practice were available at a Monrovia orphanage. The MHSW Preventive Services training room and MCH Clinic at West Point was used for blood-taking exercises.

Trial surveys were done in New Kru Town Monrovia, and Sasstown, Montserrado County.

After the first week of the survey in a neighboring county (Grand Bassa), teams returned to Monrovia where a further two days were devoted to attention to certain procedures and techniques.

C. PREPARATIONS WITHIN LIBERIA

Initial letters of notification were sent in early December by the MHSW to County and Territory Superintendents, as well as Medical Directors. Additional letters or cables were later sent when a more precise indication of the time of team arrival in the particular county was known. When the teams entered a county during the survey, further letters were required at the local level to District Commissioners, Traditional and Clan Chiefs.

Radio broadcasts in local languages and in English were provided by ELWA, to announce the survey, its purpose and schedules.

At times local arrangements had to be made well in advance on a personal basis in the areas concerned, such as Firestone.

D. TRANSPORT

During the training period a twelve-seater van was provided by the MHSW, Preventive Services. A VW minibus was also available some of the time from the National Food and Assistance Unit.

The MHSW provided a total of four vehicles for the field phase of the survey, two of which were Land Rovers. One Land Rover became available with AID/Liberia help,and the sixth vehicle, a VW van, was hired. Necessary repairs were undertaken by the MHSW motor pool and, when required, from private firms.

Drivers were provided by the MHSW. Two of these were qualified mechanics, and their presence in the field greatly limited any delays due to breakdowns.

Minor breakdowns occurred frequently but did not unduly upset the survey schedule. A delay of perhaps 2-3 days occurred in Nimba County where four of the vehicles were not running at one time.

E. COMMUNICATIONS

The MHSW radio was used where necessary, particularly from Monrovia to the inland. In certain areas mission radios were used. Messengers were often required in the field for advance notification or communication between teams and supervisors. The procedure in keeping vehicles, when possible, within contact of each other and with the survey logistics officer facilitated communication as well as timely vehicle repair.

F. SCHEDULE

All teams moved together throughout Liberia, caravan-style. They started in Grand Bassa County and finished in Montserrado and Monrovia. The schedule is summarized below.

County	Staging Site	Duration in County (Days)	No. of Sites	Average Days/Site/Team[a]
Grand Bassa	Buchanan	3½	11	3½
Gr. Gedeh Sinoe Maryland	Tchien	13	22	6
Nimba	Ganta	10	20	4½
Bong	Gbarnga	8	18	5
Lofa	Voinjamma	6	11	5½
Cape Mount*	Monrovia	4	8	5
Montserrado**	Monrovia	10	27	4

* Includes 2 sites in Lower Lofa

** Includes 3 sites in Lower Bong; does not include Monrovia proper and LAMCO, which took approximately 3 days for 6 teams

[a] Based on 10 teams.

These figures are approximations due to a lag period that sometimes occurred between teams from one staging site to the next. Duration in county covers the time of reaching the staging site to the time of arrival at the next. The six days during the field phase spent back in Monrovia are not included. These periods were used for preparation and rest.

In conclusion, the value of the survey members in keeping to schedule while maintaining a high standard of work cannot be overemphasized.

G. FIELD ACCOMMODATION

The County Superintendent or Medical Director in certain areas assisted with or provided accomodation arrangements at the stopping points. At times the services of the following were also used: friends or relatives of survey members, concession and mission facilities.

At the local level, the cooperation of village leaders varied from site to site, but in general was available. This depended greatly on the degree of prewarning they had received.

H. SERVICES

The Ministry of Planning and Economic Affairs provided advice and data from the 1974 Population Census prior to publication and supplied maps. Their statistical section advised on the sampling. Certain socio-economic indicators of the nutrition survey were patterned on this Ministry's 1976 household pilot survey.

The Ministry of Agriculture supplied essential information regarding the methods of sampling in the 1975-1976 National Rice Survey, also site locations and populations. An agricultural statistician with USAID working with the Ministry also gave advice.

Other Government Ministries, Agencies such as the Peace Corps, and USAID/Liberia provided available resources and advice, both in Monrovia and in the field.

The Liberian families and children measured were extremely cooperative and without this, the survey could not have been completed successfully.

I. ANTHROPOMETRIC EQUIPMENT

1. Height or length of children was measured in centimeters with a custom-made portable wooden board produced in Liberia from a prototype made at UCLA. Values were read to the nearest 0.1 cm.

Height of mothers was measured to the nearest cm. using an extension piece of this board.

2. Weights were measured with a Salter hanging scale (25kg.capacity). Values were read to the nearest division, 0.1 kg. Scales were adjusted to zero before each weighing and standardized against a known weight.

3. Arm circumference was measured with a Zerfas insertion tape with firm but gentle continuous contact with the left mid-upper arm. Values were read to the nearest 0.1 cm.

4. Triceps fatfold was measured with Holtain/Tanner-Whitehouse calipers at the mid-posterior point of the left upper arm. Values were read to the nearest 0.2 mm. The dial face was adjusted to zero when necessary before measuring each subject.

All teams measured children under five years and their mothers, when available. The one exception was weight, which was not done for mothers. A more detailed description is provided in Appendix F.

J. HEMOGLOBIN ESTIMATION

Capillary blood was collected by fingerprick on approximately every fifth child of the survey, excluding Monrovia and the special group at LAMCO. Specimens collected during the first week of the survey had to be discarded due to problems in technique. After this time, adequate collection technique was achieved and maintained (Appendix G).

The facilities at Phebe General Hospital and at ELWA Hospital were made available for the reading of specimens by the cyanmethemoglobin method, using available spectrophotometers. A UCLA Unit member read all the results, standardizing the method and instrument with that of the laboratory.

K. DATA PREPARATION

Field editing the survey form for clarity, completeness and consistency,was done at the sample site by the team and at times by the supervisors. Checks were also made with team participation at the end of each phase of the survey within the country. The original forms were air pouched to UCLA for processing and analysis on an IBM 360 computer at the Health Sciences Computing Facility, UCLA. The data was further edited, coded, and keypunched at UCLA.

At first, anthropometric analysis was performed using the reference values in Appendix E for anthropometric indices. Later, the core system of FORTRAN subroutines for this analysis was received from CDC, Atlanta, Georgia, USA, and programmed at UCLA.

These subroutines were used for all height-for-age, weight-for-age, and weight-for-height indices. Comparisons of the results using this procedure and the initial method described showed minimal differences in prevalence rates.

VI. SURVEY RESULTS AND ANALYSIS

A. AGE AND SEX DISTRIBUTION OF SAMPLE

Table 5 shows the age and sex distribution for the Liberia sample.

TABLE 5

DISTRIBUTION OF SAMPLE BY AGE AND SEX

Liberia

AGE	SEX					
	MALES		FEMALES		TOTAL	
(Months)	No.	%	No.	%	No.	%
0 - 1	51	3.1%	52	3.0%	103	3.1%
2 - 5	178	10.7%	186	10.8%	364	10.8%
6 - 11	242	14.6%	276	16.1%	518	15.3%
12 - 23	440	26.5%	454	26.4%	894	26,5%
24 - 35	322	19.4%	328	19.1%	650	19.2%
36 - 47	239	14.4%	265	15.4%	504	14.9%
48 - 59	186	11.2%	158	9.2%	344	10.2%
TOTAL	1658	100.0%	1719	100.0%	3377	100.0%

There is little difference between the sexes at each age range. On the other hand, relatively more children age 0-11 months (29.2%) and 12-23 months (26.5%) were selected than later year groups. This may be explained by the following:

1. Selective presentation or availability of younger children to the interviewer.
2. Error in age determination.
3. Actual demographic pattern.

No data for age distribution within children under five years of age is available in Liberia. It is probable that proportionally more children are in the younger age ranges.

Table 6 indicates age distribution by ecological area, with a very similar pattern for agricultural and non-agricultural areas but differences between the country (Liberia) sample and the others. Since the Monrovia sample was limited to children less than 24 months, comparisons should be restricted to children in this age category (Table 7). Similarly, since the LAMCO sample included proportionally more children under 6 months of age than the country sample, direct comparisons of the total numbers should exclude this group.

TABLE 6

AGE IN MONTHS - PERCENTAGE DISTRIBUTION

by Ecological Area

	<2	2-5	6-11	12-23	24-35	36-47	48-59	%	N
Agricultural	3.2	10.5	15.2	26.1	19.1	15.7	10.2	100	2,531
Non-Agricultural	2.6	11.4	15.2	27.5	19.3	13.3	10.7	100	948
Country	3.1	10.8	15.3	26.4	19.3	14.9	10.2	100	3,479
Monrovia	7.6	18.9	30.5	43.0				100	223
Special	11.2	14.4	16.5	22.1	15.1	13.3	7.4	100	285

TABLE 7

PERCENT DISTRIBUTION OF AGE ACCORDING TO AREA

	Age in Months								
AREA	2 %	2-5 %	6-11 %	12-23 %	24-35 %	36-47 %	48-59 %	%	N
Liberia	5.6	19.4	27.5	47.5	-	-	-	100	1934
Monrovia	7.6	18.9	30.5	43.0	-	-	-	100	223
Liberia	-	-	17.8	30.7	22.4	17.3	11.8	100	2995
Special Group	-	-	22.2	29.7	20.3	17.9	9.9	100	212

The age distribution for counties differs to a certain degree, particularly at the extremes, and for counties with smaller sample sizes (Table 8). Descriptions which combine these particular counties are more reliable and tend to give a more even population distribution (Table 9). The important differences in nutritional status according to age are some of the most striking found on the survey.

TABLE 8

PERCENT DISTRIBUTION OF AGE ACCORDING TO COUNTY

COUNTY	Age in Months 0-1 %	2-5 %	6-11 %	12-23 %	24-35 %	36-47 %	48-59 %	%	N
Bong	2.9	9.4	16.6	28.9	19.3	13.9	8.9	100	626
Grand Bassa	3.7	8.9	14.2	28.6	20.6	15.4	8.6	100	325
Cape Mount	6.1	13.4	16.8	29.1	19.6	10.6	4.5	100	179
Grand Gedeh	3.9	5.6	16.9	30.3	18.0	15.7	9.6	100	178
Lofa	4.8	8.1	12.9	25.9	18.8	17.8	11.7	100	394
Maryland	4.0	12.9	12.5	25.4	16.5	13.2	15.4	100	272
Montserrado	2.3	11.7	15.1	27.4	19.8	13.9	9.9	100	617
Nimba	2.0	13.0	16.4	23.0	18.1	17.6	9.8	100	591
Sinoe	3.4	12.8	16.3	18.7	23.2	11.8	13.8	100	203
TOTAL	3.3	10.8	15.3	26.4	19.2	14.9	10.2	100	3385
TOTAL NUMBER BY AGE	(111)	(364)	(518)	(894)	(650)	(504)	(344)	100	3385

TABLE 9

PERCENT POPULATION DISTRIBUTION BY AGE ACCORDING TO COUNTY GROUPING

COUNTY GROUPING	Age in Months 0-1 %	2-5 %	6-11 %	12-23 %	24-35 %	36-47 %	48-59 %	%	N
Bong Montserrado	2.6	10.5	15.8	28.2	19.5	14.0	9.4	100	1243
Lofa Nimba	3.1	11.1	15.0	24.2	18.4	17.6	10.6	100	985
Remainder	4.1	10.7	15.0	26.5	19.5	13.6	10.6	100	1157
LIBERIA	3.3	10.8	15.3	26.4	19.2	14.9	10.2	100	3385
	(111)	(364)	(518)	(894)	(650)	(504)	(344)		

The determination of correct age required great care since most of the children had no record of date of birth. Local events calendar, comparison of known sibling age, age checks to review extreme values in height-for-age results and comparison with number of milk teeth in the very young were used. Those children with a record had a lower prevalence of chronic PCM than those without (Table 10) although there was little or no difference in other PCM indices. Children without a record were not excluded preferentially except for the few occasions when no indication of age was available.

TABLE 10

PERCENT PREVALENCE OF CHRONIC PCM

ACCORDING TO METHOD OF DETERMINING AGES

AGE DETERMINATION	% Chronic PCM H/A* <90%	% N of Total	N
Birth Record	14.8	24.5	823
Other Verifiable Record	13.4	5.1	171
Other Methods (eg. Local Calendar of Events)	21.0	70.4	2363
TOTAL	18.5	100%	3357

*This denotes percentage of children below 90% of the reference median height-for-age; i.e. with chronic PCM as defined in this report.

B. PREVALENCE OF PCM IN RURAL LIBERIA

Table 11 lists the prevalence rate of various types of PCM for the Liberia sample. This sample, as defined previously, included all children surveyed except those from Monrovia proper and the special group at LAMCO.

TABLE 11

PREVALENCE PERCENT OF MALNUTRITION ACCORDING TO TYPE OF PCM

Liberia - 0-59 Months of Age

TYPE OF MALNUTRITION	PREVALENCE %*
Chronic PCM (H/A < 90%)	18.0
Acute PCM	
Moderate-Severe (W/H < 80%)	1.6
Mild or Worse (W/H < 85%)	5.6
Underweight (W/A < 80%)	24.0
Arm Wasting (AC/A < 82.5%)	10.8
(AC/H < 85%)	10.8
Fat Wasting (FF/A < 60%)	17.7

*all results by weighted average.

A prevalence rate of 18.0% for chronic PCM indicates that almost one in five children for the whole of Liberia, excluding Monrovia and Buchanan, were stunted and well below their full growth potential.

A rate of 1.6% for moderate to severe acute PCM indicates that recent onset PCM as determined in weeks duration, affected relatively few children.

Even for mild acute PCM the prevalence was relatively low (5.6%).

Almost one in four children (24%) were underweight by WHO criteria for PCM.* Taking the results for chronic and acute PCM above into consideration, it appears that this underweight was primarily related to short stature, that is children were perhaps smaller than expected but well proportioned by total body size.

Important arm wasting occurred in 10.8% of the children. The fatfold result suggests that at least some of this wasting was accounted for by deficient fat as well as muscle.

*Under 80% weight-for-age of reference population median.

C. NUTRITIONAL STATUS ACCORDING TO AGE

BY ECOLOGICAL AREA

1. Chronic PCM (Low Height-for-Age) - Table 12*

There is a marked difference between agricultural and other areas (large rural, urban and concession) at all ages, except the 2-5 months old group. For example at 6-11 months, the prevalence of chronic PCM in agricultural areas (15.6%) is almost 3 times and at 12-24 months (24.4%) twice that of non-agricultural areas ($P < 0.05$ in both instances).

The relative sparing of the 2-5 months age group emphasizes the protective influence of breast feeding throughout the country.

The greatest differences between the agricultural and semi-remote areas occur from 12-35 months. After this age there is little difference. This suggests, in these critical age periods, remoteness in agricultural areas may be an important factor associated with a higher prevalence of chronic PCM.

The Monrovia results tend to reflect those of urbanised areas throughout Liberia. As expected, the special group (LAMCO) population in almost all groups has the lowest prevalence of PCM and suggests that even in urban areas there is room for improvement.

Valid statistical comparisons cannot be made for neonates (0-1 month group) because of the small numbers. This also applies to certain other parts of this and the following tables, such as for Monrovia or Special Groups.

2. Acute PCM

a) Weight-for-Height - under 80% (Table 13)

In no age group nor area is there any important prevalence percentage results. This contrasts with the much higher prevalence of

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*Tables 12-17 are included at the end of Section C.

chronic PCM. Perhaps there was still a relative food sufficiency and the traditional "hungry season" had not yet been established.

b) Weight-for-Height - under 85% (Table 14)

This includes children with a milder degree of acute PCM than those only under 80% reference median (see p.11). The highest prevalence for all areas, occurs in the 12-23 month age range and within this age group the remote areas have the highest rate.

3. Underweight (low Weight-for-Age) - Table 15

Children in all areas had the highest prevalence for low weight-for-age from 6-23 months. Large differences again occurred between agricultural and other areas, particularly at 6-23 months. Semi-remote areas had the highest prevalence for underweight (41.1%) at this age range.

4. Arm Wasting (Low Arm Circumference-for-Age) - Table 16

Results clearly dramatise the much higher prevalence of arm wasting in the 6-24 month age group, particularly in agricultural areas. There is essentially no difference between areas for other age groups, apart from the Special Group, which approaches values for industrialised countries.

The plateau of a much higher prevalence for chronic PCM after 24 months of age illustrates the cumulative result of earlier episodes of PCM in the weaning period presumably with repeated infections, infestations, inadequate feeding and the relative failure of catch up growth even up to 5 years.

The arm circumference measure appears more sensitive in identifying these episodes than weight-for-height. This is probably reflected by the following:

a) Each measures different aspects of tissue mass.

b) A low W/H indicates a more acute onset of PCM than AC/A.

5. Fat Wasting (Low Fatfold-for-Age) - Table 17

The prevalence of fat wasting is particularly high (24.7%-36.3%) in all areas from 6-23 months apart from perhaps the special group. It must be noted that little or no difference in prevalence is seen between almost all areas. This is contrary to the results for other indices of malnutrition.

This may be possibly due to the lack of accuracy of measurement; however, any bias may tend to even out throughout the country, because teams were evenly dispersed to represent all areas.

SUMMARY

The highest prevalence for all indices occurs from 6-23 months.

The prevalence of chronic PCM and less chronic forms of PCM (underweight, arm wasting) is consistently higher in the more rural, traditional agricultural areas compared with other areas of the country. Fat wasting shows little difference however. This suggests that depletion of fat stores occurred to an equal extent throughout, whereas other body components such as skeleton and muscle were more deficient in young children in the agricultural areas. It must be noted that this refers to body tissues, not necessarily to types of food and mechanism of occurrence of the particular type of PCM.

TABLE 12

HEIGHT-FOR-AGE

Percentage within Ecological Areas According to Age Group Less Than 90% of NAS Reference Median

AREA	Age in Months 0-1	2-5	6-11	12-23	24-35	36-47	48-59	N
Agricultural	11.9	6.7	15.9	22.9	21.0	23.0	29.4	2002
Semi-Remote	17.6	7.6	14.3	30.6	25.6	21.0	28.6	500
Total Agricultural	13.1	7.1	15.6	24.4	21.8	22.5	29.2	2502
Total Non-Agricultural	8.7	7.0	4.7	13.9	19.5	14.7	13.0	977
TOTAL COUNTRY	12.1	7.0	12.5	22.3	21.1	20.5	24.7	3479
Monrovia	11.8	7.1	2.9	11.4	NC*	NC	NC	223
Special Group	12.5	0.0	4.3	7.9	13.9	13.2	4.8	285

TABLE 13

WEIGHT-FOR-AGE

Percentage within Ecological Areas According to Age Group Less Than 80% of NAS Reference Median

AREA	Age in Months 0-5	6-11	12-23	24-35	36-47	48-59	N
Agric.	20.9	36.3	30.9	20.8	17.1	19.2	2002
Semi-remote	18.7	41.1	41.4	26.1	20.2	22.9	500
Total Agric.	20.4	37.2	33.0	21.8	17.8	20.0	2502
Total Non-Agric.	17.7	26.6	22.3	18.0	16.1	17.6	977
Total Liberia	19.6	34.8	31.1	20.8	17.4	19.3	3479
Monrovia	15.1	20.3	21.2	NC*	NC	NC	223
Special Grp.	12.3	20.4	18.7	12.8	5.3	0	285

*No Children

TABLE 14

WEIGHT-FOR-HEIGHT

Percentage within Ecological Areas According to
Age Group Less than 80% of NAS Reference Median

AREA	Age in Months 0-1	2-5	6-11	12-23	24-35	36-47	48-59	N
Agricultural	6.8	2.1	2.9	2.1	1.0	0.3	0.0	2002
Semi-Remote	0.0	0.0	0.0	3.2	0.0	0.0	3.6	500
Total Agricultural	4.5	1.4	2.4	2.3	0.8	0.3	0.8	2502
Total Non-Agricultural	9.1	1.8	0.7	2.6	0.5	0.7	2.0	977
TOTAL COUNTRY	6.2	1.6	1.9	2.4	0.7	0.4	1.1	3479
Monrovia	0.0	2.4	1.5	0.0	NC*	NC	NC	223
Special Group	3.4	0.0	2.1	3.2	0.0	2.6	0.0	285

TABLE 15

WEIGHT-FOR-HEIGHT

Percentage within Ecological Areas According to
Age Group Less Than 85% of NAS Reference Median

AREA	Age in Months 0-1	2-5	6-11	12-23	24-35	36-47	48-59	N
Agricultural	11.9	4.7	7.4	9.7	4.8	2.3	1.0	2002
Semi-Remote	6.7	1.5	5.7	16.1	3.5	2.5	3.6	500
Total Agricultural	10.8	3.9	7.1	10.9	4.6	2.3	1.5	2502
Total Non-Agricultural	13.6	3.6	3.3	7.1	2.7	1.5	6.0	977
TOTAL COUNTRY	11.5	3.7	6.1	9.8	4.0	2.1	2.8	3479
Monrovia	6.2	2.4	2.9	9.1	NC*	NC	NC	223
Special Group	6.9	0.0	6.3	6.3	7.0	2.6	0.0	285

*No Children

TABLE 16

ARM CIRCUMFERENCE-FOR-AGE

Percentage within Ecological Areas According to
Age Group Less Than 82.5% of NAS Reference Median

AREA	Age in Months 0-1	2-5	6-11	12-23	24-35	36-47	48-59	N
Agricultural	16.4	7.2	25.0	19.3	8.1	3.9	2.5	2002
Semi-Remote	11.8	4.6	15.7	25.8	10.5	1.2	5.4	500
Total Agricultural	15.5	6.5	23.3	20.6	8.5	3.4	3.1	2502
Total Non-Agricultural	13.0	7.0	8.0	11.5	6.5	4.4	2.0	977
TOTAL COUNTRY	15.0	6.7	18.9	17.9	7.9	3.6	2.8	3479
Monrovia	11.8	7.1	10.3	10.2	NC*	NC	NC	223
Special Group	3.1	2.4	4.3	7.9	4.7	0.0	0.0	285

TABLE 17

FATFOLD-FOR-AGE

Percentage within Ecological Areas According to
Age Group Less Than 60% of NAS Reference Median

AREA	Age in Months 0-1	2-5	6-11	12-23	24-35	36-47	48-59	N
Agricultural	29.9	11.9	28.9	32.8	10.1	7.9	6.4	2002
Semi-Remote	29.4	7.6	27.1	32.3	5.8	3.7	3.6	500
Total Agricultural	29.8	10.8	28.6	32.7	9.3	7.0	5.8	2502
Total Non-Agricultural	17.4	11.4	24.7	27.1	9.7	6.6	11.0	977
TOTAL COUNTRY	27.1	11.0	27.5	31.1	9.4	6.9	7.2	3479
Monrovia	11.8	23.8	32.4	36.3	NC*	NC	NC	223
Special Group	9.4	9.8	21.3	19.0	9.3	2.6	4.8	285

*No Children

D. LIBERIA SAMPLE, MONROVIA AND SPECIAL GROUP COMPARISONS

The Liberia sample, Monrovia and Special Group (LAMCO) require combining at particular age ranges for comparisons of nutritional status (see Table 7). The sample sizes in the latter two groups were small, so that results should be viewed with necessary caution. Large differences, however, are strongly suggestive.

Table 18 shows that approximately 80% of children from the Liberia sample have normal nutritional status (neither wasting nor stunting) compared with some 90% from other groups. There is little difference between the Monrovia and Special Group. The format of the table is described on page 11. Stunting (chronic PCM as determined by low height-for-age) accounts for this difference, whereas wasting (acute PCM or low weight-for-height) prevalence is low throughout.

The NAS reference population is based on the percentage distribution of the USA samples where the median reference data was obtained and represents the estimated percentage of stunting and wasting.

The prevalence underweight and of arm wasting is much higher in the rural Liberia sample (Table 19). The rates for fat wasting on the other hand are of similar magnitude for Liberia and Monrovia, and perhaps lower in the Special Group.

Results are complementary to those presented in the section for ecological areas. It is apparent that chronic PCM, underweight children and those with arm wasting show important prevalence rates for rural Liberia, and within this particularly the more ruralized, traditional agricultural areas.

TABLE 18

PERCENT DISTRIBUTION OF CHILDREN AT SELECTED AGE RANGES BY CLASSIFICATION OF STUNTING AND WASTING FOR LIBERIA RURAL SAMPLE, MONROVIA AND SPECIAL GROUP

	Normal	Stunting	Wasting	Stunting & Wasting	TOTAL %	Sample Sizes
0-23 months						
Liberia	82.9	14.8	1.6	0.8	100	1930
Monrovia	90.6	7.6	1.3	0.4	100	223
6-59 months						
Liberia	79.3	19.2	0.8	0.7	100	2998
Special	88.7	8.5	2.4	0.5	100	212
6-23 months						
Liberia	80.7	17.1	1.3	0.9	100	1449
Monrovia	91.7	7.1	0.6	0.6	100	156
Special	90.9	5.5	2.7	0.9	100	110
6-72 months						
NAS reference	98.7	0.4	0.8	0.0	100	(4947)

TABLE 19

PREVALENCE PERCENT OF CHILDREN AT SELECTED AGE RANGES ACCORDING TYPE OF PCM FOR LIBERIA RURAL SAMPLE, MONROVIA AND SPECIAL GROUP

	Underweight	Arm Wasting	Fat Wasting	Sample Sizes
0-23 months				
Liberia	28.8	16.4	26.0	1930
Monrovia	19.3	9.9	30.5	223
6-59 months				
Liberia	24.9	11.9	18.6	2998
Special	13.3	4.2	13.2	212
6-23 months				
Liberia	32.1	19.1	29.7	1449
Monrovia	20.7	10.9	34.6	156
Special	19.1	6.4	22.0	110

E. NUTRITIONAL STATUS ACCORDING TO SEX

For the Liberia survey population, the prevalence of chronic PCM is significantly higher in males than females ($Z = 2.6$, $P < 0.05$). This appears more limited to the 6-36 month age group (Table 20) and is not explained by unequal distribution according to age. In this age group, a similar sex difference is apparent for other parameters (W/H, AC/A) but not for fatfold.

Although the percentage differences are not great, the consistent overall trend may suggest a true difference. Cultural or other practices may have a bearing although there is no clear reason for better nutritional status in young female children.

It should be noted, however that in both sexes the prevalence of acute PCM is low.

TABLE 20

AGE AND SEX DIFFERENCES IN NUTRITIONAL STATUS

Prevalence Percentages

AGE AND SEX	H/A <90% Chronic PCM	WT/HT <80% AC PCM (Mod-Severe)	WT/HT <85% AC PCM (Mild+)	AC/A <82.5% Arm Wasting	FF/A <60% Fat Wasting	TOTAL NUMBER
<6 MTHS.						
Male	8.1	3.9	7.4	10.2	12.3	235
Female	8.1	1.2	3.3	6.9	16.7	246
6-36 MTHS.						
Male	21.8	2.1	8.0	16.0	23.6	1057
Female	16.8	1.3	5.8	13.5	22.0	1122
36-59 MTHS						
Male	22.1	0.5	2.2	2.7	7.1	411
Female	20.6	1.0	2.9	3.9	7.4	408
0-59 MTHS						
Male	20.0	1.9	6.5	12.0	18.0	1703
Female	16.5	1.2	4.8	10.4	17.9	1776
TOTAL	18.2	1.6	5.6	11.2	18.0	3479

F. BETWEEN COUNTY COMPARISONS OF NUTRITIONAL STATUS

Certain counties are grouped to supply sufficient sample sizes for valid comparisons. The results for a few counties with a sample size over 500 are given also. Results for all counties are included to provide basic data for further county groupings, if required.

1. Agricultural Areas

TABLE 21

PREVALENCE PERCENTAGES OF MALNUTRITION[a]
BY COUNTY GROUPINGS FOR TRADITIONAL AGRICULTURAL AREAS ONLY
ACCORDING TO TYPE OF PCM

COUNTY GROUPINGS	TYPE OF PCM					
	Chr. H/A	Acute W/H	Under Wt. W/A	Arm Wasting AC/A	Fat Wasting FF/A	N
	< 90%	< 80%	< 80%	< 82.5%	< 60%	
Bong Montserrado Grand Bassa	16.9	1.5	23.2	8.8*	15.7	950
Nimba Lofa	21.3	1.6	25.4	13.6	18.8	894
Cape Mount Grand Gedeh Maryland Sinoe	22.0	1.6	28.7	14.0	19.8	687
Bong	13.0*	1.5	21.0*	8.4*	18.0	538
Nimba	21.2	1.3	27.8	15.9*	20.3	536
LIBERIA	20.2	1.6	25.5	12.0	18.0	2,531

[a]All results by weighted averages

*Significant percentage and statistical difference from the rest of the country ($p < 0.05$)

H/A: Height-for-Age; W/H: Weight-for-Height; W/A: Weight-for-Age; AC/A: Arm Circumference-for-Age; FF/A: Triceps Fatfold for-Age.

N - Total number of children measured in agricultural area of each county.

Bong, Montserrado, and Grand Bassa together have children with a lower prevalence than the rest of the country,of chronic PCM (Z score = 2.83; $p < 0.01$); of underweight ($Z = 2.08$; $p < 0.05$); arm wasting ($Z = 3.53$; $p < 0.01$); and fat wasting ($Z = 2.84$; $p < 0.01$). PCM appears less of a problem in these counties, at least concerning agricultural areas. It is apparent from Table 22 that the major contribution to these differences comes from Bong and Montserrado counties.

Bong county alone has the lowest prevalence of chronic PCM and underweight children for all agricultural areas of Liberia and is well below the total country prevalence for arm, but not fat, wasting. All these results are statistically significant at the $p < 0.05$ level and cannot be explained by age or sex differences.

Nimba and Lofa together, and the group consisting of Cape Mount, Grand Gedeh, Maryland, and Sinoe, have prevalence rates for all types of PCM similar to the country values.

Nimba alone has a higher rate of arm wasting in children than the rest of the country ($t = 3.23$; $p < 0.01$). It is difficult to interpret this isolated finding.

Coastal counties apart from Montserrado have a slightly higher prevalence than inland counties, apart from Bong, of chronic PCM (23.5% vs. 20.7%), underweight children (28.6% vs. 25.9%), and arm wasting (15.0% vs. 12.9%). The magnitude of these differences is not significant.

The extent of acute PCM (low weight-for-height) is small throughout all counties.

TABLE 22

AGRICULTURAL AREAS
PERCENT PREVALENCE UNDERNUTRITION[a]
BY COUNTY ACCORDING TO TYPE OF PCM

COUNTY	TYPE OF PCM					
	Chr. H/A	Acute W/H	Under Wt. W/A	Arm Wasting AC/A	Fat Wasting FF/A	N (Sample Size)
	< 90%	< 80%	< 80%	< 82.5%	< 60%	
Bong	13.0	1.5	21.0	8.4	18.0	538
Grand Bassa	22.4	2.1	27.0	10.9	18.1	237
Cape Mount	26.8	1.1	33.5	16.2	20.7	179
Grand Gedeh	17.4	0.7	27.5	7.4	23.5	149
Lofa	21.7	2.0	22.3	11.2	16.7	358
Maryland	20.1	2.2	24.5	15.2	18.0	184
Montserrado	18.9	1.1	24.0	8.0	10.3	175
Nimba	21.1	1.3	27.8	15.9	20.3	536
Sinoe	28.0	2.3	33.1	20.6	16.0	175
TOTAL	20.2	1.6	25.5	12.0	18.0	2,531

[a]All results by weighted average

2. Total Counties

TABLE 23

PREVALENCE PERCENTAGES OF MALNUTRITION[a] BY COUNTY GROUPINGS FOR ALL AREAS ACCORDING TO TYPE OF PCM

COUNTY GROUPINGS	TYPE OF PCM					
	Chr. H/A	Acute W/H	Under Wt. W/A	Arm Wasting AC/A	Fat Wasting FF/A	N
	< 90%	< 80%	< 80%	< 82.5%	< 60%	
Bong Montserrado	14.5*	1.4	21.3*	8.0*	16.6	1,335
Nimba Lofa	20.1	1.5	24.6	12.6	18.4	982
Cape Mount Grand Gedeh Maryland Sinoe Grand Bassa	20.2	1.8	26.6	12.4	18.3	1,162
Bong	13.2*	1.5	20.9	8.3	18.0	628
Montserrado	15.5	1.4	21.6	7.6*	15.3	707
Nimba	19.6	1.4	26.7	14.2	19.9	575
LIBERIA	18.0	1.6	24.0	10.8	17.7	3,479

[a]All results by weighted average

*Significant percentage and statistical difference from the rest of the country ($p < 0.05$)

Almost without exception, the prevalence of chronic PCM and arm wasting was less in agricultural areas within each county. As expected, the prevalence rates for total counties (Table 23, 24) were less than for agricultural areas alone.

Bong and Montserrado still have by far the lowest rates of PCM for Liberia. Results comparing other counties and groups are similar to those for agricultural areas presented in the last section.

Regrouping counties other than Bong and Montserrado in various combinations such as inland and coastal, eastern and northern, did not reveal any important differences between the groups.

TABLE 24

ALL AREAS OF COUNTIES
PERCENT PREVALENCE UNDERNUTRITION[a]
BY COUNTY ACCORDING TO TYPE OF PCM

COUNTY	TYPE OF PCM					
	Chr. H/A	Acute W/H	Under Wt. W/A	Arm Wasting AC/A	Fat Wasting FF/A	N
	< 90%	< 80%	< 80%	< 82.5%	< 60%	
Bong	13.2	1.5	20.9	8.3	18.0	628
Grand Bassa	19.8	2.0	25.0	10.1	17.6	325
Cape Mount	23.6	1.3	30.1	14.0	20.2	179
Grand Gedeh	16.5	0.8	26.7	6.9	22.0	179
Lofa	20.9	1.7	21.4	10.1	16.2	387
Maryland	18.4	2.1	23.8	13.6	17.7	275
Montserrado	15.5	1.4	21.6	7.6	15.3	707
Nimba	19.6	1.4	26.7	14.2	19.9	595
Sinoe	24.0	2.2	29.7	17.8	15.4	204
TOTAL	18.0	1.6	24.0	10.8	17.7	3,479

[a]All results by weighted average

G. NUTRITIONAL STATUS WITHIN NON-AGRICULTURAL AREAS

In Montserrado County there is a lower rate of chronic PCM and fat wasting compared with the rest of the country; the differences are not marked nor statistically significant ($Z = 1.54$, $P > 0.05$ for low height-for-age).

Within non-agricultural areas, there appears a greater rate of chronic PCM in urban areas and a lesser rate of low fatfold in large rural areas. Apart from this finding, there appear no important differences. In these descriptions, the numbers are too small for optimal statistical precision.

TABLE 25

PERCENT PREVALENCE BY TYPES OF PCM
ACCORDING TO NON-AGRICULTURAL AREAS

I PART OF COUNTRY

Non-agric. areas: Site	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	Sample Size	%of Total
Monteserrado	12.2	1.9	7.7	16.0	531	56.2%
Rest of Country	15.7	1.4	7.7	18.1	414	43.8%
TOTAL	13.8	1.7	7.7	16.9	945	100.0%

II DESCRIPTION

Non-agric. areas: Type	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	Sample Size	% of Total
Large Rural	12.1	2.2	8.7	11.8	322	34.1%
Urban	16.5	1.8	8.8	20.7	328	34.7%
Concession	11.8	1.0	5.1	18.9	295	31.2%
TOTAL	13.8	1.7	7.7	16.9	945	100.0%

H. ANEMIA - Table 26.

There is clearly a very high prevalence of anemia, as shown by low hemoglobin levels, for all age groups. Although the cut-off point for anemia is not clear in the 1-5 month age group, the data suggests a high prevalence also.

These results are expected, due to the known problems of malaria, hookworm infestation and poor diet. On the other hand, the prevalence of severe anemia demanding urgent clinical attention (i.e. hemoglobin below 6 gm/100 cc) is 1.1%.

I. KWASHIORKOR

Only four children in the total sample had clinical evidence of kwashiorkor; that is the presence of bilateral pitting edema of the lower legs. It is possible that in a few cases this sign may have been overlooked. Even then, the prevalence would be very low. The lack of this sign is consistent with the low weight-for-height acute PCM estimate throughout the country.

It must be noted that this sign is very insensitive in detecting prevalence of malnutrition and identifies only a certain severe type of PCM, florid kwashiorkor.

TABLE 26

PERCENT DISTRIBUTION OF HEMOGLOBIN LEVELS ACCORDING TO AGE

Liberia Sample

AGE IN MONTHS		Hemoglobin Levels gms/100cc <6.0	6.0-7.9	8.0-9.9	10.0-10.9	11.0-11.9	12.0+	%	n
1-5		0.0	4.3	34.3	37.1	11.5	12.8	100	70
6-11		2.2	16.8	53.3	24.4	1.1	2.2	100	90
12-23		1.3	11.4	36.2	30.9	14.8	5.4	100	149
24-35		1.0	16.5	35.0	23.2	16.5	7.8	100	103
36-59		0.7	10.4	29.2	30.5	18.1	11.1	100	144
	TOTAL	1.1	12.1	36.7	29.1	13.3	7.7	100	556
		6	67	204	162	74	43	100	556

ANEMIA

AGE IN MONTHS	PREVALENCE PERCENTAGE[1]
6-11	72.3%
12-23	48.9%
24-35	75.7%
36-59	70.8%
TOTAL	62.1%

[1] In the 6-23 month age group a hemoglobin less than 10 gms/100 cc is abnormal. In the 24-72 month age group a hemoglobin less than 11 gms/100cc is abnormal.

J. FEEDING PRACTICES

Up to six months of age, 93.8% of all children in the Liberia sample were fully breast fed; from 6-11 months of age, 84.4% and 12-24 months of age, 49.2% (Table 27). Partly breast fed children were defined for the purposes of the survey, as those receiving the breast intermittently but not as a major source of nourishment.

Between the ages of 6-11 months, of those children receiving food other than milk (83.6%), the proportion of children receiving specially prepared food was almost equal to those sharing food with the family. In the survey, only the major source of food was identified. Between the ages of 12-24 months, only 8.6% of children still received specially prepared food (Table 28).

It is important to note that 10.4 of all rural children 6-11 months of age received no food, apart from milk. The proportion of children receiving rice water as food apart from milk was 3.2% for this age group. This may be an underestimate as no specific question for rice water was asked.

TABLE 27

PERCENT DISTRIBUTION OF MILK FEEDING ACCORDING TO AGE

Liberia Sample

TYPE OF MILK	0-5 Mths	6-11 Mths	12-24 Mths
Fully Breast Fed	93.8	84.4	49.2
Partly Breast Fed	2.6	4.6	14.3
Non Breast Milk Only	2.6	7.6	4.8
No Milk	1.0	3.4	31.7
TOTAL %	100.0	100.0	100.0
N	468	526	945

TABLE 28

PERCENT DISTRIBUTION OF METHODS OF FOOD PRESENTATION

ACCORDING TO AGE - Liberia Sample

	0-5 Mths	6-11 Mths	12-24 Mths
FOOD SPECIALLY PREPARED	32.6	40.9	8.6
FOOD SHARED WITH FAMILY	3.4	39.5	86.6
NO FOOD	58.9	16.4	3.5
RICE WATER ONLY	5.1	3.2	1.3
TOTAL %	100.0	100.0	100.0
N	467	526	942

It is of interest that for children not fully breast fed, the person responsible for making sure the child received food, was often the child or other family member in the case of infants and usually the child after one year of age (Table 29). Even allowing for some bias because of the difficulty in obtaining precise information, it appears that the child may have to compete on his own with other family members for food.

TABLE 29

PERCENT DISTRIBUTION OF PERSON FEEDING CHILD ACCORDING TO AGE - Liberia Sample

	INCLUDING BREAST FEEDING			EXCLUDING FULL BREAST FEEDING		
	0-5 Mths	6-11 Mths	12-24 Mths	0-5 Mths	6-11 Mths	12-24 Mths
MOTHER	97.9	94.3	60.0	73.7	63.4	20.0
SIBLING/OTHER	1.5	2.3	4.3	18.4	14.6	8.5
NONE	0.6	3.4	35.7	7.9	22.0	71.5
TOTAL %	100.0	100.0	100.0	100.0	100.0	100.0
N	477	526	931	38	82	466

Comparison of the nutritional status of the child according to food and/or milk provision, showed no important nor consistent differences, where sufficient numbers were adequate for analysis (Table 30). This may be explained by a lack of sensitivity in defining groups during the survey or by the qualitative nature of the information, which did not consider amounts nor types of food.

TABLE 30

PERCENT PREVALENCE OF PCM BY AGE GROUPS ACCORDING TO

MILK AND FOOD PROVISION - Liberia Sample

	H/A	W/H	W/H	AC/A	FI/A	N	% N of Total
0-5 MONTHS							
	< 90%	< 80%	< 85%	< 82.5%	< 60%		
Food Only	-	-	-	-	-	5	1.0
Milk Only	7.4	2.2	5.8	7.4	14.5	283	59.0
Food and Milk	8.9	1.2	2.4	8.3	11.9	168	35.0
Rice Water/Milk	-	-	-	-	-	24	5.0
TOTAL	8.1	2.5	5.2	8.5	14.6	480	100%
6-11 MONTHS							
	H/A	W/H	W/H	AC/A	FI/A	N	% N of Total
	< 90%	< 80%	< 85%	< 82.5%	< 60%		
Food Only	-	-	-	-	-	18	3.4
Milk Only	13.9	1.2	2.3	18.6	25.6	86	16.4
Food and Milk	12.8	1.7	5.7	18.3	27.2	405	77.0
Rice Water/Milk	-	-	-	-	-	17	3.2
TOTAL	12.5	1.9	6.1	18.4	27.3	526	100%
12-24 MONTHS							
	H/A	W/H	W/H	AC/A	FI/A	N	% N of Total
	< 90%	< 80%	< 85%	< 82.5	< 60%		
Food Only	22.0	3.3	10.3	16.0	26.0	300	31.7
Milk Only	24.2	9.1	12.1	15.1	33.3	33	3.5
Food and Milk	20.7	1.3	9.0	17.5	33.0	600	63.5
Rice Water/Milk	-	-	-	-	-	12	1.3
TOTAL	21.4	2.3	9.8	17.4	30.9	945	100%
0-24 MONTHS							
Rice Water/Milk	14.1	5.3	15.8	24.6	29.8	57	2.8
Remainder	15.3	2.1	7.2	14.9	25.9	1951	97.2
TOTAL						2008	100%

K. ASSOCIATED VARIABLES

1. Household Size

The smaller the household size the greater the prevalence of nutritional deficiency in children. This result needs qualification, in that the households in the sample were only those having children under 5 years of age, and perhaps not representative of all the households in the survey universe. In addition, more than one family may have been included in a household.

TABLE 31

PREVALENCE PERCENTAGE BY TYPE OF PCM ACCORDING TO HOUSEHOLD SIZE

Liberia Sample

HOUSEHOLD SIZE	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
1-4	21.3	2.3	15.0	21.9	521	15.2
5-8	18.9	1.2	11.5	17.4	1457	43.3
9+	17.0	1.7	9.4	17.0	1388	41.2
TOTAL	18.5	1.6	11.2	18.0	3366	100%

2. Birth Order of Child

Children with a birth order of nine or more had a much lower prevalence of chronic PCM and arm wasting. This was an unexpected finding in view of results in other parts of West Africa. The household size was greater than that found in the 1970 Demographic survey (15).

TABLE 32

PREVALENCE PERCENTAGE BY TYPE OF PCM ACCORDING TO BIRTH ORDER

Liberia

BIRTH ORDER	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
1-3	19.1	1.9	5.6	11.4	18.2	1802	52.2
4-6	17.5	1.6	5.5	10.8	16.5	952	27.6
7-9	18.0	1.2	7.1	12.6	19.1	496	14.4
9+	12.9	0	3.0	6.5	20.4	200	5.8
TOTAL	18.2	1.6	5.6	11.1	18.0	3450	100%

3. Birthplace of Child

Children born in a hospital or clinic had less chronic PCM and less arm wasting than those born at home, both in the 0-24 and the 24-60 age groups. This may be accounted for by the urban-rural differences in under-nutrition already discussed, with health and other services more available in urban areas.

Children born outside their present county of residence comprised 10% of the total sample. About one half of these were born in Montserrado county. No firm conclusions can be made because of the small numbers, but their prevalence malnutrition, for arm wasting, was higher than for their county of birth.

TABLE 33

PERCENT PREVALENCE BY TYPE OF PCM ACCORDING TO BIRTHPLACE

Liberia

CHILD 0-24 MONTHS OLD

BIRTHPLACE	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Hospital/Clinic	11.8	3.2	8.2	11.6	24.7	534	28.1
Home	17.0	2.0	7.5	17.6	26.3	1367	71.9
TOTAL	15.6	2.3	7.7	15.9	25.9	1901	100.0

CHILD 24-60 MONTHS OLD

	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Hospital/Clinic	19.1	0.4	2.0	2.9	8.8	444	29.1
Home	22.5	0.8	3.6	6.1	7.6	1082	70.9
TOTAL	21.5	0.7	3.1	5.2	7.9	1526	100.0

ALL CHILDREN

	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Hospital/Clinic	15.1	1.9	5.4	7.6	17.5	978	28.5
Home	19.5	1.5	5.8	12.6	18.2	2449	71.5
TOTAL	18.3	1.6	5.7	11.2	18.0	3427	100.0

TABLE 34

PERCENT PREVALENCE BY TYPE OF PCM ACCORDING TO COUNTY OF BIRTHPLACE

Liberia

COUNTY OF BIRTH	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Same County	18.5	1.6	11.3	18.4	2888	89.2
Other County (Montserrado)	18.9	2.9	10.9	16.6	175	5.4
Other County (excl. Montserrado)	16.7	0.6	5.2	16.8	173	5.4
TOTAL	18.4	1.6	11.0	18.2	3236	100

4. Sta. of Parents

Children of mothers absent, that is no longer with the child, or dead, were a small part of the sample (3.7%) and those with father absent or dead, 11.6%. In both cases, relatively more of these children had chronic long-term PCM.

TABLE 35

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO STATUS OF MOTHER - Liberia

STATUS OF MOTHER	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%		% N of Total
Dead	(40.0)	(6.7)	(26.7)	(6.7)	15	0.5
Absent	30.8	1.0	9.3	14.0	107	3.2
Not Absent	18.1	1.6	11.2	18.3	3241	96.3
TOTAL	18.6	1.6	11.2	18.1	3363	100%

TABLE 36

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO STATUS OF FATHER - Liberia

STATUS OF FATHER	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Dead	4.3	0	0	8.7	23	0.7
Absent	26.2	2.4	12.7	22.0	377	10.9
Not Absent	17.3	1.5	11.0	17.5	3054	88.4
TOTAL	18.2	1.6	11.1	18.0	3454	100.0

5. Tribal Group of Father

The distribution of tribal groups within the sample corresponded closely to that of previous demographic data, apart from the Bassa. These were underrepresented because Buchanan was not surveyed. The effect of excluding Monrovia proper also has to be taken into account.

The Kpelle and Mandingo tribes had the least children with chronic PCM whereas the Krahn, Kru, Kissi and Dan had the most. A similar pattern was evident with arm circumference, apart from the Kissi. Only the Kpelle results have complete statistical validity because of adequate sample size.

TABLE 37

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO TRIBAL GROUP OF FATHER - Liberia

TRIBE	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Bassa	21.8	2.4	11.8	19.4	381	11.1
Kpelle	13.3	1.5	7.7	15.7	819	23.9
Gio (Dan)	22.9	1.0	15.6	22.9	288	8.4
Gola	19.6	0.5	12.5	18.5	184	5.4
Grebo	17.7	1.2	9.5	21.4	327	9.5
Kissi	22.9	0	6.9	14.3	175	5.1
Krahn	23.5	2.0	17.4	18.8	149	4.3
Kru	24.4	2.2	17.8	17.3	225	6.5
Loma	16.7	3.1	10.5	16.2	191	5.6
Mano	16.8	1.2	10.0	17.2	250	7.3
Mandingo	8.4	1.9	7.8	14.3	154	4.5
Others	21.6	1.4	15.3	19.9	287	8.4
ALL TRIBES	18.5	1.6	11.2	18.0	3430	100.0

6. Mothers' Knowledge of English

Only about 10% of mothers could read English. Lack of knowlege of English was clearly associated with an increased chronic PCM and arm wasting prevalence in their children. This suggests that children of mothers with a more formal education or of perhaps better socio-economic status have less PCM than those without. However, this may also be related to degree of urbanization.

TABLE 38

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO MOTHER'S KNOWLEDGE OF ENGLISH

Liberia

ENGLISH	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Tota
Knows/Reads	11.3	2.3	5.5	7.7	17.1	310	9.0
Knows	16.2	1.5	5.3	9.3	18.4	1088	31.7
Don't Know	20.5	1.5	5.7	12.6	17.9	2034	59.3
TOTAL	18.3	1.6	5.6	11.1	18.0	3432	100.0

7. Mother's Age Group

There was little difference in child nutritional status according to maternal age. Only in arm measures was a higher prevalence of PCM found in children of mothers under 20 years of age.

TABLE 39

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO MOTHER'S AGE GROUP - Liberia

MOTHER'S AGE (YEARS)	H/A < 90%	W/H < 80%	W/H < 85%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
20	17.7	2.8	6.6	14.3	21.6	571	20.0
20-40	18.6	1.3	5.4	10.5	15.8	2140	75.2
40	16.8	1.5	4.4	9.5	14.6	136	4.8
TOTAL	18.3	1.6	5.6	11.2	16.9	2847	100.0
UNKNOWN	17.7	1.4	5.8	10.8	22.7	620	

8. Occupation of Father

A much higher prevalence of child chronic PCM and arm wasting resulted for farming households compared with others, reflecting the nutritional differences between agricultural and more urbanised areas of the country.

Child chronic PCM prevalence was the same for farmers' and chiefs' families. Within the larger groups apart from farmers, there was little difference in the rates for chronic PCM. The self-employed were usually traders.

TABLE 40

PERCENT PREVALENCE OF TYPE OF PCM ACCORDING TO OCCUPATION OF FATHER - Liberia

OCCUPATION OF FATHER	H/A < 90%	W/H < 80%	AC/A < 82.5%	FF/A < 60%	N	% N of Total
Farmer	21.0	1.9	13.5	18.2	1835	55.0
Chief	22.1	0	8.8	22.1	136	4.1
Concession Worker	13.8	1.1	5.6	18.7	449	13.5
Government Worker	16.4	2.7	8.2	14.0	292	8.8
Private Firm	15.9	1.1	10.3	19.0	378	11.3
Self-Employed	4.9	0.2	11.1	6.2	190	5.7
Unemployed	9.1	1.8	7.3	9.1	55	1.6
TOTAL	18.5	1.6	11.2	18.0	3335	100%

L. MATERNAL NUTRITIONAL STATUS

Just over 2000 mothers of the survey children were measured (Table 41). The rate for pregnancy was almost 10%. This was probably an underestimate because disclosure of pregnancy at times was a sensitive issue. It must be noted that only those mothers available at the time of the interview (approximately 75%) were measured.

TABLE 41

PERCENT DISTRIBUTION MATERNAL SAMPLE
BY ECOLOGICAL AREA ACCORDING TO
AGE AND STATUS - LIBERIA

ECOLOGICAL AREA	AGE GROUP		All ages		
	<20 Yrs	20-40 Yrs	Pregnant	%	Total
Agricultural	22.2	68.4	9.4	100	1177
Semi-remote	19.8	71.1	9.1	100	308
TOTAL Agric.	21.7	69.0	9.3	100	1485
Non-agricultural	22.6	67.7	9.7	100	523
Liberia	21.9	68.6	9.5	100	2008
Monrovia	17.9	82.1	*	100	168
Special Group	16.4	83.6	*	100	207

*No special enquiry made

Maternal Measures by Status of Mother and Ecological Area

Table 42 shows that approximately 10% of all mothers in the Liberia sample had low stature, 5% had arm wasting as defined by low arm circumference and 20% fat wasting according to low fatfold. The last figure should be viewed with caution because of the difficulty in measuring fatfold.

Pregnant women had a greater prevalence of low fatfold than the non-pregnant and a lesser prevalence of low height. Small numbers, however, preclude valid comparisons.

TABLE 42

PERCENTAGE DISTRIBUTION LOW
MATERNAL* NUTRITIONAL MEASURES AND STATUS
ACCORDING TO ECOLOGICAL AREA - LIBERIA

	HEIGHT < 150cm.		ARM CIRC. < 22.9cm.		FATFOLD < 7.4mm.	
ECOLOGICAL AREA	Preg.	Non-Preg.	Preg.	Non-Preg.	Preg.	Non-Preg.
Agricultural	8.0% (139)	11.2% (1346)	3.6%	5.6%	27.3%	21.0%
Non-Agric.	7.8% (51)	13.3% (472)	2.0%	5.3%	13.7%	11.7%
TOTAL COUNTRY	8.0% (190)	11.8% (1818)	3.2%	5.5%	23.7%	18.6%

*Ages up to 40 years

Figures in parentheses indicate sample size in the particular group

The prevalence of low fatfold, but not other measures, was much higher in the agricultural than other areas. There may be several reasons for this difference. Farming women may work harder and use up more energy and caloric reserve. Non-farming women may have different food habits, eating more carbohydrate, particularly from processed food.

The specific nutritional significance of the results, particularly when the prevalence of arm wasting is low, cannot be easily clarified. Fat wasting alone could perhaps be interpreted as a lessening of caloric reserve with a greater susceptibility to further nutritional problems.

Table 43 shows a gradient of low fatfold rates from the highest in the semi-remote areas to the least in the special group.

TABLE 43

PERCENTAGE DISTRIBUTION LOW MATERNAL (20-40 YRS)
NUTRITIONAL MEASURES BY ECOLOGICAL AREAS - LIBERIA

ECOLOGICAL AREA	MEASURE				
	HEIGHT <150cm.	ARM C. <22.9cm.	F.FOLD <7.5mm.	N	%N of Total
Agricultural	10.0	4.5	20.5	805	58.4
Semi-remote	13.9	5.9	25.8	219	15.9
Total Agric.	10.8	4.8	21.6	1024	74.3
Total Non-agric.	10.6	6.2	11.6	354	25.7
TOTAL COUNTRY	10.8	5.2	19.0	1378	100.0
Monrovia	17.0	4.3	10.9	138	
Special Group	9.2	4.0	8.7	173	

2. Maternal Measures by County

Small sample sizes for each county do not allow for individual comparisons. With county groupings, low fatfold prevalence was far less in Bong and Montserrado than the rest of the country ($Z = 3.51$; $P < 0.01$). No other significant differences were apparent. It is of interest that these two countries had the lowest prevalence of child PCM (apart from fatfold) than the rest of the country.

TABLE 44

PREVALENCE PERCENTAGE OF MATERNAL (AGED 20-40 YEARS)

LOW NUTRITIONAL MEASURES BY COUNTY

	AC	FF	HEIGHT	N	% N of Total
	< 23 cm	<7.5 mm	<150 cm		
Bong	4.1	16.2	9.9	266	19.3
Grand Bassa	6.3	25.3	11.3	143	10.4
Cape Mount	8.2	16.4	11.5	61	4.4
Grand Gedeh	4.6	30.8	18.5	65	4.7
Lofa	6.3	13.7	8.1	175	12.7
Maryland	3.0	20.0	8.9	101	7.3
Montserrado	6.6	12.8	13.7	274	19.9
Nimba	3.4	28.4	8.2	208	15.1
Sinoe	4.7	17.6	10.6	85	6.2
TOTAL COUNTRY	5.1	19.0	10.8	1378	100.0%
COUNTY GROUPING					
Bong Montserrado	5.4	14.4	11.8	540	39.2
Lofa Nimba	4.7	21.7	8.2	383	27.8
All other Counties	5.3	22.3	11.7	455	33.0
TOTAL	5.1	19.0	10.8	1378	100.0%

ASSOCIATED VARIABLES

1. Tribal Group of Father

The Mandingos, Loma and Mano tribes showed the lowest prevalence of short mothers. All tribal groups had a small percentage of mothers with low arm circumference.

The Spearman rank correlation test showed a significant agreement for tribe ranking of mothers (20-40 years) and children (Table 37) regarding prevalence of low height and low H/A ($r = 0.79$; $t = 4.07$; $P < 0.01$) but not for arm measures. This suggests there may be a genetic factor in determining child stature. It must be noted, however, that if the mother was stunted as a child, perhaps to an unfavorable nutritional environment, this may result in her eventual short stature.

TABLE 45

TRIBAL GROUP BY PERCENTAGE PREVALENCE OF MATERNAL LOW NUTRITIONAL MEASURES

Liberia

MOTHER 20-40 YEARS AGE

TRIBE	AC < 23 cm	FF < 7.5 mm	HEIGHT <150 cm	N	% N of Total
Bassa	7.0	22.9	12.8	158	11.5
Kpelle	5.5	15.8	10.1	329	23.9
Gio (Dan)	3.5	26.7	12.8	86	6.2
Gola	8.3	23.8	13.6	84	6.1
Grebo	2.4	15.9	12.7	126	9.2
Kissi	7.7	19.2	14.5	78	5.7
Krahn	6.9	32.8	15.8	58	4.2
Kru	4.6	20.9	11.5	87	6.3
Loma	6.2	8.2	4.2	97	7.0
Mano	3.8	27.4	5.7	106	7.7
Mandingo	1.7	16.7	3.3	60	4.4
Other	3.7	10.3	13.1	107	7.8
TOTAL	5.2	19.0	10.8	1376	100%

2. Occupation of Household Head

For mothers 20-40 years there was no difference in prevalence of chronic PCM nor arm wasting for the two major occupations. In mothers under 20 years the prevalence rates for these two types of PCM were different according to occupation. This may be explained by the small sample size or different precise ages in the two groups.(Table 46).

Low fatfold on the other hand, was much greater in farming groups, even allowing for a possible bias in measurement. Caloric reserve, thus may be low in farming and pregnant women of all ages,suggesting they are ill prepared to cope with any added nutritional problem.

3. Mother's Knowledge of English

With decreasing literacy groups, there was a progressive increase in prevalence of low nutritional arm measures for all maternal groups listed. Low stature followed a similar trend for 20-40 year olds.(Table 47).

TABLE 46

OCCUPATION OF HOUSEHOLD HEAD BY

PREVALENCE PERCENTAGE OF MATERNAL LOW NUTRITIONAL MEASURES - LIBERIA

MOTHER UNDER 20 YEARS AGE

OCCUPATION	AC*	FF*	HEIGHT	N*	% N of Total
	< 23 cm	< 7.5 mm	< 150 cm		
Farmer	9.5	22.3	12.9	241	56.7
Non-Farmer	3.8	13.0	17.4	184	43.3
TOTAL	7.0	18.3	14.8	425	100%

MOTHER 20-40 YEARS AGE

	AC	FF	HEIGHT	N	% N of Total
	< 23 cm	< 7.5 mm	< 150 cm		
Farmer	5.4	23.4	11.2	818	60.8
Non-Farmer	5.1	13.3	10.8	527	39.2
TOTAL	5.3	19.4	11.0	1345	100%

PREGNANT MOTHERS

	AC	FF	HEIGHT	N	% N of Total
	< 23 cm	< 7.5 mm	< 150 cm		
Farmer	3.6	25.9	9.1	112	60.9
Non-Farmer	2.8	20.8	7.0	72	39.1
TOTAL	3.3	23.9	8.2	184	100%

*AC: Arm Circumference

*FF: Triceps Fatfold

*N: Total number in each group.

TABLE 47

MOTHER'S KNOWLEDGE OF ENGLISH BY

PREVALENCE PERCENTAGE OF MATERNAL LOW NUTRITIONAL MEASURES - LIBERIA

MOTHER UNDER 20 YEARS AGE

ENGLISH	AC <23 cm	FF <7.5 mm	HEIGHT <150 cm	N	% N of Total
Knows & Reads	1.5	10.6	9.1	66	15.2
Knows	6.4	19.1	19.2	157	36.1
Don't Know	9.0	19.3	12.8	212	48.7
TOTAL	6.9	17.9	14.6	435	100%

MOTHER 20-40 YEARS AGE

	AC < 23 cm	FF <7.5 mm	HEIGHT <150 cm	N	% N of Total
Knows & Reads	1.4	6.8	4.1	73	5.4
Knows	3.8	11.3	9.3	386	28.3
Don't Know	6.0	23.3	11.9	904	66.3
TOTAL	5.2	19.0	10.8	1363	100%

PREGNANT MOTHERS

	AC < 23 cm	FF <7.5 mm	HEIGHT <150 cm	N	% N of Total
Knows or Reads	0	8.1	9.8	62	32.8
Don't Know	4.7	31.5	7.1	127	67.2
TOTAL	3.2	23.8	8.0	189	100%

RICE PRODUCTION AND NUTRITIONAL STATUS

The relationship of rice production and nutritional status was investigated for the following reasons:

1. Comparing food availability (staple production) during the period just prior to the nutrition survey with nutritional status.

2. Comparing this correlation according to different areas of the country and different age groups measured.

Data for production by traditional agricultural site per household and per caput were available from the 1976 National Rice Survey, the same sites being visited in this survey, but not the same households (see p. 22). Differences in sampling within the site may influence the results. A higher correlation thus may suggest more comparable sampling.

The mean value of the percentage of reference for the anthropometric indicator, such as weight for height, signified nutritional status of children 6-59 months of age at that site. For mothers, the mean value of the raw data was used.

A positive correlation is to be expected; that is, the higher the rice production, the better the nutritional status.

The results (Table 48) indicate that this may not be the case; in fact, the direction of most of the important correlations is negative. From this data alone, interpretation must be made with extreme caution, because of the small numbers, different sampling and other factors influencing food availability, such as food other than rice, and local trade in rice.

Even after allowing for the above limitations, the consistency of the negative correlations is striking. It is possible to consider that the rice produced is not utilized to the full for nutritional purposes,or

TABLE 48

CORRELATION COEFFICIENTS OF RICE PRODUCTION/CAPITA

ACCORDING TO COUNTY AND SUBJECT BY NUTRITIONAL INDEX

COUNTY	NUTRITIONAL INDEX			
	W/H	Height or H/A	Arm C. or AC/A	Fat Fold or FF/A
BONG(18)[a]				
Mother		.15	-.41	-.45*
Child	-.44	-.20	-.45*	-.18
LOFA(10)				
Mother		-.29	-.34	-.50
Child	-.35	-.65*	-.57	.52
NIMBA(18)				
Mother		-.44	-.23	.10
Child	.22	.23	.03	.24
REMAINDER(34)				
Mother		-.21	-.12	-.19
Child	-.28	-.19	.05	-.34*
LIBERIA(78)				
Mother		-.22*	-.20	-.18
Child	-.15	-.14	-.08	-.08

[a] Number of sites

* Significant difference from zero at the $P < 0.05$ level.

subjects in those agricultural areas which produce less rice, e.g.semi-urbanized, are benefited more according to nutritional status for other reasons. The latter inference is supported by the survey results that the prevalence of PCM is less in more urbanized areas.

VIII DISCUSSION

A. RATIONALE

The Liberia National Nutrition Survey was a cross-sectional survey of the Liberia rural population. It was the first national survey related to nutrition. The optimal method to determine nutritional status was necessary in the light of ideal statistical requirements, practical aspects of field performance and precision of results, and satisfying the request of the Government of Liberia.

The basic approach used a simplified field assessment procedure which consisted mainly of anthropometry in young children to determine prevalence of protein-calorie malnutrition (PCM) and hemoglobin estimation to assess anemia. Young children comprise an important vulunerable group; that is, they are the most likely to have PCM and their health status is often intimately related to the degree of PCM.

The nutritional status and needs of the total population depends on the relative importance and complexity of ecological factors (e.g. food intake, sanitation) selectively affecting particular age groups. It is not clear whether the degree of PCM in young children indicates that the problem exists at other ages.

Liberia is sparsely populated in many rural areas with a poor road network. This presented a particularly difficult problem to reach the survey population. Sample size requirements are related to the number of separate descriptions required, not necessarily to the country's total population.

Prior to the field phase of the survey, it was evident that if the survey was purely limited to the simplified assessment method, no more than perhaps 15% of total field duration would be spent actually with the index child.

The rest of the time would be required to each this child; time for reaching the county, the site,and within the site often one locality to the next,and within localities one household to the next.

To improve the efficiency of the survey more information was sought, provided it was requested by the Government and feasible for useful analysis. The setting of priorities for this extra information balanced against the total sample size required for prevalence description was one of the most difficult tasks of this survey. The opportunity arose to present to the Government certain unique information relating to health and nutrition; information which may not be obtained at least in the near future unless a national study is done.

An important factor was the quality of the trainees and supervisors. Almost all had health and nutrition-related experience in the Liberian hinterland, although very few had experience in survey techniques. Trainee enthusiasm, motivation and intelligence was relatively high.

The choice of the extra information was based on objectivity, ease of collection, validity and use to the Government. Historical information was a problem because it relied on the memory of the participant. Complex techniques of interviewing were not possible nor were detailed dietary methods. Even with trained people, quantitative dietary studies may have questionable validity.

The information selected included maternal anthropometry, socio-economic, and basic health and agricultural.

Maternal anthropometry had first priority as it was strongly recommended by the National Nutrition Committee and provided an opportunity to measure another age group apart from young children. Interpretations were difficult however and weight could not be done.

There was insufficient time for complete field testing prior to the survey, although some of the variables, such as socio-economic status were fairly reliable. At first simple dietary information on types of foods eaten was not found to be reliable when questioning was limited to a few minutes. When this period was extended in the subsample, more reliable information was expected.

An important opportunity arose to combine part of the nutrition survey sampling with that of the ongoing National Rice Survey. Although this presented certain problems in weighting, the advantages far outweighed the disadvantages. Attaching in the most feasible and useful way a simple anthropometric indicator to a nutrition-related survey is a method that should be considered more often in countries where logistic and resource constraints are great.

Protein-Calorie Malnutrition

Acute and chronic PCM have different implications for the design and evaluation of appropriate remedial programs.

Acute PCM or wasting suggests a current or recent deficiency usually as a result of complex factors involving inadequate feeding and impaired absorption due to diarrhea or other acute diseases. Nutrition and infection may be so interlinked that attention to one aspect will assist the child regarding the other. In acute famine situations, at least in the initial phase, the problem may be less complex with the most important factor being food inadequacy

which can be corrected by food distribution programs. At other times there may be no simple solution.

Chronic PCM or stunting reflects the cumulated result of a child's past growth, and to a large extent, nutrition history. Both weight and height are affected by episodes of acute infection and underfeeding; weight reduction is greater and can be restored more quickly than height deficit. With the cumulation of repeated episodes the child's height and weight (as determined by height-for-age and weight-for-age) may become progressively reduced even between such episodes. On the other hand, weight-for-height will be relatively normal during the interims.

There is also the more subtle continuous, non-acute problem of underfeeding and low grade illness which will be reflected by the reduced weight and height of a child.

B. RESULTS

Anemia

The most important nutrition-related problem in young children in terms of numbers affected is anemia (page 56). At least 60% of all children aged 6-59 months were anemic by WHO classification*. This occurred throughout all age ranges and is reflected by the high prevalence of malaria. Significantly in children 6-11 months old, 16.4 were not receiving food, apart from milk (page 58). Milk contains little iron. Unless iron-containing foods, such as cereals and leafy vegetables are given, the young child has no chance of restoring repleted iron stores after infection, infestation or diarrhea.

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*Nutritional Anemias (1968) World Health Organization, Tech.Rep.Ser. No.405.

Acute and Chronic Malnutrition

The prevalence of PCM in rural Liberia is summarized in Table 50. Included in the data are added groups: Special (LAMCO), Monrovia and NAS Reference which can be conveniently compared.

Acute PCM or wasting at the time of the survey did not appear to be a problem in rural Liberia, nor in any part of the country - within counties (page 51) or ecological areas. This indicates there is no famine nor near famine situation and no special urgency is required for remedial action at least on a large scale.

However, if milder degrees of wasting are considered, there may be a problem in the more rural areas of the country during the second year of life, where approximately 10% are affected (Table 51). This suggests that the problem of acute PCM in this age group, particularly, lies just under the surface and any deterioration due to poor environment, such as the hungry season or the onset of increasing diarrhea at other times of the year may be sufficient to tip the balance.

Chronic PCM or stunting does present a problem in that 18% of all children studied had impaired growth sufficient to suggest that environmental factors were implicated. The prevalence of chronic PCM was higher in the agricultural areas (20.2%) than in the more densely populated localities in rural Liberia (12.4%), in Monrovia (8.0%) and LAMCO (9.0%).

Figures 3 and 4 show by sex the rural Liberian mean height-for-age as a curve compared with the NAS reference population median and 90% of NAS median height-for-age curves. Also included is the LAMCO Special Group results.

Stunting begins around 6 months of age, increases to a plateau in the second year and continues at least until 5 years of age. The much higher prevalence of acute (mild) wasting and other forms of PCM at 6-23 months, suggests that children already stunted by this age may fail to improve in later years. (Table 51).

TABLE 50

PERCENT.PREVALENCE OF MALNUTRITION ACCORDING TO POPULATION DESCRIBED AND TYPE OF PCM - CHILDREN AGED 0-59 MONTHS.

POPULATION DESCRIBED	Type of PCM: CHRONIC H/A * <90%	ACUTE W/H <80%	UNDER-WEIGHT W/A <80%	ARM WASTING AC/A <82.5%	FAT WASTING FF/A <60%	SAMPLE SIZE
Agricultural Areas [d]	20.2	1.6	25.5	12.0	18.0	2502
Non-Agricultural Areas [d]	12.4	1.5	20.1	7.7	16.9	977
RURAL LIBERIA [d]	18.0	1.6	24.0	10.8	17.7	3479
MONROVIA [b]	8.0	1.5	19.3	9.9	30.5	223
SPECIAL GROUP (LAMCO)	9.0	2.9	13.4	4.2	13.0	285
REFERENCE POPULATION [c]	1.0	1.0	3.0	3.0	3.0	

[a] Weighted values

[b] 0-23 Months

[c] Approximate estimates according to expected distribution

*H/A : Height-for-age W/H : Weight-for-height W/A : Weight-for-age

AC/A : Arm circumference-for-age FF/A : Triceps fatfold-for-age

TABLE 51

NUTRITIONAL STATUS-PERCENT PREVALENCE OF MALNUTRITION ACCORDING TO TYPE AND AGE

TYPE OF MALNUTRITION	Age in Months: 0-1 %	2-5 %	6-11 %	12-23 %	24-35 %	36-47 %	48-59 %	TOTAL %
Chronic PCM (H/A)	12.1	7.0	12.5	22.3	21.1	20.5	24.7	100
Acute PCM (W/H)								
Mod-Severe <80%	6.2	1.6	1.9	2.4	0.7	0.4	1.1	100
Mild-Moderate <80%	11.5	3.7	6.1	9.8	4.0	2.1	2.8	100
Underweight (W/A)	26.1	17.4	34.8	31.1	20.8	17.4	19.3	100
Arm Wasting (AC/A)	15.0	6.7	18.9	17.9	7.9	3.6	2.8	100
Fat Wasting (FF/A)	27.1	11.0	27.5	31.1	9.4	6.9	7.2	100
TOTAL NUMBER	(111)	(364)	(518)	(894)	(650)	(504)	(344)	(3385)

FIGURE 2

COMPARISON OF RURAL LIBERIA SURVEY POPULATION MEDIAN HEIGHT-FOR-AGE WITH LIBERIA SPECIAL GROUP AND NAS REFERENCE POPULATION- GIRLS

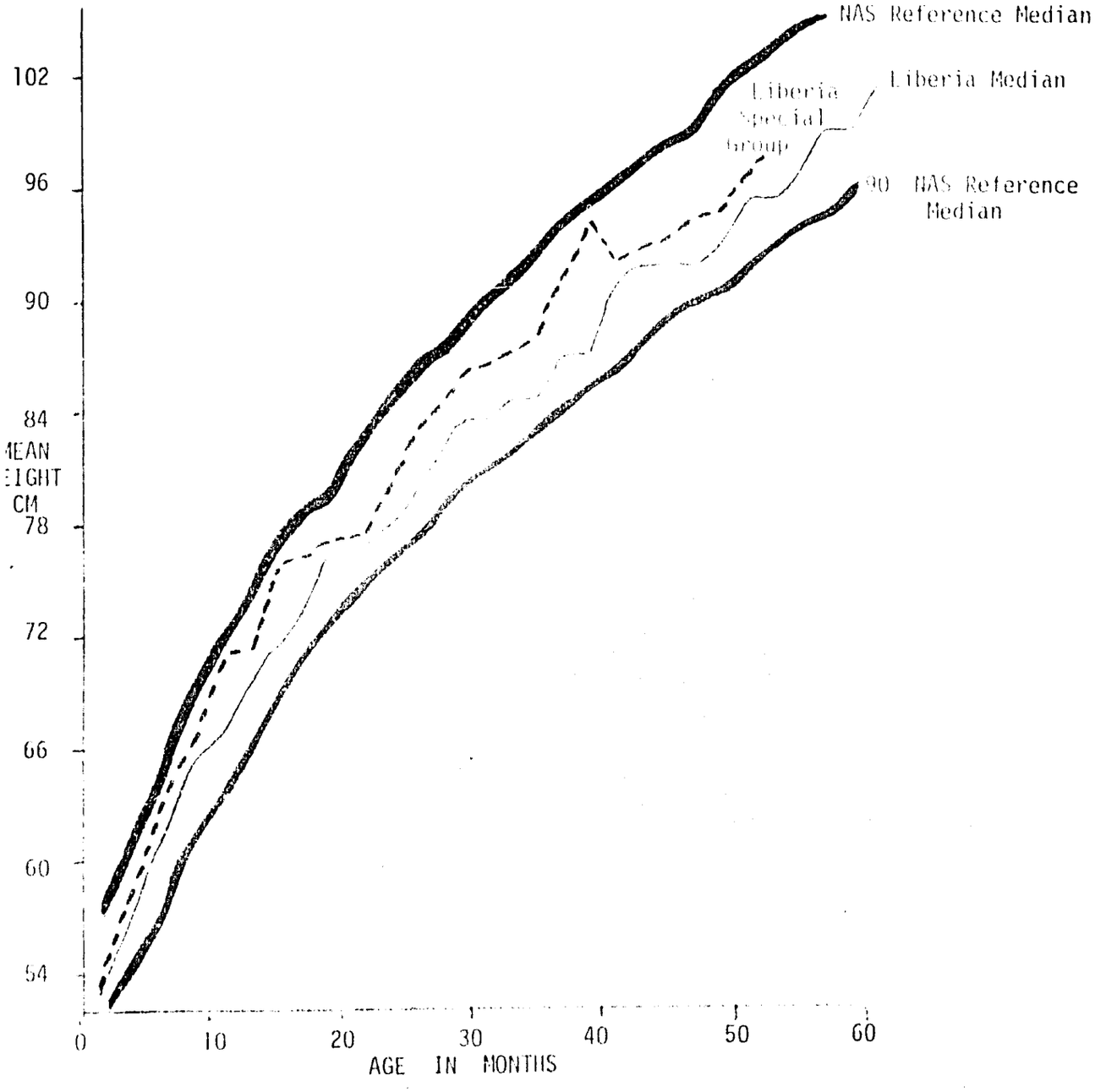
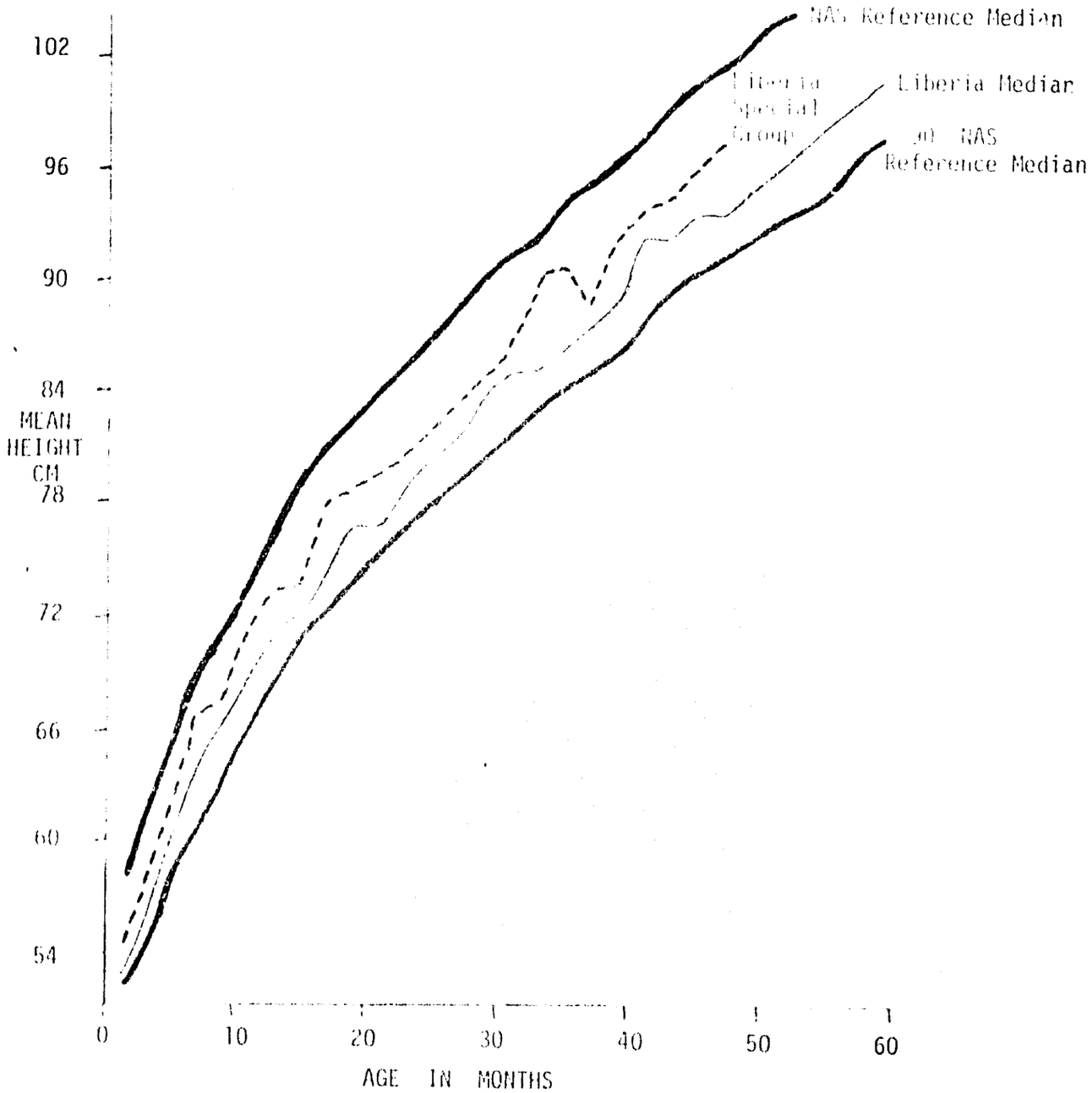


FIGURE 3

COMPARISON OF RURAL LIBERIA SURVEY POPULATION MEDIAN HEIGHT-FOR-AGE WITH LIBERIA SPECIAL GROUP AND NAS REFERENCE POPULATION- BOYS



The significance of stunting is much more subtle than that of wasting, usually being a cumulated result of a child's past nutritional history. Measures to correct the problem should be approached carefully in nutrition-related health, agricultural and development projects.

That stunting in young children is more a reflection on the environment than genetic factors is suggested by its correlation with low maternal height within each family. Although the relationship is statistically significant, the coefficient of determination is only 4% which suggests that low maternal height accounts for only a very small proportion of stunting in children (Appendix 1).

Tribal affiliation shows important differences in the prevalence of chronic PCM (page 67). The Kpelle tribe has one of the least rates. It is not clear whether this is purely tribal or due to the fact that they live in the two counties with the least prevalence of chronic PCM. The prevalence rates for Kpelle children in Bong (12.0% ; N = 451) and Montserrado (12.8%; N = 234) compared with the rest of rural Liberia (18.5%; N = 135) suggest that the counties may be more important than the tribe, although the numbers are too low to be sure.

Low maternal height prevalence for the Kpelle tribe, on the other hand is nearly equal to the rest of rural Liberia, and the rates are similar in the county groups. It is likely that the low rates for children cannot be explained on the basis of maternal height and that environmental factors are more important.

Loma, Mano and Mandingo mothers have the least rate for low maternal height but only the Mandingo child has a low prevalence of child chronic PCM. Again the numbers for Mandingo are too small for confident statistical analysis.

The relatively low rates of chronic PCM for Montserrado County perhaps can be explained by the proximity to Monrovia; those for Bong are more difficult to interpret. Even for agricultural areas alone, the prevalence for Bong County was comparatively low. There were two agricultural sites selected in Bong that may have been more urbanised according to the sample. These were located at Salala and Suakoko. Even if this was taken into account, the results for Bong agricultural areas would be much the same. It is not possible to indicate from this survey whether the intensive public health program in Bong County is a factor in the lower prevalence rates.

It is of interest that in the 1971 Nutrition and Health Survey ([1]) the prevalence of chronic PCM based on low height-for-age in Kpelle children aged 0-5 years was approximately 50 , equal to the rate for Loma children, and much higher than this survey result. Results in the previous survey, however, reflect a sample of children in villages which had a health facility.

Important associations of higher prevalence rates of chronic PCM found on the present survey include: birthplace at home rather than in hospital or a clinic (page 65); absence or death of parent (page 66); tribal group (page 67); illiteracy of the mother (page 68); occupation of father (page 69).

An association cannot be interpreted as causal. Health service utilization (at birth), parental absence, tribe, illiteracy and occupation associations may be explained by other important factors, including degree of urbanization.

The lower prevalence rates for chronic PCM in the Kpelle tribe has already been discussed; the Kwa-speaking peoples (Bassa, Grebo, Kru and Kahn) in the sample had a significantly higher prevalence rate than the other tribes together.

A lack of association in the results does not necessarily indicate that

there is no relationship. This may be the case regarding feeding practices, where there was no important difference regarding nutritional status according to person responsible for feeding the child and whether only milk or other food was given.

It should be noted, however, that 31.7% of all survey children 12-23 months received no milk and 16.4% received milk without any added food. Probably at least 50% of children in this age group received little or no assistance during feeding where the child was no longer fully on the breast (page 61). Taking into account the higher prevalence rates of chronic and other types of PCM, these results may suggest important associated factors.

The reduction in breast feeding is a global problem (12) and has particular relevance in countries such as Liberia where fresh milk is usually unavailable and commercial milk is costly. On the other hand, breast milk alone is insufficient for adequate nutrition of children after 6 months of age where the child becomes more exposed to infection and infestation (31). In this transitional period, the child simply requires more food.

Even when the child receives food, it appears from the survey, that he may have to compete with other family members. It was understandably very difficult to receive valid information for feeding assistance within the family. The problems of reduced breast feeding in Monrovia have been emphasized by Norman (19). This survey suggests that this reduction may already be occurring in rural areas also.

Underweight Children

The prevalence estimates for underweight children and those with arm wasting have the best value when considered with the indicators discussed, such as for acute and chronic PCM. The survey results showed that acute PCM

was relatively uncommon;therefore it was likely that short stature contributed at least in a large extent to low weight. In the majority of results the relationships of underweight prevalence between groups mirrored that of chronic PCM.

The percentage underweight for rural Liberia was 24.0, which was a little higher than for chronic PCM. It is probable that reduction in this rate will be achieved by the same approach discussed regarding chronic PCM: intermediate and long term nutrition-related health, agricultural and other projects.

Arm Wasting

The prevalence for arm wasting has a rather different significance than for underweight in that there is relatively little contribution from bony skeleton. This perhaps explains why rates for arm wasting drop sharply in the third year of life (like low weight-for-height) whereas those for underweight continue high up to five years of age (like low height-for-age). (Table 51). Although the prevalence for arm wasting in rural Liberia is approximately 10%, it should be noted that in children aged 6-23 months living in the more rural areas, the rates exceed 20 .

The correlation of arm circumference-for-age and weight-for-height was sufficiently high (Appendix I) to suggest that it may be used especially where apparatus for weight and height measures is impractical. In addition the correlation between arm circumference and arm muscle area is high (r = 0.92 for children 6-23 months) suggesting that the former may be used to estimate muscle bulk.

The arm circumference-for-height index was reported only a few times in the results, as rates were very similar to arm circumference-for-age.

Fat Wasting

The prevalence rate for fat wasting in rural Liberia was 17.7% These children probably have a low caloric reserve which may be the result of low food intake, infection, or even increased physical activity. Within rural Liberia there was no difference in prevalence rates for the more agricultural areas (Table 50). The higher prevalence in Monrovia may be in part explained by the age range selected.

Like other measures, a steep increase in prevalence rates occurred from 6-23 months and reduces after two years of age (Table 51).

Maternal Results

Nutritional status in adults is much more difficult to define using anthropometric measures than in young children. Useful reference information is scanty and the significance of differences is not clear. The cut off points for low maternal measures used in the Liberia survey are based on prior experience in different countries of the world.

A mother less than five feet tall does not necessarily mean inadequate nutrition during her childhood, although this may be suggestive, particularly if her tribal origin shows no marked extreme in stature.

Measures less than 23 cm for arm circumference or 7.5 mm for triceps fatfold have similar implications for recent onset undernutrition. The addition of maternal weight to the survey may have helped to clarify maternal results. There was, however, no suitable instrument that could be used in the field.

A comparison of maternal results in rural Liberia with those in the Special Group (LAMCO) and Monrovia did not show the marked difference in low height and arm circumference rates that were evident for their children. There is evidence to suggest from fatfold results, that maternal caloric

reserve is much lower in the more rural areas of Liberia compared with the rest of the country. Even this finding should be viewed with a certain degree of caution because of the difficulty in obtaining reliable fatfold measurements.

There is a consistent relationship, however, between the results for children and their mothers. In those areas where chronic PCM, underweight and arm wasting in children is a greater problem (such as more ruralized areas or counties apart from Bong and Montserrado) maternal fatfold wasting is conspicuously greater. The implications from this finding in regards to maternal nutritional status are not clear. It is likely that rural mothers at the time of the survey had a relatively low caloric reserve and that a common factor, degree of remoteness from densely populated areas, was associated.

This alone is insufficient evidence from the survey to indicate that maternal undernutrition is a public health problem in rural Liberia, particularly in view of the small prevalence for low arm circumference measures; in general no more than 5%.

On the other hand, the prevalence of low maternal height, approximately 10%, may be considered in part an index of their nutritional status during childhood. If such women deliver babies that are relatively larger than the mother's bony pelvic capacity, disproportion and prolonged labor may result, with disability or death of the mother or infant. This is particularly relevant in view of the very high mortality rates in neonates reported by the 1971 Demographic Survey (15).

Results for arm circumference and fatfold for mothers, like those for children, may be used as baseline information for future studies or evaluations. If the rate for low arm circumference or fatfold increased significantly, it would be highly suggestive of a worsening in nutritional status.

The survey was conducted during a period of relative food sufficiency. The prevalence of acute PCM at the time thus may be less than that expected during the "hungry season" (i.e. from June to September). A further, more restricted similar study may be necessary during this period, perhaps utilizing one or more of the ongoing surveys of the Ministry of Agriculture or Ministry of Planning and Economic Affairs. Simple techniques of nutritional assessment may be readily included to provide intrinsic information regarding prevalence of undernutrition as well as data complementary to the main objectives of the survey.

For example, in view of the high priority for self-sufficiency in rice production, two Ministries combined in 1974 to begin a yearly country-wide food production survey. Basic information on nutritional status would be extremely desirable to complement the results. In 1976 the Ministry of Planning and Economic Affairs (MPEA) began a study of Household Food and Expenditure for selected large localities in each county. Basic anthropometric information on nutritional status would indicate the prevalence of protein-calorie malnutrition as well as its association with socio-economic status and food purchasing practices.

The Demographic Studies by the MPEA begun in 1970 (15) provide essential demographic information over statistically representative regions of the whole of Liberia and provide a further possible basis for a simple nutrition indicator for ongoing information.

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APPENDIX A

SURVEY SAMPLE SIZE *

Some of the key factors which determine sample size include:

1. Available resources; financial, personnel and physical.

2. Constraints such as time and logistical problems affecting the survey in the field, particularly transport.

3. Nature of the sample distribution assumed applicable.

4. The extent and depth of information desired.

5. Precision desired for statistical estimates and the confidence level to be associated with them.

Considering the effect of these factors on the survey, 30 sampling units will allow the use of binomial theory in the estimation of the portion of the population in an area having a characteristic provided the characteristic is not rare ($< 5\%$) or very sporadic in its distribution.

To determine the appropriate survey sample size for a geographic area, the applicability of binomial theory is assumed. Using binomial theory modified for cluster sampling, there are four variables affecting sample size, 'n'.

Z - normal deviate for confidence level desired (1.96 for 95% confidence and 1.645 for 90% confidence).

p = proportion of population having the attribute measured.

D = deviation from "p" due to sampling with confidence level chosen. The confidence limits for p would be $p \pm D$.

K = adjustment for "clustering effect."

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* Most of this section very closely follows the format for the method of sample size selection used by the Center for Disease Control, Atlanta, Georgia, USA.

The formula for n is:

$$n = \frac{K\ Z^2}{D^2} (p) \quad (1 - p)$$

Past experience with Stuart-Meredith (Boston "Standards") percent of standard weight for height has shown that K = 2 should provide at least the desired precision. The Z score is generally chosen for 95% confidence (Z = 1.96).

While the value of D can be predetermined, it depends on the value of "p" and may or may not be acceptable; for example, 50% ± 5% might be considered acceptable, but 10% ± 5 might not.

The value of "p" yielding the largest n is .5, so if a number of different attributes are to be measured for the universe, it is usuallly safest to assume p = .5. After fixing K, Z, and p, n and D are the only values not determined.

By determining maximum deviation tolerable (D) "n" can be solved for as follows:

K = 2 (cluster effect)

Z = 1.96 (95% confidence)

p = .5 (50%)

D = .046 (4.6%) (arbitrarily selected as acceptable for n = 900)

$$n = \frac{2\ (1.96)^2}{(.046)^2} (.5)\ (.5)$$

n = 900

Thirty children will be drawn using a random start technique within each selected unit. A total sample of 900 children (30 sample units x 30 children) with proportions having a characteristic varying as follows would have the following approximate precisions:

% having characteristics	95% confidence limits
50.0%	± 4.6%
20.0% (80.0%)	± 3.7%
10.0% (90.0%)	± 2.8%

Predetermination of sample size does not predetermine precision of survey estimation. Some variables will have greater precision than predicted and others will have less. Preliminary computation for estimates of prevalence of low height-for-age of 828 children sampled in Bong County, suggests the K value is close to 1 instead of 2. This indicates that the sample size may in fact be sufficient in this example. However this may not be the case for other parameters or counties. Proportions less than 5% do meet standards of statistical reliability in the survey except for subregion estimates.

APPENDIX B

SAMPLING WITHIN SITES

Agricultural Areas

Using information from the Rice Survey, it was possible in most cases for the Survey Director to predetermine the initial and subsequent villages to be visited in the selected site. This was done by cumulating the total population of the selected enumeration area (EA), which often comprised of several small villages, and using a random table of numbers to select a random start to identify the first village. Subsequent villages were selected according to the EA rice listing of villages below the first selected, until the total estimated population equalled approximately 400. If the bottom of the list was completed before this total the next village to be selected was that on the top of the list and the procedure continued.

Villages (or localities) were not necessarily listed in order of geographic proximity, although they were usually within a few miles from each other and often much closer. Rice survey information usually revealed village locations within sites and their distances apart. This enabled important planning for transport requirements as well as for expected duration of a team at each site.

In certain cases when initial information indicated that some of the localities in a site were several hours walking from others, the site universe was stratified into two: one stratum for these more remote localities and another for the rest. Within each universe a cumulated total and random start was predetermined as before, to derive two clusters instead of one. The sample size in each cluster was proportional to its estimated

population according to the site population.

In all sites, 30 children up to 5 years of age were selected. A few times there were insufficient children from the selected EA to make up the 30. In these cases the nearest village in the next EA was visited to make up the total required.

At times, individual villages selected had a population well over 500 or an estimated number of children under 5 years of at least 50 in that village. In this situation a rough on the spot map of the village was drawn and separated into several groups of roughly equal total numbers of structures. In the field, the team used a random table of numbers to identify in which group to begin and a compass to indicate the predetermined direction of selecting subsequent households and children. This direction was sectoral, e.g. NW by N first, then anticlockwise to the next quadrant N by NE and so forth until the required number of children were measured.

In densely populated areas two clusters were selected applying the above method, to each of two initial population groups rather than one. In each, 15 children were selected.

Non-Agricultural Areas

When available, census lists were used in the same way as described with the rice survey lists. Usually, however, these areas had localities with relatively large populations and it was difficult to identify individual EA's within these localities. Field maps were drawn and the procedures usually followed those described above for densely populated areas.

It is apparent that the methods outlined were often different from simply selecting a random start and selecting the nearest 30 children. The intention was to guard against selecting a complete cluster which may

include children unrepresentative for the area. Choosing for example two clusters of 15 children instead of one of 30 may achieve this aim. The greatest care was required in not biasing the starting point. The number of chiefs' children comprised approximately 6% of all children of farmers. Usually the chief's family was larger, thus the proportion of chiefs to farmers in the survey sample would probably be less than this.

Further Procedure in All Sites

1. The first child and all subsequent children included in the survey had to be:

(a) A permanent resident of the household.

(b) Between the ages of 0 and 59 months.

(c) Made available to the survey team for completion of survey measurements.

(d) Have the consent of a parent or household head to participate in the survey.

2. When more than one child in the 0-59 month age group lived in a household, a survey form was completed on each of these children.

3. Only households with children in the 0-59 month age group measured were assigned household numbers in the sequence encountered.

4. When a child under 60 months old was temporarily absent from the household, arrangements were made where convenient for a revisit at a later hour and the appropriate household number entered.

APPENDIX C

SAMPLING PROCEDURES - WEIGHTING

Traditional Agricultural Areas

The 1975-1976 rice survey procedure defined the number of agricultural sites in any one county in approximate proportion to its total rice production, based on data from the 1974 National Rice Survey. As a result, certain countries such as Cape Mount and Sinoe had more sites selected than exactly required according to population proportionality and certain counties less, such as Montserrado.

The proportion of the number of sites or children actually selected to that required according to population, estimates the degree of representation and the inverse ratio the correction factor (Table 52). This correction factor is the same as the ratio of the actual sampling interval to that required for population proportionality sampling. This is 1.000 if no correction is required.

In order to derive a weighted prevalence for agricultural areas of the whole country it was necessary to weight individual county prevalences by population proportion and sum the results.

Thus the weighted total prevalence $\overline{P}$ (AG) equals the following.

PREVALENCE OF TOTAL AGRICULTURAL AREAS OF THE COUNTRY

$$\overline{P}\ (AG) = \sum \left[P\ (AG)_i \times \frac{n\ (AG)_i}{N\ (AG)} \right]$$

Where:

$\overline{P}$ (AG) = weighted prevalence of agricultural areas of the country.

P (AG) = prevalence of agricultural areas in county i.

n (AG)i = population of agricultural areas in county i.

N (AG) = total agricultural population for the country.

The weighted prevalence of the whole country [$\bar{P}$ (CT)] was the sum of the contributions of the weighted agricultural prevalence and the other areas.

PREVALENCE OF TOTAL COUNTRY - All Areas

$$\bar{P}\ (CT) = \left[\bar{P}\ (AG) \times \frac{n\ (AG)}{N}\right] + \left[\bar{P}\ (LUC) \times \frac{n\ (LUC)}{N}\right]$$

Where:

$\bar{P}$ (CT) = weighted prevalence of total country

$\bar{P}$ (AG) = weighted prevalence of agricultural areas of the country.

$\bar{P}$ (LUC)= prevalence of large rural, urban and concession areas of country.

n (AG) = as above.

n (LUC)= total population of large rural,uurban and concession areas of the country.

N = total country population

The prevalence for all areas within each county is the sum of the weighted result for agricultural areas within that county with that for each other area. The country prevalence value for the particular non-agricultural area was used in the county estimate. The population contributions within each county are listed in Table 2. It should be noted that apart from Montserrado, most of the country population comes from the agricultural areas.

County prevalence, $P(CT)_i$ equals the following:

COUNTY PREVALENCE

$$P(CT)_i = \left[P(AG)_i \cdot \frac{n(AG)_i}{n(CT)_i}\right] + \left[\bar{P}(L) \cdot \frac{n(L)_i}{n(CT)_i}\right] + \left[\bar{P}(U)_i \cdot \frac{n(U)_i}{n(CT)_i}\right] + \left[\bar{P}(C) \cdot \frac{n(C)_i}{n(CT)_i}\right]$$

$$= \frac{1}{n(CT)_i} \left[\left[P(AG)_i \cdot n(AG)_i\right] + \left[\bar{P}(L) \cdot n(L)_i\right] + \left[\bar{P}(U) \cdot n(U)_i\right] + \left[\bar{P}(C) \cdot n(C)_i\right]\right]$$

Where:

$P(CT)_i$ = weighted prevalence for county i.

$P(AG)_i$ = weighted prevalence for agricultural in county i.

$\bar{P}(L)$ = mean prevalence for all large rural areas in the sample.

$\bar{P}(U)$ = mean prevalence for all urban areas in the sample.

$\bar{P}(C)$ = mean prevalence for all concession areas in the sample.

$n(AG)_i$ = population of agricultural areas in county i.

$n(L)_i$ = population of large rural areas in county i.

$n(U)_i$ = population of urban areas in county i.

$n(C)_i$ = population of concession areas in county i.

$n(CT)_i$ = population of all areas in county i.

Within each county, the agricultural sample universe was stratified by large geographic areas often representing districts (page 22). In general, this enabled each district to contain at least one site, at least in the larger counties. These large areas, although not of exactly equal populations within each county were almost always close enough for practical purposes. Once the county agricultural total was weighted as described above, relatively few of these populations had a correction factor far from 1.00 (Table 53). Thus weighting within a county was not considered necessary. In several analyses, comparisons of weighted values using sites within counties, with unweighted values, differed no more than 0.5% for all measures.

The two sites within each of these large areas were obtained using a random start, and a sampling interval derived from the ratio of the cumulated total population to the number of sites (two).

Methods used in the nutrition survey after this point have been described (see page 102).

TABLE 52

COMPARISON OF POPULATION AND SAMPLE PROPORTIONS

Agricultural Areas

COUNTY	Population Proportion (1)	Sample Proportion (2)	Degree of Representation (3)	Correction Factor (4)
Bong	0.170	0.211	1.24	0.80
Grand Bassa	0.080	0.094	1.12	0.84
Cape Mount	0.047	0.071	1.49	0.67
Grand Gedeh	0.074	0.059	0.79	1.26
Lofa	0.161	0.141	0.88	1.14
Maryland	0.079	0.071	0.90	1.12
Montserrado	0.111	0.071	0.64	1.56
Nimba	0.232	0.211	0.91	1.09
Sinoe	0.046	0.071	1.53	0.65
COUNTRY	1.000	1.000	1.00	1.00

(1) County population ÷ Country population

(2) County sample size ÷ Country sample size

(3) = (2) ÷ (1) 1.00 indicates overrepresentation of sample
1.00 indicates underrepresentation of sample

(4) = (1) ÷ (2) Factor required to correct sample proportion to population proportion

TABLE 53

DEGREE OF REPRESENTATION AND CORRECTION FACTORS FOR AGRICULTURAL SITES WITHIN COUNTIES. (AFTER WEIGHTING THE TOTAL COUNTY ALONE)

COUNTY	SITE NUMBER	DEGREE OF REPRESENTATION	CORRECTION FACTOR
BONG	1,2	0.91	1.10
	3,4	0.96	1.04
	5,6	0.90	1.11
	7,8	0.97	1.03
	9,10	1.19	0.84
	11,12	0.93	1.08
	13,14	0.94	1.06
	15,16	1.39	0.72
	17,18	0.98	1.02
GRAND BASSA	19,20	1.06	0.94
	21.22	1.02	0.98
	23,24	0.91	1.10
	25,26	1.02	0.98
CAPE MOUNT	27,28	1.12	0.89
	29,30	0.90	1.11
	31,32	1.00	1.00
GRAND GEDEH	34	0.96	1.04
	35,36	0.76	1.32
	37,38	0.86	1.18
LOFA	39,40	1.67	0.60
	41,42	0.82	1.22
	43,44	0.90	1.11
	45,46	0.87	1.15
	47,48	0.93	1.08
	49,50	1.20	0.83
MARYLAND	51,52	1.00	1.00
	53,54	0.99	1.01
	55,56	1.06	0.94
MONTSERRADO	57,58	1.12	0.89
	59,60	0.96	1.04
	61,62	0.93	1.07
NIMBA	63,64	0.86	1.16
	65,66	0.97	1.03
	67,68	0.96	1.04
	69,70	0.88	1.13
	71,72	1.09	0.92
	73,74	0.92	1.09
	75,76	1.08	0.93
	77,78	1.00	1.00
	79,80	1.47	0.68
SINOE	81,82	0.90	1.11
	83,84	0.87	1.15
	85,86	1.35	0.74

APPENDIX D

REFERENCE POPULATION DATA

Data from reference populations are used throughout the world to indicate whether a subject, usually a child, may be normal or not with regard to a particular measure such as weight or height. The reference median value is a basis of comparison between the child studied and that of the reference population.

The result is usually presented in the form of percentages (2). The child studied has, for example, a body weight with a value of a certain percentage of the median weight for children of the same age from the reference population. This result is expressed as % weight-for-age. In the same way, percentages of other measures may be expressed such as % height-for-age. The % weight-for-height is the ratio of the weight of the child with that of the median weight of reference children, for the same height.

Requirements for reference data include (20):

1. A large and valid sample, representative of a well defined group.
2. Relatively modern data.
3. Adequate measuring techniques.

If the reference such as from an industrialized country, is characterized by reasonably adequate health and nutrition care, then it may indicate for other populations a median level of a measure near which the risk of morbidity and mortality related to undernutrition is relatively low. This is one basis for the Road to Health weight charts used throughout the world, where a continuing upper level of the "safe" weight range is based on a reference median.

Such a level is neither ideal nor is it necessarily a "standard" that a population would be expected to achieve with improved health and nutrition status. Within the country itself there is usually an upper socio-economic group which can indicate to some extent the potential growth and tissue bulk of the rest of the country. A perspective may thus be achieved by comparing the reference median such as from the USA, a Liberian optimum and the rest of Liberia.

No reference data is available from Liberia. Studies however in West Africa, such as in Ibadan (31) show that young children of families attending the University have similar measurements of weight and height as those in the USA. Habicht presents evidence from studies in various poorer countries throughout the world that the difference in growth of preschool children associate with social class and environment are many times those attributable to ethnic factors alone (21). Tanner from recent results of the International Biological Program indicated that genotype differences in growth perhaps do not exist between Africans and Europeans.(32). In other words, environmental factors, such as health and nutrition, are all important in growth.

Reference data for height and weight for this survey were derived from large scale and in general, representative studies recently in the USA. This followed recommendations of the National Academy of Sciences (NAS) Committee on Nutrition Advisory to the Center for Disease Control, USA in 1974. The populations included children aged 0-36 months from middle to upper socio-economic status families and those aged 2-6 years from a National study throughout the USA.

This data is similar but not identical to that recommended by WHO using the "Boston" reference population compiled 30 years ago (2). Comparisons

of results for this survey with others using the Boston references should be aware of the differences.

There is no suitable data in the USA for arm circumference and fatfold measures. In this survey arm circumference median values were based on smoothed data from Polish children (33). Arm-for-height reference was derived by combining these values with the NAS height median data. The source for fatfold data came from a survey of London children, reported in 1962 by Tanner.(34).

Using the reference data on what basis can an index for undernutrition be derived? For practical purposes it should indicate a level below which suggests that an individual or population is at serious risk to ill health. Other factors involving the young child, such as delayed mental development and reduced potential for learning have also been implicated (35).

These levels have been listed in this report (page 8). They approximate to the 1st and 3rd percentile of the reference population measures. Experience in Africa regarding weight-for-age (36), weight-for-height (5), arm circumference-for-height (37), arm circumference alone from 1-5 years and fatfold for age (38) with young children has clarified to some extent the value of these levels or "cut-off points" referred to in the text.

APPENDIX E

REFERENCE DATA VALUES

The data listed are the median values from the reference populations according to age or height.

The sources for these populations are as follows:

WEIGHT-FOR-AGE, HEIGHT-FOR-AGE AND WEIGHT-FOR-HEIGHT:

Center for Disease Control, USA from data of two major USA surveys.

ARM CIRCUMFERENCE-FOR-AGE:

Burgess, HJ and Burgess, AP (1969) A Modified Standard for Mid-Upper Arm Circumference in Young Children, J Trop Ped 15:189. Using data collected by N. Wolanski for Polish children.

TRICEPS FATFOLD-FOR-AGE:

Tanner, JM and Whitehouse, RH (1962) Standards for Subcutaneous Fat in British Children, Brit Med J, 1:446.

LIBERIA NUTRITION SURVEY

REFERENCE ANTHROPOMETRIC DATA

AGE IN MONTHS	WEIGHT (kg)		HEIGHT (cms)		ARM CIRCUMFERENCE (cms)		TRICEPS FATFOLD (mm)	
	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS
0	3.5	3.2	50.2	49.6	10.5	10.2	6.0	6.5
1	4.4	4.0	54.6	53.8	11.5	11.1	7.0	7.5
2	5.3	4.8	58.3	57.1	12.5	12.0	8.0	8.5
3	6.1	5.5	61.3	59.8	13.5	13.0	9.0	9.0
4	6.7	6.1	63.8	62.0	14.1	13.7	9.5	9.5
5	7.4	6.7	65.8	63.9	14.5	14.2	10.0	10.0
6	7.9	7.2	67.6	65.6	14.9	14.5	10.0	10.0
7	8.4	7.7	69.3	67.3	15.2	14.8	10.0	10.0
8	8.8	8.2	70.8	68.9	15.4	15.0	10.2	10.2
9	9.2	8.6	72.3	70.3	15.6	15.2	10.2	10.2
10	9.6	8.9	73.6	71.8	15.7	15.4	10.2	10.2
11	9.9	9.2	74.9	73.1	15.8	15.5	10.5	10.5
12	10.2	9.5	76.2	74.6	15.9	15.6	10.5	10.5
13	10.4	9.7	77.4	75.6	16.0	15.6	10.5	10.5
14	10.6	9.9	78.5	76.8	16.0	15.6	10.5	10.5
15	10.8	10.1	79.5	77.9	16.0	15.8	10.5	10.5
16	11.0	10.3	80.5	78.9	16.2	15.8	10.5	10.5
17	11.2	10.5	81.5	79.9	16.2	15.8	10.5	10.5
18	11.4	10.7	82.4	80.9	16.2	15.8	10.2	10.2
19	11.6	10.9	83.2	81.8	16.2	15.8	10.2	10.2
20	11.8	11.0	84.0	82.7	16.2	16.0	10.2	10.2
21	12.0	11.2	84.8	83.5	16.2	16.0	10.2	10.2
22	12.2	11.4	85.6	84.4	16.2	16.0	10.2	10.2
23	12.3	11.6	86.4	85.1	16.2	16.0	10.0	10.0
24	12.5	11.8	87.1	85.9	16.4	16.0	10.0	10.0
25	12.7	12.0	87.8	86.6	16.4	16.0	10.0	10.0
26	12.8	12.1	88.5	87.3	16.4	16.2	10.0	10.0
27	13.0	12.3	89.2	88.0	16.4	16.2	10.0	10.0
28	13.1	12.5	89.9	88.7	16.4	16.2	10.0	10.0
29	13.3	12.7	90.6	89.4	16.4	16.2	9.6	9.8
30	13.4	12.8	91.3	90.1	16.4	16.2	9.6	9.8
31	13.6	13.0	92.0	90.8	16.4	16.2	9.6	9.8
32	13.7	13.2	92.7	91.4	16.4	16.2	9.6	9.8
33	13.9	13.4	93.3	92.1	16.4	16.2	9.6	9.8
34	14.0	13.5	94.0	92.7	16.4	16.4	9.6	9.8
35	14.2	13.7	94.6	93.4	16.4	16.4	9.3	9.6

AGE IN MONTHS	WEIGHT (kg)		HEIGHT (cms)		ARM CIRCUMFERENCE (cms)		TRICEPS FATFOLD (mm)	
	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS
36	14.3	13.9	95.3	94.0	16.4	16.4	9.3	9.6
37	14.5	14.0	95.9	94.6	16.4	16.4	9.3	9.6
38	14.6	14.2	96.6	95.3	16.6	16.4	9.3	9.6
39	14.8	14.4	97.2	95.9	16.6	16.4	9.3	9.6
40	14.9	14.5	97.8	96.5	16.6	16.4	9.3	9.6
41	15.1	14.7	98.5	97.1	16.6	16.4	9.0	9.4
42	15.2	14.9	99.1	97.7	16.6	16.4	9.0	9.4
43	15.4	15.0	99.7	98.3	16.6	16.4	9.0	9.4
44	15.2	15.2	100.3	99.0	16.6	16.4	9.0	9.4
45	15.7	15.3	100.9	99.6	16.6	16.4	9.0	9.4
46	15.9	15.5	101.5	100.1	16.6	16.6	9.0	9.4
47	16.0	15.7	102.1	100.7	16.6	16.6	8.8	9.3
48	16.2	15.8	102.7	101.3	16.6	16.6	8.8	9.3
49	16.4	16.0	103.3	101.9	16.6	16.6	8.8	9.3
50	16.5	16.2	103.8	102.5	16.6	16.6	8.8	9.3
51	16.7	16.3	104.4	103.1	16.8	16.8	8.6	9.3
52	16.9	16.5	105.0	103.6	16.8	16.8	8.6	9.3
53	17.0	16.7	105.5	104.2	16.8	16.8	8.6	9.2
54	17.2	16.8	106.1	104.8	16.8	16.8	8.4	9.2
55	17.4	17.0	106.6	105.3	17.0	16.8	8.4	9.2
56	17.6	17.1	107.2	105.9	17.0	16.8	8.4	9.2
57	17.7	17.3	107.7	106.4	17.0	16.8	8.2	9.2
58	17.9	17.5	108.3	107.0	17.0	16.8	8.2	9.2
59	18.1	17.6	108.8	107.5	17.0	17.0	8.2	9.2
60	18.3	17.8	109.4	108.1	17.0	17.0	8.2	9.2
AGE IN WEEKS*								
0-1	3.4	3.2	50.2	49.6	10.5	10.2	6.0	6.5
1-2	3.8	3.5	51.5	50.8	11.0	10.6	6.5	7.0
2-4	4.3	3.9	54.6	53.8	11.5	11.1	7.0	7.5
4-6	4.7	4.3	56.5	55.5	12.0	11.6	7.5	8.0
6-8	5.1	4.6	58.3	57.1	12.5	12.0	8.0	8.5

* Values by extrapolation.

LIBERIA NUTRITION SURVEY

REFERENCE ANTHROPOMETRIC DATA ACCORDING TO HEIGHT/LENGTH

HEIGHT/LENGTH (Cm)	WEIGHT (Kg) BOYS	WEIGHT (Kg) GIRLS	ARM CIRCUM. (Cm) SEXES COMBINED	HEIGHT/LENGTH (Cm)	WEIGHT (Kg) BOYS	WEIGHT (Kg) GIRLS	ARM CIRCUM. (Cm) SEXES COMBINED
				67.5	7.9	7.7	14.[illegible]
48.0	3.1	3.1	10.0	68.0	8.0	7.8	14.9
48.5	3.1	3.1	10.1	68.5	8.2	7.9	15.[illegible]
49.0	3.2	3.2	10.2	69.0	8.3	8.1	15.[illegible]
49.5	3.2	3.3	10.3	69.5	8.4	8.2	15.2
50.0	3.3	3.3	10.4	70.0	8.6	8.3	15.3
50.5	3.4	3.4	10.5	70.5	8.7	8.4	15.[illegible]
51.0	3.5	3.5	10.6	71.0	8.8	8.6	15.[illegible]
51.5	3.6	3.6	10.7	71.5	9.0	8.7	15.[illegible]
52.0	3.7	3.7	10.8	72.0	9.1	8.8	15.5
52.5	3.8	3.8	10.9	72.5	9.2	8.9	15.[illegible]
53.0	3.9	3.9	11.0	73.0	9.3	9.0	15.6
53.5	4.0	4.0	11.1	73.5	9.5	9.2	15.[illegible]
54.0	4.1	4.1	11.2	74.0	9.6	9.3	15.7
54.5	4.2	4.2	11.3	74.5	9.7	9.4	15.[illegible]
55.0	4.3	4.3	11.4	75.0	9.8	9.5	15.[illegible]
55.5	4.4	4.4	11.6	75.5	9.9	9.6	15.[illegible]
56.0	4.6	4.5	11.8	76.0	10.1	9.7	15.8
56.5	4.7	4.7	12.0	76.5	10.2	9.8	15.8
57.0	4.8	4.8	12.2	77.0	10.3	10.0	15.8
57.5	5.0	4.9	12.4	77.5	10.4	10.1	15.8
58.0	5.1	5.0	12.6	78.0	10.5	10.2	15.[illegible]
58.5	5.2	5.2	12.7	78.5	10.6	10.3	15.9
59.0	5.4	5.3	12.8	79.0	10.8	10.4	15.[illegible]
59.5	5.5	5.4	13.0	79.5	10.9	10.5	15.9
60.0	5.7	5.6	13.1	80.0	11.0	10.6	16.0
60.5	5.8	5.7	13.3	80.5	11.1	10.7	16.0
61.0	6.0	5.9	13.4	81.0	11.2	10.8	16.[illegible]
61.5	6.1	6.0	13.5	81.5	11.3	10.9	16.0
62.0	6.3	6.1	13.7	82.0	11.4	11.1	16.[illegible]
62.5	6.4	6.3	13.8	82.5	11.5	11.2	16.1
63.0	6.5	6.4	13.9	83.0	11.6	11.3	16.[illegible]
63.5	6.7	6.6	14.0	83.5	11.8	11.4	16.[illegible]
64.0	6.8	6.7	14.1	84.0	11.9	11.5	16.[illegible]
64.5	7.0	6.8	14.2	84.5	12.0	11.6	16.[illegible]
65.0	7.1	7.0	14.4	85.0	12.1	11.7	16.1
65.5	7.3	7.1	14.4	85.5	12.2	11.8	16.2
66.0	7.4	7.3	14.5	86.0	12.3	11.9	16.2
66.5	7.6	7.4	14.6	86.5	12.4	12.0	16.2
67.0	7.7	7.5	14.7	87.0	12.5	12.1	16.[illegible]

HEIGHT/LENGTH (cm)	WEIGHT (Kg) BOYS	WEIGHT (Kg) GIRLS	ARM CIRCUMF. (Cm) SEXES COMBINED	HEIGHT/LENGTH (cm)	WEIGHT (Kg) BOYS	WEIGHT (Kg) GIRLS	ARM CIRCUMF. (Cm) SEXES COMBINED
87.5	12.6	12.2	16.2	107.5	17.7	17.4	16.9
88.0	12.7	12.3	16.3	108.0	17.9	17.6	16.9
88.5	12.8	12.5	16.3	108.5	18.0	17.8	16.9
89.0	13.0	12.6	16.3	109.0	18.2	17.9	16.9
89.5	13.1	12.7	16.3	109.5	18.4	18.1	17.0
90.0	13.2	12.8	16.3	110.0	18.5	18.3	17.0
90.5	13.3	12.9	16.3	110.5	18.7	18.4	17.0
91.0	13.4	13.0	16.4	111.0	18.9	18.6	17.1
91.5	13.5	13.1	16.4	111.5	19.0	18.8	17.1
92.0	13.6	13.2	16.4	112.0	19.2	19.0	17.1
92.5	13.7	13.4	16.4	112.5	19.4	19.1	17.2
93.0	13.9	13.5	16.4	113.0	19.6	19.3	17.2
93.5	14.0	13.6	16.4	113.5	19.8	19.5	17.2
94.0	14.1	13.7	16.4	114.0	19.9	19.7	17.3
94.5	14.2	13.8	16.4	114.5	20.1	19.9	17.3
95.0	14.3	14.0	16.4	115.0	20.3	20.0	17.4
95.5	14.4	14.1	16.4	115.5	20.5	20.2	17.4
96.0	14.6	14.2	16.5	116.0	20.7	20.4	17.4
96.5	14.7	14.3	16.5	116.5	20.9	20.6	17.5
97.0	14.8	14.5	16.5	117.0	21.1	20.8	17.5
97.5	14.9	14.6	16.5	117.5	21.3	21.0	17.6
98.0	15.0	14.7	16.5	118.0	21.5	21.2	17.6
98.5	15.2	14.8	16.5	118.5	21.7	21.4	17.6
99.0	15.3	15.0	16.5	119.0	21.9	21.6	17.7
99.5	15.4	15.1	16.6	119.5	22.1	21.8	17.7
100.0	15.6	15.2	16.6	120.0	22.3	22.0	17.8
100.5	15.7	15.4	16.6	120.5	22.5	22.2	17.8
101.0	15.8	15.5	16.6				
101.5	16.0	15.6	16.6				
102.0	16.1	15.8	16.7				
102.5	16.2	15.9	16.7				
103.0	16.4	16.1	16.7				
103.5	16.5	16.2	16.7				
104.0	16.7	16.4	16.7				
104.5	16.8	16.5	16.8				
105.0	16.9	16.7	16.8				
105.5	17.1	16.8	16.8				
106.0	17.2	17.0	16.8				
106.5	17.4	17.1	16.8				
107.0	17.6	17.3	16.9				

APPENDIX F

IX. PROCEDURES FOR ANTHROPOMETRIC MEASUREMENTS*

A. Principles

Anthropometry is the measurement of body structure either part or all.

Protein-Calorie Malnutrition (PCM) is the most important nutritional deficiency in the age group surveyed. Its description in this survey for prevalence, severity and duration relies almost entirely on anthropometry.

In this survey we are using weight, height (or length), left upper arm circumference and left triceps fatfold measurements; all are useful in PCM assessment. All are objective, relatively rapid and simple and present results appropriate for analysis and interpretation. However, the accuracy and precision of these measurements is often poor, so that the description of PCM becomes far less valid. All the effort for the survey would be wasted if we could not demonstrate a consistently good measurement validity. This validity requires good technique, practice and care.

Supervisors will check performance during the training but only intermittently in the field. Good measurement is a team responsibility, so that during the survey one team member may regularly check the result before it is finalized.

Adherence to the procedures which follow will appreciably minimize the most common sources of error.

*Taken from the Liberia Nutrition Survey Training Manual.

B. PROCEDURES

The measurements will be done in the following order:

1. Length/Height
2. Weight
3. Left mid upper arm circumference
4. Left triceps fatfold

For training purposes, steps are listed in order. These may be simultaneous or in a different order depending on field circumstances. For example, a valid measurement for length depends on proper positioning of the whole child for at least 2-3 seconds.

LENGTH OR HEIGHT ?

Child stands unassisted

Measure LENGTH if 80 cm or less

Measure HEIGHT if more than 80 cm

Child cannot stand unassisted

Always measure LENGTH

(a) Length Measurements

1) Lay the measuring board horizontally on flat, firm ground or preferably on a table top.

2) Instruct the mother (or substitute) to remove any footwear or headgear on the child and carry the child over to the board.

3) With the help of your team member and the mother, place the child on the board with the crown of the head against the fixed end of the board.

4) (i) Position the child so that shoulders, back and buttocks are flat along the center of the board. Have the mother on the opposite side of the board to face you and keep her child flat and central.

(ii) Your team member is to stand or kneel behind the fixed end of the board and position the child's head so that the eyes are pointing directly upwards and the Frankfort plane (line joining ear hole to lower margin of eye socket) is perpendicular to the main board.

NOTE: If the child is too far down the board, shift the body as well as the head!

5) Use your right hand to bring the movable foot board firmly against the child's heels so that the feet are perpendicular to the main board. You may have to manually straighten the feet.

6) Keeing the movable board snuggly against the child's flattened feet, grasp the knees and depress them firmly against the main board.

7) With your team member check the child's total position-head, body, legs and feet.

8) If this is unsatisfactory repeat the necessary previous step(s).

9) If position is adequate, read and call out the value to the nearest 0.1 cm (see reading and recording methods). KEEP THE FOOTBOARD STILL. Remember the figures.*

10) Your team member (with Form I handy) relaxes the child's head, records the value directly in the appropriate boxes and immediately calls back the recorded value to you.
Say OK if the figures are identical. If not, repeat steps 9 & 10.

11) Request the mother to fully undress the child in preparation for weighing.

OR Repeat the length measurement on any other survey member in the household, if this measure is indicated.

(b) Height Measurements

1) Select a site where there is a hard flat surface leading to an upright structure e.g. wall or door. Stand the measuring board vertically and remove its sliding piece. Fit the upper attachment snuggly into the board end and place the instrument against the upright structure. (See Diagram)

2) Instruct the mother (or substitute) to remove any footwear or head gear on the child and lead the child to the board.

3) Your team member with the mother's help places the child on the horizontal platform so that the feet are together and central.

4) Your team member kneels on the right side of the child and places the open survey form in a convenient place next to him.

---

*If the child's length is 82.5 cm or more, you must measure height instead.

5) Your team member makes sure:

- the child stands flatfooted with the knees fully extended
- the back of the heels, calves, buttocks, trunk and shoulders all touch the vertical surface of the measuring board
- the mother keeps the buttocks, trunk and shoulders flat and central.

6) Bring the movable sliding piece headboard to rest firmly on the crown of the child's head. Position the child's head so that the eyes are pointing directly forwards i.e. Frankfort's plane is now parallel to the head board.

(7-10) As in (a) 7-10 (length)

NOTE: If the child's height is 77.5 cm or less, you must measure length instead.

11) Request the mother to strip the child in preparation for weighing.

OR Repeat the height measurement a) on another child in the household if selected for this; b) on the mother.

(c) Weight

1) Have the child fully undressed by the mother (or substitute). Get the mother to hold (or keep holding) the child.

2) Suspend the Salter Scale from an available crossbar (e.g door frame) or from a pole held by two assistants. The top of the scale should be at standing eye level.

3) Calibrate the scale with attached hook (and any accessory of significant weight) to the zero point, using the scale screw.

4) Standing in front of the child put your arms through the leg holes of the salter pants and draw the legs of the child through these holes. Make sure the slings are IN FRONT OF THE CHILD.

5) Get the mother to carry the child (with pants attached) to the scale site.

6) Attach the sling (which is in front of the shoulders) to the scale hook; the child still being supported by the mother. Lower the child firmly, but gently to allow free suspension from the scale. Check for a few seconds that the child is positioned safely.

7) Read the scale face to the nearest 0.1 Kg only when the child is reasonable still and the needle is stationary. It may be necessary to wait a minute or so.

8) When you are satisfied the value is stable, record it in the appropriate boxes on form I.

9) Keeping the recorded numbers in mind look again at the scale value.

Result

(a) Difference no more than 0.1 Kg - complete the procedure

(b) Difference 0.2 Kg or greater - ask yourself

i Is it a reading or recording error? - correct it.

ii Is it due to another reason? Such as, child not suspended freely or moving. - Decide which measure is valid and/or repeat if uncertain.

Notes on Weighing

(1) If it is impossible for child to be fully undressed, weigh an equivalent amount of clothing and subtract this value.

(2) If child urinates/defecates during the procedure, do not cease procedure unless child is unduly restless.

(3) If the scale pointer keeps swinging greatly even after 1-2 minutes and the child remains very restless, remove the scale and repeat later.

(d) LEFT MID-UPPER ARM CIRCUMFERENCE

Position at time of Measurement

The mother sits comfortably on a chair, ledge or similar suitable site.

The child is held, facing frontwards, by the mother on her lap. The child's left hand is grasped gently but firmly by the mother's right hand and placed on the child's left hip, so that the child's elbow is flexed at about a right angle. (See diagram)

You sit or crouch to face the child's left side.

Procedure

1) Get the mother (or substitute) to bare the child's left arm and shoulder. (This may be done immediately after the height/length measurement completion).

2) Ensure suitable positioning of child, mother and yourself (see above). Be comfortable. The child's left arm should be relaxed with his (or her) elbow point and should tip facing you.

3) (a) Hold the widened part of the Zerfas tape so that the ball of your thumb is over the tape window.
   (b) Use this thumb to identify the posterior tip of the acromion process of the left scapula.
   (c) Straighten the tape down arm and note distance to nearest cm at the elbow point.
   (d) Halve the distance and mark a horizontal straight line across the arm corresponding to your result.

4) Loop the tape around the left upper arm and thread the narrower free end through the slot from behind. Have the window face your line of vision.

5) Pull the distal end of the tape, until firm but gentle and uniform contact is made with the arm circumference skin surface at the marked midpoint. Do not compress the soft tissues of the area.

6) Use your thumb and index finger of the right hand to fix the position of the tape at its junction with the slot (see diagram). With the tape fixed, check ALL THE WAY AROUND THE ARM CIRCUMFERENCE for proper tape alignment and tension. Adjust where required.

7) Read the value indicated between the opposing arrows to the nearest 0.1 cm.

8) Record the arm circumference value clearly in the appropriate boxes on Form 1.

NOTE: Arm circumference of babies (children under 6 months)

- The arm tissues are often flabby and it is difficult to maintain suitable tension around the arm.

- The upper arm is difficult to keep still. Thus modifications with these children are:

  (1) Have the mother hold the out the baby's hand so that the arm is away from the side and steady.

  (2) Check tape tension around the arm at least twice, before reading the measure.

  (3) After the measure is called out, recheck tension a further time keeping the tape fixed at the same value.

(e) TRICEPS FATFOLD THICKNESS

1) This directly follows the left mid upper arm circumference. The positioning is the same.

2) Align a long pencil or equivalent directly up the back of the upper arm from the elbow point. Mark along this line at the region of the mid-upper mark previously made for the arm circumference. The two lines should cross at an right angle.

3) Standardize your caliper to zero if indicated and pick it up with you right hand. Do not show the open jaws to the child. Place the left thumb and index finger about 2 cm apart* so they are 1 cm above the mid upper arm point and in line with the just completed mid-line mark. Gently but firmly pick up a fold of fat at this site (see diagram). Do not pinch underlying muscle nor only the skin (it hurts!) - Check the child's expression.

4) Lift the fatfold enough to clear it from underlying tissue felt deeply with your fingertips.

5) Apply caliper jaws just below the pinch to the part of the fatfold at the mid upper arm point with the jaws meeting in the plane of the marked mid line. (the upper margin of the jaws should be no closer than ½ cm below the finger and thumb; the jaws placed at the same depth as the pinch but about 1 cm down the arm.)

6) From the onset of jaw application wait for 2 seconds (e.g. count one thousand, two thousand). At the same time you will note the dial indicator de-creasing a little. Exactly after these 2 seconds read and call out the value to the nearest 0.1 millimeter. See reading and recording methods.
*The distance apart may be adjusted to accomodate the fatfold.

7) Remove caliper, keeping the left thumb and index finger gently in position.

8) Your team member records the value and calls it back to you. Check that it is correct.

9) Reapply the caliper at the same site and repeat(6) -(8). Do not do this if child is noticably uncomfortable due to the procedure.

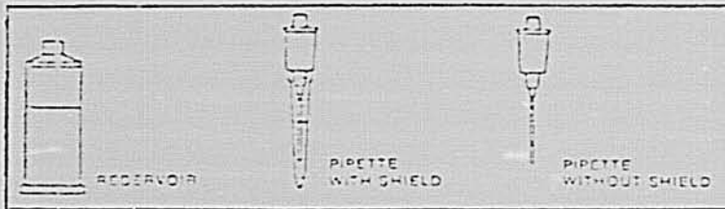
NOTES

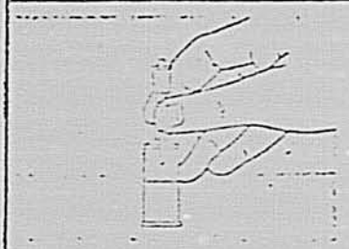
Reading - Depending on your ease of identifying the fatfold, confidence in jaw positioning and child cooperation, step (6) may be repeated 2 or 3 times before a consistent reading is called out.

Recording - The first called value is written above the appropriate boxes for triceps fatfold on form I and the second called value below. Record the mean of the two measures within the boxes. DO NOT erase nor cross out the other two recordings. Be honest. We expect some variation in this measure.

APPENDIX G

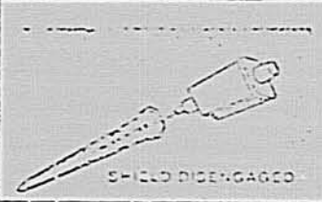
STEPS FOR TAKING BLOOD FOR HEMOGLOBIN USING UNOPETTES



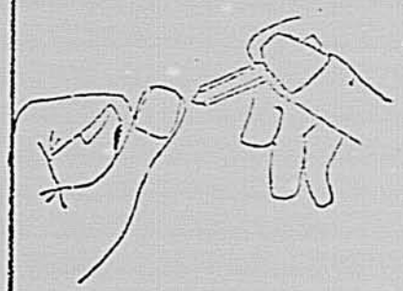


1. Take one unopette reservoir from the sealed plastic bag which has been premarked with the village ID code.

2. Grasping the reservoir in one hand, holding the pipette assembly with the other, apply firm even pressure and push the tip of the pipette shield through the diaphragm in the neck of the reservoir. Remove the pipette with shield.

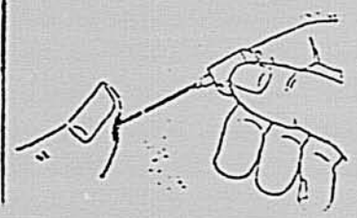


3. Disengage shield from the pipette with a twist action and leave the pipette loose in the shield (as shown) until ready to use. Place reservoir and pipette aside until ready to use.

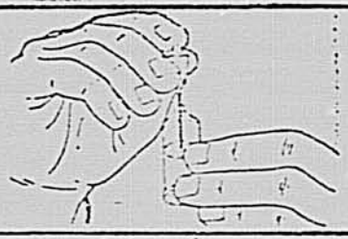


4. Clean thumb of subject's hand by rubbing with alcohol swab. Allow area to dry.

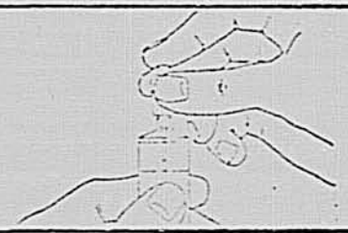
5. Hold the subject's thumb in your hand. Make a quick, but firm jab with the lance to the fleshy part of the thumb. (Be prepared for a sudden, instinctive withdrawal movement by the subject).
Using a dry gauze swab, wipe away the first two drops of blood.



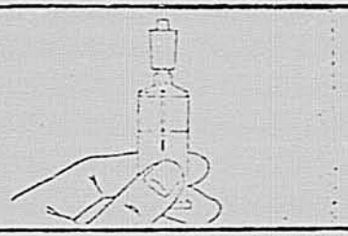
6. Allow a drop of blood to form on the thumb. Holding the pipette horizontally, touch the pipette to, but not into this drop, and allow the pipette to fill by capillary action. Wipe away excess blood from outside of the pipette, being careful not to touch the tip which would draw blood out.



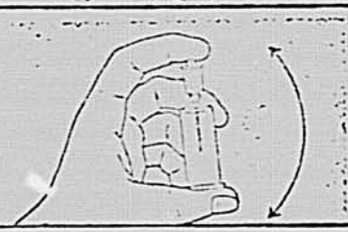
7. Loosely insert pipette into the opening of reservoir bottle.



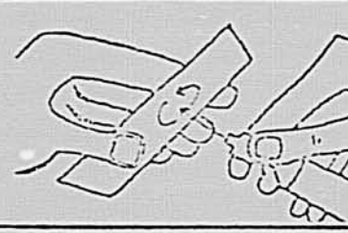
8. Gently squeeze the bottle with one hand.
With the other hand cover upper opening of pipette with your index finger. Seat pipette into reservoir.



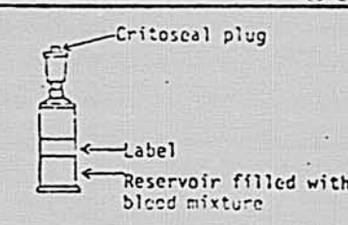
9. Release pressure on reservoir. Release finger from pipette. (Blood will then be drawn into reservoir bottle).
Squeeze the container several times. Be careful not to let reservoir liquid overflow.



10. Place your index finger over the opening of reservoir and pipette unit and invert a few times to mix.



11. Hold Critoseal upside down in one hand.
With thumb and index finger of other hand, hold reservoir and pipette unit by grasping pipette top.
Place pipette opening into Critoseal. Use twisting action to plug pipette. Remove.



12. Make sure subject's hand is wiped off and if desired, apply bandaid.
Write ID# of subject on unopette table. Return unopette to premarked plastic bag. Place bag in pack.

APPENDIX H

SURVEY QUESTIONNAIRE FORM *

MINISTRY OF HEALTH-GOVERNMENT OF LIBERIA
Form I LIBERIA NATIONAL NUTRITION SURVEY

Interview Date: Day | Mth | Year

COUNTY (1-2) | ECOLOG (3-4) | SITE No (5-7) | LOCALITY (8-9) | H'HOLD (10-11) | CHILD ID. (12-13) | TEAM (14-15)

HH HEAD ____ Occup.F ____ Pl.Work ____ (16)

PERSON INTERVD. (17): 1 Mother, 2 Substitute, 3 Relative, 4 Other

H'HOLD SIZE (18): 1-4=1, 5-8=2, 9 +=3

NAME CHILD ____

SEX (19): 1 M, 2 F

BIRTH ORDER (20-21)

DATE OF BIRTH: Day | Mth | Year

AGE: Yrs | Mths | MONTHS (22-23)

SOURCE USED BIRTH DATE (24-25): 1 Record, 2 Calendr, 3 Sib Age, 4 Teeth, 5 Stated, 6 Other

MILK TEETH COUNT (26-27)

BIRTH PLACE (28): 1 Hosp/Clinic, 2 Home, 3 Other

OTHER COUNTY (29-30)

SOCIAL DATA

Mother: MOTHER'S KNOWLEDGE OF ENGLISH (31): 1 Knows, 2 Reads, 3 Both, 4 Neither

AGE OF MOTHER (32): 1 Under 20, 2 20-40, 3 Over 40, 4 Unknown

STATUS MOTHER (33): 1 Absent, 2 Dead, 3 Neither, 4 Pregnant, 5 Obvious, 6 Stated, 7 Unknown

Father: TRIBE (34-35)

RELIGION (36): 1 Moslem, 2 Christian, 3 Other

STATUS FATHER (37): 1 Absent, 2 Dead, 3 Neither

DIET DATA CHILD UNDER 24 MTH. (38): 1 Fully Breast Fed, 2 Partly Breast Fed, 3 Non-breast milk

(39): 1 Food specially prepared, 2 Food shared with family, 3 No food given

WHO HELPS CHILD EAT (40): 1 Mother, 2 Sib, 3 Other, 4 No one

HEASUREMENTS — CHILD

WEIGHT (41-43) Kg

LENGTH HEIGHT (44-47) Cm

MEASURER (48-49)

ARM CIRC (50-52) Cm

TRICEPS FATFOLD (53-55) Mm

MEASURER (56-57)

HEASUREMENT — MATHL

MATHL ARM CIRC. (58-60)

MATHL TRIC. FATF. (61-63) Mm

MATHL HT. (64-66) Cm

MEASR (67-68)

CLIN. SIGNS: BILAT PEDAL EDEMA (69): 1 Yes, 2 No

IF YES, URINE PROTEIN: 3 0,1,2+, 4 3,4+, 5 Not done

ANALYSIS

WT/LGTH HEIGHT: 1 Under 80%, 2 90-110%

LGTH HT/AGE: 3 Under 90%, 4 90-100%

FOR SUBSAMPLE SELECTION (70-71): CASE A (1+4), CASE B (2+3), CONTROL (2+4), M ASHLORKOR

SUBSAMPLE SELECTED (72): 1 Yes, 2 No

*For LGTH HT/AGE must be at least 1 cm from borderline before selected

LAB. BLOOD COLLECTED UNOFFTE: 1 Yes OK, 2 Yes TOK, 3 No

HEMOGLOBIN VALUE (73-75) Gm%

SUPERVISION: TEAM EDIT (76): 1 On Spot, 2 Later

SUPERVISOR (77): 1 On Spot, 2 Later

OFF SITE (State where) ____ (78) ____ (79)

No. of Corr^ns 3 ____ Init (76) ____ Init (77) ____ Init (78) ____ Init (79)

Comments: ____

* REDUCED FROM ACTUAL SIZE

APPENDIX I

CORRELATIONS BETWEEN ANTHROPOMETRIC MEASUREMENTS

Using the data from the Liberia survey, relationships between anthropometric measurements were determined according to:

1. Measurements of children at two age ranges; 6-23 months and 24-59 months.

2. Comparisons between measurements of the child and mother in each family.

Tables 54&55 show a matrix of first degree function correlation coefficients (r values) between the measures and indices.

Strong correlations for children are arbitrarily defined as .70 and above, or 50% of the variation in one measure is accounted for by its regression on the other (coefficient of determination).

For child and mother comparisons a high correlation is more difficult to define as the measures are more independent than for children. For example, in children one would expect one measure to vary in the same direction with the other. Thus as a child's age increases, height, weight, and other measures usually increase, but not necessarily that of the mother. An r value of 0.1 or more indicates a significant correlation at the $P \leq 0.01$ level for the number of measures selected., but the actual correlation is weak.

CHILDREN AGED 6-23 MONTHS

Measures

One of the strongest correlations is that between weight and height ($r = 0.88$). This is to be expected as the bony skeleton contributes greatly

to the weight of a child. Both arm circumference (r = 0.76) and arm muscle (r = 0.71) show important correlations with weight, which is also to be expected. The high r value between arm circumference and arm muscle area (0.92) suggests that the former measure gives a good indication of muscle bulk.

Indices

The correlation between arm circumference for age and weight for height (0.74) suggests that AC/A or a similar arm circumference index could be used to assess the more acute types of PCM when weighing scales are not available.

The relationship between arm circumference and arm muscle area for age is high (0.91).

Maternal

A significant correlation (r = 0.2) is apparent for height comparisons. However, the coefficient of determination is only 4% which suggests that only a very small variation in height for age of the child can be accounted for by maternal height. This is perhaps important evidence to indicate that the genetic factors determining stunting in young children are weak and far less important than environmental ones such as nutrition and health.

CHILDREN 24-59 MONTHS

Child Measures and indices

The important results discussed are in general similar to those in the younger children. The correlations including arm measures are however a little less perhaps because these measures vary less with increasing age.

TABLE 54

CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC MEASURES AND INDICES - CHILDREN 6-23 MONTHS - LIBERIA

	Wt	Ht	AC	FF	AF	AM
Weight						
Height/Length	.88*					
Arm circum.	.76*	.50				
Fatfold	.34	.13	.51			
Arm fat area	.53	.28	.75*	.95*		
Arm muscle area	.71*	.51	.92*	.13	.43	

	W/H	H/A	AC/A	FF/A	AF/A	AM/A
Weight for Ht.						
Height for age	.21					
Arm circ. for age	.74*	.53				
Fatfold for age	.51	.22	.53			
Arm fat for age	.65	.35	.75*	.95*		
Arm muscle for age	.62	.51	.91*	.14	.43	

*r value equal or more than 0.70

CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC MEASURES AND INDICES - CHILDREN 6-23 MONTHS AND THEIR MOTHERS LIBERIA

Child	Maternal				
	Height	Arm C.	Fat F.	Arm Fat	Arm Musc.
Weight for Ht.	.00	.07	.04	.04	.06
Height for age	.20	.11	.12	.12	.03
Arm circ. for age	.09	.12	.07	.08	.09
Fatfold for age	.07	.01	.12	.10	-.08
Arm fat for age	.08	.06	.12	.11	-.03
Arm muscle for age	.07	.13	.03	.04	.14

TABLE 55

CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC

MEASURES AND INDICES - CHILDREN 24-59 MONTHS - LIBERIA

	Wt	Ht	AC	FF	AF	AM
Weight						
Height/Length	.86*					
Arm circum.	.69	.42				
Fatfold	-.09	-.13	.38			
Arm fat area	.13	.01	.62	.94*		
Arm muscle area	.28	.52	.84*	-.17	.10	

	W/A	H/A	AC/A	FF/A	AF/A	AM/A
Weight for Ht.						
Height for age	.09					
Arm circ. for age	.70*	.34				
Fatfold for age	.43	-.08	.43			
Arm fat for age	.56	.04	.65	.94*		
Arm muscle for age	.48	.39	.80*	-.11	.10	

*r value equal or more than 0.70

CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC
MEASURES AND INDICES - CHILDREN 24-59 MONTHS AND THEIR MOTHERS
LIBERIA

Child	Maternal				
	Height	Arm C.	Fat F.	Arm Fat	Arm Musc.
Weight for Ht.	.02	.20	.12	.10	.15
Height for age	.16	.14	.15	.15	.08
Arm circ. for age	.04	.23	.15	.15	.17
Fatfold for age	.01	.02	.16	.10	-.10
Arm fat for age	.02	.09	.18	.13	-.03
Arm muscle for age	.04	.24	.07	.11	.25

APPENDIX J DISTRIBUTION TABLES FOR ANTHROPOMETRIC INDICES RURAL LIBERIA.

HEIGHT-FOR-AGE

Percentage of Liberia Survey Population
by % of NAS Reference Height-for-Age Median
by Ecological Areas

AREA	Percent of NAS Reference Median						
	< 85	85-89	90-94	95-99	100+	Total %	N
Agricultural	3.4	16.0	40.0	30.8	9.8	100	2031
Semi-Remote	5.4	16.6	45.6	24.2	8.2	100	500
Total Agriculture	3.8	16.1	41.1	29.5	9.5	100	2531
Large Rural	1.5	16.6	35.5	35.8	10.6	100	265
Urban	3.9	7.6	29.3	37.7	21.5	100	387
Concession	1.3	11.2	39.2	35.8	12.5	100	296
Total Non-Agricultural	2.4	11.3	34.1	36.6	15.6	100	948
TOTAL COUNTRY	3.4	14.8	39.2	31.5	11.1	100	3479

WEIGHT-FOR-HEIGHT

Percentage of Liberia Survey Population
by % of NAS Reference Weight-for-Height Median
by Ecological Areas

AREA	Percent of NAS Reference Median							
	< 80	80-84	85-89	90-94	95-99	100+	Total %	N
Agricultural	1.6	4.3	10.9	18.3	22.6	42.3	100	2022
Semi-Remote	1.2	5.4	11.4	17.7	19.1	45.2	100	498
Total agricultural	1.5	4.5	11.0	18.2	21.9	42.9	100	2520
Large Rural	2.2	2.3	12.8	21.1	21.6	40.0	100	265
Urban	2.1	2.6	10.9	18.1	21.0	45.3	100	387
Concession	1.0	3.7	8.8	19.6	23.0	43.9	100	296
Total Non-Agricultural	1.8	2.8	10.8	19.4	21.8	43.4	100	948
TOTAL COUNTRY	1.6	4.0	10.9	18.5	21.9	43.1	100	3468

APPENDIX J DISTRIBUTION TABLES FOR ANTHROPOMETRIC INDICES

WEIGHT-FOR-AGE

Percentage of Liberia Survey Population by
% of NAS Reference Weight-For-Age Median
by Ecological Areas

AREA	Percent of NAS Reference Median							
	< 60	60-69	70-79	80-89	90-99	100+	Total %	N
Agricultural	1.8	5.3	17.7	32.4	25.5	17.2	100	2031
Semi-Remote	0.4	9.2	19.6	32.4	23.2	15.2	100	500
Total Agricultural	1.6	6.1	18.1	32.4	25.1	16.8	100	2531
Large Rural	0.4	4.2	17.0	33.3	25.8	19.3	100	265
Urban	0.8	4.6	12.9	23.5	30.5	27.7	100	387
Concession	0.0	2.0	18.6	30.7	25.0	23.7	100	296
Total Non-Agricul-tural	0.4	3.7	15.8	28.5	27.5	24.1	100	948
TOTAL COUNTRY	1.2	5.4	17.5	31.3	25.8	18.8	100	3479

ARM CIRCUMFERENCE-FOR-HEIGHT

Percentage of Liberia Survey Population by
% of NAS Reference Arm Circumference-For-Height Median
by Ecological Areas

AREA	Percent of NAS Reference Median							
	< 80%	80-84	85-89	90-94	95-100	100+	Total %	N
Agricultural	4.3	7.9	15.1	22.3	22.4	27.9	100	2031
Semi-Remote	4.2	8.4	13.2	22.6	25.4	26.2	100	500
Total Agricultural	4.3	8.0	14.7	22.4	23.0	27.6	100	2531
Large Rural	3.4	6.4	14.0	26.8	18.9	30.5	100	265
Urban	1.8	5.7	12.1	24.5	20.4	35.5	100	387
Concession	0.7	4.4	12.2	19.9	25.7	37.1	100	296
Total Non-Agricultural	1.9	5.5	12.7	23.7	21.6	34.6	100	948
TOTAL COUNTRY	3.7	7.3	14.1	22.8	22.6	29.5	100	3479

APPENDIX J DISTRIBUTION TABLES FOR ANTHROPOMETRIC INDICES RURAL LIBERIA

FAT FOLD-FOR-AGE

Percentage of Liberia Survey Population by
by Ecological Areas

AREA	Percent of NAS Reference Median						
	< 60	60-79	80-99	100-119	120+	Total %	N
Agricultural	18.8	35.9	26.3	12.9	6.1	100	2031
Semi-Remote	15.8	36.6	31.6	11.6	4.4	100	500
Total Agricultural	18.2	36.1	27.3	12.7	5.7	100	2531
Large Rural	14.0	39.2	26.0	15.8	4.9	100	265
Urban	18.1	41.6	24.8	11.1	4.4	100	387
Concession	19.9	38.2	29.4	7.1	5.4	100	296
Total Non-Agricultural	17.5	39.9	26.6	11.2	4.8	100	948
TOTAL COUNTRY	18.0	37.1	27.1	12.3	5.5	100	3479

APPENDIX K

LISTING OF SPECIAL AREAS WITHIN SURVEY UNIVERSE NON-AGRICULTURAL (RURAL)

LARGE RURAL POPULATIONS

CENSUS CODE	COUNTY	DISTRICT	CLAN/LOCALITY	POP.	NO. OF SITES SELECTED
02-1-05	Bong	Gbarnga	Jorquelle (Gbarnga)	6115	(1)
03-1-08	Grand Bassa	District I	Lloydsville Territory	2511	
03-1-09	Grand Bassa	District I	Owensgrove Territory	5569	(1)
03-2-13/17	Grand Bassa	District II	Edina/Kingsville	1683	
03-3-11	Grand Bassa	District II	Hartlandsville Territory	1657	
04-4-03	Cape Mount	Robertsport	Robertsport Municipality	2597	
05-4-04	Grand Gedeh	Techien	Techien Menson (Zwedru)	4054	(1)
05-5-11	Grand Gedeh	Webbo	Nyaake Town	1631	
07-4-03	Lofa	Kolahon	Tahamba (Foya Rice Field)	2470	
07-5-03	Lofa	Voinjamma	Upper Worker (Voinjamma)	5599	(1)
07-6-03	Lofa	Zorzor	Gizzima (Zorzor)	3564	
09-2-0	Maryland	Harper	Rocktown	1900	
09-2-0	Maryland	Harper	Whole Graway	1628	(1)
	Montserrado	Careysburg	all	13139	(1)
	Montserrado	St. Paul River	all	21870	(3)
08-1-06	Montserrado	Manba-Kaba	Charlesville Town	7356	
08-1-07	Montserrado	Manba-Kaba	Lloydsville Town	123	
08-2-	Montserrado	Marshall City	Marshall City	751	
08-2	Montserrado	Marshall City	Schiefflin	2059	(1)
11-4-04	Nimba	Sanniquellie	Sehyi (Sanniquellie)	6349	
14-5-05	Sinoe	Greenville	Lexington	408	
	Sinoe	Greenville	Louisana	248	
	Sinoe	Greenville	Greenville	7558	(1)
	Sinoe	Greenville	Murryville	921	
			TOTAL	102860	

APPENDIX K

LISTING OF SPECIAL AREAS WITHIN SURVEY UNIVERSE NON-AGRICULTURAL (RURAL)

URBAN POPULATIONS

(excluding Monrovia proper and Buchanan)

CENSUS CODE	COUNTY	DISTRICT	CLAN/LOCALITY	POP.	NO. OF SITES SELECTE
02-4-09	Bong	Salala	Zarwiakomu/Bong Town	7537	(1)
03-3-12	Grand Bassa	No. 3	Tubmanville	3582	(1)
04-2-05	Grand Cape Mount	Porkpaa	Sokpo/Mano River	7888	
09-2-01	Maryland	Harper	Cavalla	1198	
09-2-04	Maryland	Harper	Harper Munic	10333	(2)
01-1-10	Montserrado	Klay	Senjeh/Tubmanburg	19992	(2)
10-6-02	Montserrado	Monrovia	Paynesville	8907	(1)
10-6-04	Montserrado	Monrovia	Gardnersville	5904	
10-6-04	Montserrado	Monrovia	Congo Town	18395	(3)
11-4-05	Nimba	Sanniquellie	Camp 4	11724	(1)
11-4-05	Nimba	Sanniquellie	Garper	4705	
			TOTAL	100174	(11)

CONCESSION POPULATIONS

CENSUS CODE	COUNTY	DISTRICT	CLAN/LOCALITY	POP.	NO. OF SITES SELECTE
01-4-09	Bong	Salala	Zarwiakomu (Mine)	4203	(1)
03-3-13 (old)	Grand Bassa	District No. III	LAC (Gbuglay)	7637	(1)
04-2-05	Cape Mount	Porkpaa	Sokpo/Mano River	3089	
01-1-10	Montserrado	Klay	Senjeh (LMC)	3404	
01-1-10	Montserrado	Klay	Senjeh (Goodrich)	6401	(1)
02-4-01 (old)	Montserrado	Kakata	Dinning-TA (German Camp)	2488	
10-5-01	Montserrado	Firestone	Firestone Division (#1-#45)	50801	(6)
07-5-01	Lofa	Voinjanma	Bondi (Lisco-New Kpademai)	2056	
11-4-05	Nimba	Sanniquellie	Yarmien (Lamco)	10576	(1)
14-3-02	Sinoe	Juarzon-Sub	Wedjah AFC)	1822	
			TOTAL	92477	(10)

APPENDIX K

RURAL AREAS NOT INCLUDED IN SURVEY UNIVERSE

CONSECUTIVE REMOTE AREAS

(From National Rice Survey)

CENSUS CODE	COUNTY	DISTRICT	CLAN	POP.
02-1-26	Bong	Gbaranga	Yaindawoun	3025
02-5-04	Bong	Sonoyea	Menquelleh	4171
02-5-06	Bong	Sonoyea	Wallahun	2335
03-2-02	Grand Bassa	DT2. Boe-Glahn	Chan No. -1	1140
03-2-03	Grand Bassa	DT2. Boe-Glahn	Chan No. -2	1426
12-all	Grand Bassa (River Cess)	all	all	25176
06-1-04	Maryland (Kru Coast)	Barclay Ville	Wedabo	4627
07-1-01	Lofa	Bopolu	Bartee	3204
07-1-02	Lofa	Bopolu	Bokomu	4086
07-1-04	Lofa	Bopolu	Goe	4301
07-1-07	Lofa	Bopolu	Tawala-Ta	1176
07-2-02	Lofa	Gbarma	Jawajeh	385
07-2-03	Lofa	Gbarma	Tongail	180
07-2-05	Lofa	Gbarma	Zoi	2800
14-1-03	Sinoe	Bloni-Sinoe	Lower Kabour	435
14-1-08	Sinoe	River	Totoe-Grand Sanquin	233
14-1-09	Sinoe	Bloni-Sinoe	Totoe-Little Sanquin	315
14-1-11	Sinoe	River	Upper Kabour	192
14-4-03	Sinoe	Sinoe River	Bokon Jaedae	1160
14-4-04	Sinoe	Sobobo	Braoh	596
14-4-05	Sinoe	Sinoe River	Drapo	229
14-4-08	Sinoe	Sobobo	Lower Jadapoh	2326
14-4-10	Sinoe	Sinoe River	Nanakru	832
14-4-20	Sinoe	Sobobo	Upper Jadapoh	1142
			TOTAL	65493

APPENDIX K

LIST OF AREAS TAKEN FROM THE SAMPLE TO DESCRIBE REMOTENESS

LIST OF SEMI-REMOTE AREAS FROM SAMPLE

COUNTY	SITE #	DISTRICT	CLAN	MAJOR LOCALITY	# OF CHILDREN IN SAMPLE
Bong	3	Gbarnga	Panta	Dinanai	13
	11	Gbarnga	Wolota	Mining-Ta	30
	13	Sanoyea	Sanoyea	Momokawe-Ta	14
	15	Salala	Lorlah	Quoi-Ta	30
Grand Bassa	21	Number 2	Goingbe	Gleebeh Town	23
	22	Number 3	Gorblee	Zua Garblee	5
	24	Number 3	Zeewein	Joe Town	17
	25	Number 6	Grand Colla	Gbui Gbah	30
Cape Mount	28	Garwula	Vaikonnah	Zaway	20
	29	Garwula	Mannah	Freetown	10
Grand Gedeh	37	Webbo	Deabo	Parke	30
	38	Webbo	Tuobo	Tumake	15
Lofa	41	Kolahun	Tangia	Kporculor	8
	42	Kolahun	Tangia	Kongbarma	30
	44	Kolahun	Wuah	Koinuumumu	30
	47	Zorzor	Gizzima	Yanlor	30
Maryland	55	Barclayville	Flenekpo	Mission Fleken	30
Nimba	71	Bahn	Butulu	Beeplay Bartuahplay	8
	74	Sanniquellie	Gbain	Soepa	30
	76	Karnplay	Zor	Guagortru	30
	80	Tappita	Quellah	Mensannplay	30
Sinoe	82	Sinoe Rive/Sobo	Wolee	Kanja Town	7
	84	Juarzon	Weo Jah	Sargbeh	30
				TOTAL	500