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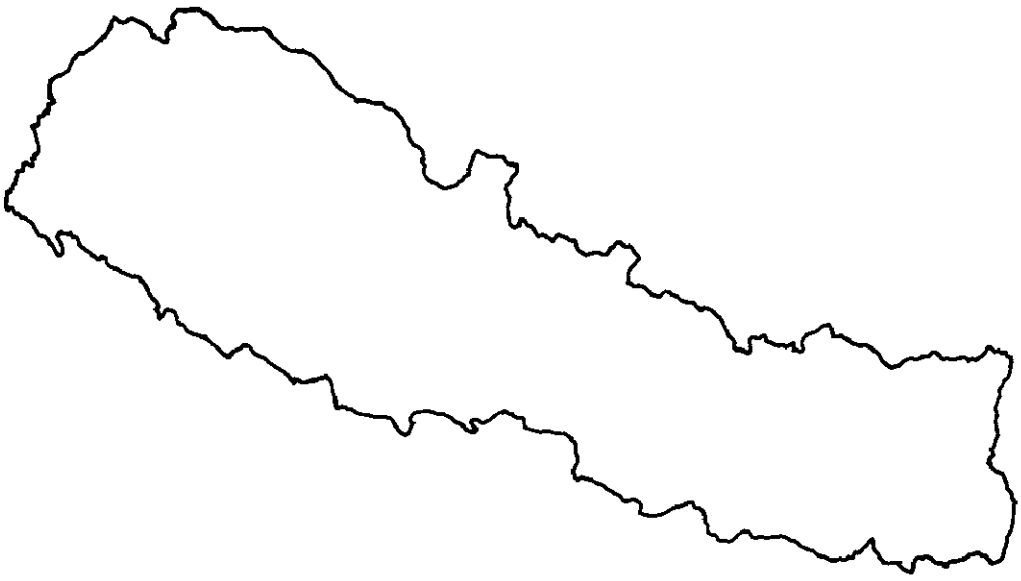
NEPAL

Nutrition Status Survey

1975



NEPAL NUTRITION STATUS SURVEY

JANUARY - MAY 1975

CONDUCTED BY

HIS MAJESTY'S GOVERNMENT OF NEPAL

WITH THE ASSISTANCE OF THE
CENTER FOR DISEASE CONTROL
PUBLIC HEALTH SERVICE
U.S. DEPARTMENT OF HEALTH EDUCATION AND WELFARE

IN COOPERATION WITH

THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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(January - May 1975)

Prepared by
U.S. Department of Health, Education and Welfare
Public Health Service
Center for Disease Control
in Cooperation with
U.S. Agency for International Development
and
His Majesty's Government of Nepal

"The aim of a nutrition status survey is to obtain the maximum of useful information, using a minimum of staff, inexpensive equipment and uncomplicated techniques that can be analyzed easily." (D.B. Jelliffe, The Assessment of the Nutritional Status of the Community, 1966, World Health Organization, Monograph Series, 53.)

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I. Introduction

Only a few reports are available on the nutritional status of the population of Nepal (1,2,3). These studies have used various criteria for determining undernutrition including weight-for-age, weight-for-height, height-for-age and clinical signs. These surveys were conducted on selected hospital populations, clinic populations, and village populations in many parts of the country. All found some degree of undernutrition in each section of the country surveyed. Although these surveys have indicated varying degrees of endemic goiter and anemia in certain areas, only Pourbaix (3) provides information on the type and duration of the protein energy nutrition deficit. Information on the extent of present and past undernutrition is important to describe the type and natural history of protein-energy undernutrition and to serve as a guideline for developing responses (4).

Nutrition evaluation should be a dynamic process. Descriptive baseline findings can lead to more specific and localized studies to provide direction in planning remedial programs (5). A survey method which assesses nutritional status should also be useable as one of the methods of assessing the impact of instituted remedial programs.

A very detailed Food Consumption Survey projected to include 25 of the 75 districts of Nepal is underway (6). The scope

and magnitude of this survey precludes the availability of useable data as a guide for Government of Nepal decisions on nutrition priorities for several years. Detailed food intake surveys, biochemical, and micronutrient surveys are expensive in terms of time, personnel and laboratory facilities, and usually encounter imposing logistical problems in the field. In addition, analysis of food intake survey data is complex. USAID personnel identified the Center for Disease Control's concept of a "simplified field assessment of nutritional status" (7) as a workable method of rapidly identifying and presenting a reasonably good picture of the nutritional status of the population in various sections of Nepal. With GON concurrence, CDC consultation was arranged in the Spring of 1974 and a Nepal Nutrition Status Survey protocol was prepared. With the assistance of GON, USAID and CDC the field survey was carried out from January through May 1975.

The primary objective of the 1975 Nepal Nutrition Status Survey was to provide statistically valid data on the type, extent and distribution of protein-energy undernutrition in Nepal using anthropometric measurements and selected clinical criteria. Quantitation of the prevalence of anemia was a second goal. Interregional comparisons of nutritional conditions within the country are necessary to establish priorities for regional remedial programs. The information is complimentary to the

ongoing Food Consumption Survey. Furthermore, the survey methodology can be used as one form of assessing the effects of nutrition intervention at later points in time.

II. General Information

Nepal is a mountainous country with a total land area of 140,080 sq km of which only 14.1% is available presently for cultivation. Some increase in the land area under cultivation can be expected with the opening of forest lands to agriculture, especially in the Terai. The country is divided geographically into Mountain, Hill and Terai terrains, and politically into 4 development regions: Far West, West, Central, and East with 75 districts. Each district is divided on a combined political-population basis into a number of panchayats ranging from 5 to 31 per district.

According to the 1971 Nepal Census (8), there were 11,289,000 people with an imbalance between the Hills and the Terai. Approximately two-thirds of the population live in the Hills and produce one-third of the total food, whereas one-third of the people live in the Terai where two-thirds of the food is grown. Slightly less than ten percent of the population lives in the Mountain terrain. The average household size in Nepal is 5.6 according to the 1971 Census.

The Nepal Health Survey 1965-66 (1) mentions 54 cases of "clinical undernutrition" among an estimated 1333 children seen in the age group 0-9 years giving a prevalence of 4%. "Clinical undernutrition" implies people weighing less than 80% of the Indian

(ICMR) reference median, which falls well below the 80% of Stuart Meredith reference median. In children attending a MCH clinic at Bhaktapur Hospital in Kathmandu Valley, van Dijk (2) found a 1966 annual edema prevalence of 7.1% among first visit infants and preschool children, and a 1967 annual edema prevalence of 5.1%. Her data suggested seasonal differences, with the fourth quarter prevalence highest in both years. Unpublished data by Ziegler and Ziegler (9) on 645 children in 5 villages in the age group 10 months to 2 years showed 20.9% of the children to be less than 80% of Stuart Meredith reference median weight-for-height. None of these data were collected so as to be representative of Nepal.

A more extensive anthropometric survey was conducted by Pourbaix (3) in 1974. Although numbers are small for any one section of Nepal, data were collected on a total of 1,044 preschool children in 17 clinics or villages in geographically widely divergent sections of Nepal. Clinical edema was sought, as well as anthropometric data. If less than 80% of Stuart Meredith reference median weight-for-age and weight-for-height are accepted as critical divisions between abnormal and normal values for these indices, 71.1% of the total survey population had abnormal weight-for-age and 19.3% had abnormal weight-for-height. These are alarming percentages. Even more alarming is the 5.2% of the surveyed population who were described as having clinical

protein-energy undernutrition based upon an elaborate combination of criteria for marasmus, kwashiorkor and pre- and post-kwashiorkor. If pedal edema is regarded as the single most important sign for diagnosing kwashiorkor, then 3 of 1404 (2.1/1000) survey children had kwashiorkor. Most cases of pedal edema were probably in children less than 80% of reference median weight-for-height. A kwashiorkor rate of 14.9/1000 survey children less the 80% weight-for-height can be calculated assuming all edema was in this severely wasted group of children.

III. Survey Specifics

A. Survey Design

Survey design begins with the premise that data must be representative of the geopolitical area for which inferences are desired. A nutrition survey should provide valid information on the magnitude and geographic distribution of undernutrition.

Before deciding on sampling methodology, the parameters to be estimated need to be defined and the geopolitical and demographic parameters of the universe and subdivisions to be surveyed must be described. With these decisions completed and resource constraints identified, optimum sample size can be estimated for the statistical precision desired, the associated confidence levels required, and the resource constraints involved. In order to measure statistical precision, sample units must be selected using mathematical probability so that every child in the geopolitical area has a known probability of being selected.

Simple random or stratified random sampling techniques usually yield the best precision for a given sample size. These techniques are seldom used in surveys covering large geographic areas because sampling frames using all the sampling units are rarely available and the cost of locating

the selected units in money, personnel and time is prohibitive. These constraints make it desirable to use a technique which restricts sampling to a small number of relatively compact geographic areas and sample more than one individual in each of these areas. The major drawback to this technique, called "area probability sampling," is that a loss in precision generally occurs from sampling groups of individuals rather than single individuals. Because the magnitude of this loss in precision cannot be predetermined, estimated correction factors are used to determine the survey sample size. Analysis of the survey data provides actual precision values for comparison with their closeness to the desired pre-survey precision values. Actual precision is determined for each survey characteristic on which data is obtained and varies depending on the distribution of that characteristic within the sample.

To summarize, for a survey to be useful in planning nutrition activities, the data collected must be statistically reliable. Survey design must incorporate:

1) definition of areas for which inferences are desired;
2) definition of survey variables to be measured;
3) probability sampling techniques;
4) statistical precision desired and confidence levels required.

B. Sampling Methods

The survey universe was defined as the rural population of Nepal. For this reason, the 3 districts composing Kathmandu Valley plus town panchayats (13 in number) were excluded. The total population excluded was approximately eight-tenths of a million people, leaving a survey universe population total of 10.7 million of which approximately 1.8 million were in the survey age range of 6-72 months.

A minimum of 30 sampling units was allotted to any area for which data were to be presented with statistical precision. This permits the estimation of population characteristics of each such area and allows for the testing for significant differences in population characteristics between such areas.

For survey purposes Nepal was divided into 12 subregions or cells along geopolitical boundaries, that is development regions and ecological terrains (Figure 1).

Figure 1
Geopolitical Division of Nepal into Subregions, and Numerical Codes Used for Survey

Development Regions

Terrains	Far West (Surkhet)	West (Pokhara)	Central (Kathmandu)	East (Dhankuta)
Mountain	41*	31	21	11
Hill	42	32	22	12
Terai	43	33	23	13

*Subregion (cell) numbers used for identification in program coding.

The identification of sample sites was done using the 1971 Nepal Census line-listing of villages, and employing a fixed interval method of population proportionate sampling:

1) the populations of all villages within the universe were cumulated;
2) the cumulated total population was divided by the number of sample sites required to obtain a sampling interval;
3) a starting number within the bounds of the sampling interval was randomly selected;
4) the village including this number in its cumulative population range was identified as sample site one;
5) the interval size was added consecutively to the starting number thus identifying corresponding villages as sample sites until the required number of sample sites was determined.

"Enriched" sampling, that is, proportionately more intense sampling, was done in selected subregions to provide the total number of development region, terrain and subregion inferences felt to be necessary for adequately describing the nutrition status of Nepal (Appendix A). Each data form collected does not represent the same proportion of total rural Nepal universe because three sampling intervals were used in the survey. Five subregions were sampled at double

the overall country rate and one subregion was sampled at one and one-half times the overall country rate. Essentially, the actual total number of children surveyed, 6578, when subjected to the effects of varying sampling intervals, is represented in the calculation of percentages by 4275 "individuals." Where number of children is mentioned in the text and tables, the actual survey counts are presented within parentheses. However, percentages used in the text and tables have been corrected to account for the three sampling intervals.

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

1) Total country	(1)
2) Individual development regions	(4)
3) Hill and Terai ecological terrains	(2)
4) Each of the four subregions within the hill terrains	(4)
5) The Eastern Terai (composed of the two most eastern terai subregions) The Western Terai (composed of the two most western terai subregions)	(2)
Total Sets of Valid Inferences =	13

For each area for which estimates were calculated at least 30 sampling units were required. By using binomial theory an area sample size total of 900 children 6-71 months of age was determined to be the minimum number required for adequate precision. Therefore, the individual sample unit size was established to be 30 children (Appendix B).

All sample sites were located on a large wall map of Nepal and on supplementary maps provided by the Ministry of Education. A detailed logical framework of sampling procedures including the selection of individuals within sample sites is given in Appendix C.

C. Survey Items

The practical constraints of time, money, equipment and personnel make a classical nutritional assessment including anthropometric, biochemical, dietary, clinical, agricultural, and sociological data unrealistic. Known resource constraints are important for establishing assessment objectives. The parameters selected to assess nutrition should be simple and easy to measure, satisfy stated objectives, and remain within resource constraints. A minimum number of selected anthropometric, biochemical and clinical measurements collected from a representative group of children of a nutritionally sensitive age will indicate the general nutritional status of the community and answer the question "What is the extent of the problem?".

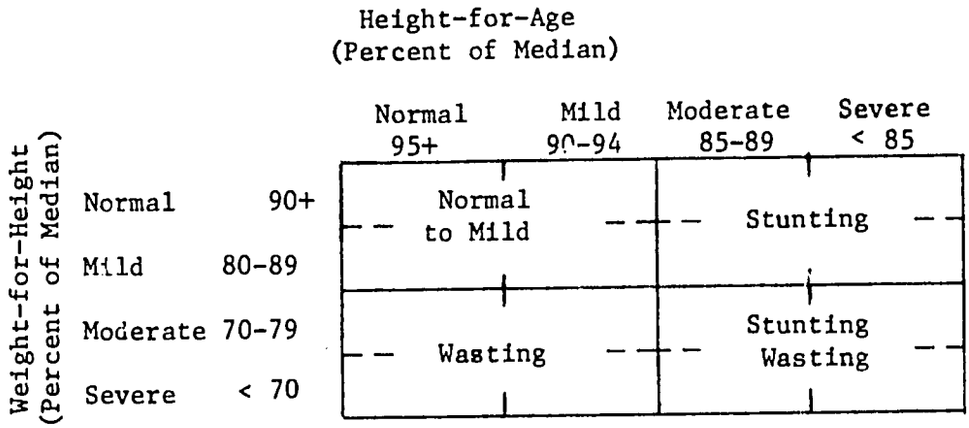
The greatest value of anthropometry in the developing world is the assessment of growth failure and undernutrition, principally protein-energy malnutrition. Anthropometry describes the range and type of protein-energy undernutrition within a study population. Careful anthropometry can identify the spectrum of undernutrition for which objective clinical criteria may not be present. The most usual measurements are those made to assess (a) body mass as judged by weight; (b) linear dimensions, especially height or length; (c) and the composition of body mass as reflected by skinfold and arm circumference (5).

Analysis of combinations of measurements with and, in some instances, without age data provides a detailed nutritional profile. Waterlow et al (10, 11) and Seone and Latham (12) have suggested a system to broadly categorize types of undernutrition using height-for-age and weight-for-height determinations.

A linear deficit in growth defined as less than 90% of reference median height-for-age suggests past chronic undernutrition and is termed 'stunting.' Current acute short duration undernutrition, termed 'wasting,' is recent weight loss where the individual's weight-for-height ratio is less than 80% of the reference median. The individual with a combined status of less than 80% of weight-for-height

and less than 90% of height-for-age has current long duration malnutrition classified as concurrent wasting and stunting. This classification is shown in Figure 2 which is adapted from Waterlow (11).

Figure 2
Simplified 4-Cell Classification of Nutrition Status
by Height-for-Age and Weight-for-Height



Arm circumference measurements for height provide information similar to weight-for-height. If a high correlation is shown, arm circumference might be a practical alternative for weight measurements and obviate the need for weighing equipment. Thus arm circumference-for-height monitoring might be a simple method for ongoing nutritional surveillance.

The Nepal Nutrition Status Survey data are generally presented as percent of median of the National Academy of Sciences anthropometric reference population (Appendix D). The presumptive contribution of ethnic differences in making data comparisons and in interpreting anthropometric data is at a minimum within the age group under study (13), (Appendix D).

Nutritional edema and hemoglobin determinations can be objectively determined and easily taught. They were included in the survey to provide valid data on severe protein deficiency and iron metabolism.

Given this minimum core of basic nutritional indicators, a well designed survey can provide prevalence baseline data on the most common and severe nutritional problems of young children.

D. Anthropometry Methods

Detailed procedures for anthropometry are in Appendix E.

1) Height or length was measured in centimeters with a custom-made portable wooden board produced at CDC. Values were read to 0.1 cm accuracy.
2) Weights were measured with a Salter hanging scale (25 kgm capacity) with 0.1 kgm divisions. Values were read to the nearest 0.1 kgm mark on the scale face. Scales were adjusted before each weighing and standardized against a known 10 kgm weight periodically.
3) Arm circumference was measured with a Zerfas slotted tape with firm but gentle continuous contact with the left arm. Values were read to 0.1 cm accuracy.
4) Triceps skinfold measurements in millimeters were measured with the Holtain/Tanner-Whitehouse calipers at a determined point on the left arm. Values were read to the nearest 0.2 millimeter. The dial face was checked and adjusted to a zero reading when necessary before measuring each child. (Only four of the eight teams did skinfold measurements and during the final quarter of the survey one caliper was broken.)

E. Hematology

Detailed procedures for the collection and processing of blood samples are in Appendix F.

1) Hemoglobin

Capillary blood was collected by fingerstick on approximately every fifth child in the survey. Specimens were shipped to Kathmandu where a clinical laboratory pathologist ran all samples for hemoglobin by the cyanmethemoglobin method using Bausch and Lomb minispec 20 TM spectrophotometer.

2) Measles

Blood was collected on labeled filter papers, air dried, and were sent to CDC where the presence of antibodies was detected by a Hemoagglutination Inhibition microtechnique.

F. Data Preparation

Field editing for survey form clarity, completeness and consistency was done at the sample site by the team, and again at AID/Nepal by office staff. The original forms were air pouched to CDC-Atlanta for processing and analysis on an IBM 370/145 computer.

CDC has a comprehensive computer program with a core system capable of handling the data input of several nutrition surveys with minimum programming modifications. The system core can handle the tabular output formats and comparisons of various anthropometric measurements with and without an age data basis.

G. Special Group

A group of 486 children between the ages of 6 and 72 months was selected from Kathmandu and Patan families which could afford to provide adequate nutrition for their children. This group represents a more advantaged Nepalese population than the rural survey group.

Although the Special Group contains a small number of children who cannot be considered as statistically representative of any defined universe, they constitute an elite group to which the rural Nepalese children can be compared. They were weighed and measured so that standard calculations of weight-for-height, height-for-age and arm circumference-for-height could be made.

IV. Survey Results

A. Distribution of Sample Sites

The distribution of the total 221 sample sites used to describe the rural population of Nepal is given in Figure 3 and is summarized by geopolitical division in Table 1.

Table 1
Distribution of 221 Sample Sites in Rural Nepal
by 12 Cell Geopolitico Matrix

Terrains	Development Regions: Far West (Surkhet)	West (Pokhara)	Central (Kathmandu)	East (Dhankuta)	Total
Mountain	6	1	5	4	16
Hill	37	36	30	29	132
Plain	16	16	23	18	73
Total	59	53	58	51	221

Before enrichment of certain geopolitico units, the survey sample was described by 145 sample sites. These sample sites were geographically allocated by population proportioned sampling so that the number of sample sites per subregion, development region or terrain was directly related to the population of the described area. The figures for the distribution of 145 sample sites shown in Table 2 are rounded to the nearest whole number.

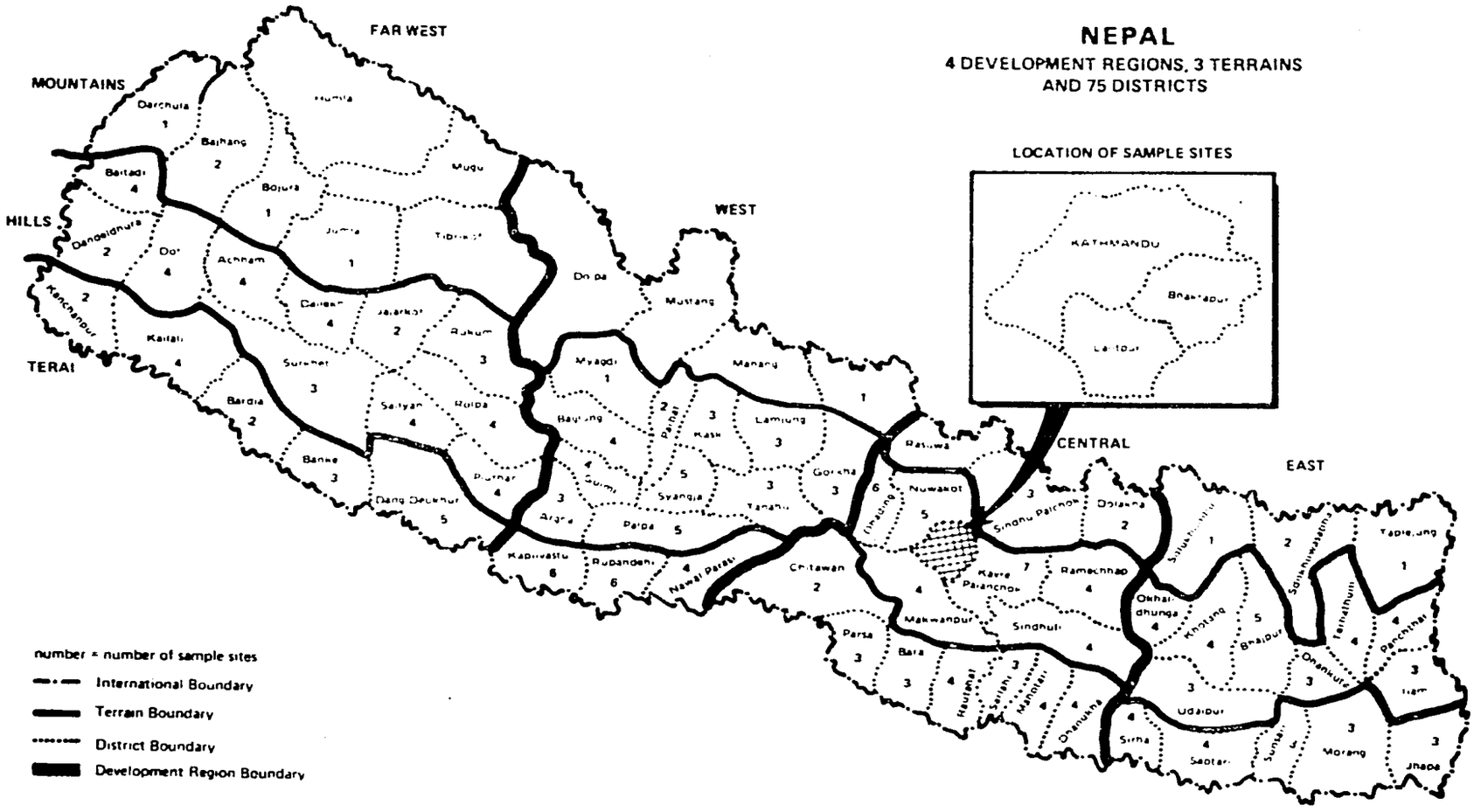

NEPAL
4 DEVELOPMENT REGIONS, 3 TERRAINS
AND 75 DISTRICTS
LOCATION OF SAMPLE SITES
KATHMANDU
FAR WEST
MOUNTAINS
HILLS
TERAI
WEST
CENTRAL
EAST
number = number of sample sites
International Boundary
Terrain Boundary
District Boundary
Development Region Boundary

Figure 3

Table 2
Distribution of 145 Sample Sites in Rural Nepal
by 12 Cell Geopolitico Matrix
with Subregion Rural Population* Counts

Development Regions

Terrains	Far West (Surkhet)	West (Pokhara)	Central (Kathmandu)	East (Dhankuta)	Total
Mountain					
Sites	6	1	5	4	16
Pop.	(442,931)	(72,928)	(368,931)	(294,930)	(1,179,720)
Hill					
Sites	18	24	15	15	72
Pop.	(1,330,938)	(1,774,941)	(1,108,936)	(1,108,936)	(5,323,751)
Terai					
Sites	8	8	23	18	57
Pop.	(590,932)	(590,932)	(1,700,941)	(1,330,938)	(4,213,743)
Total					
Sites	32	33	43	37	145
Pop.	(2,364,801)	(2,438,801)	(3,178,808)	(2,734,804)	(10,717,214)

*Figures in parentheses represent rural population according to 1971, Nepal Census.

In Table 2 the figures in parentheses within the matrix represent population counts for the subregions. The totals in the vertical columns indicate the population counts for development regions and the totals in the horizontal rows indicate the population counts in the terrain divisions of Nepal.

B. Age and Sex Distribution

Survey age distribution (Table 3) differs from 1971, Nepal Census age distribution. Both distributions differ from

what would be expected in a country with a relatively high prevalence of infant-through-23 month mortality. The survey difference from expected distribution suggests:

1) observer errors in age determination;
2) selective presentation of older children to the observer;
3) laxity of the observer in obtaining all children 6-72 months in survey households.

Table 3
Age Distribution of Nepal Survey Population by Percentage

Population Group	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-71m	Total
Rural Nepal Survey	10.1%	19.4%	16.6%	18.0%	16.5%	18.7%	100.0%
1971 Nepal Census Data	7.4%	13.7%	17.8%	19.6%	17.2%	24.3%	100.0%
Sample Size	(692)[1]	(1265)	(1079)	(1163)	(1124)	(1202)	(6525)

[1]Actual sample size for age group in parenthesis.

Survey sex distribution differs significantly from the 1971 Nepal Census sex distribution and differs from what would be expected normally. (Table 4) Field survey errors, and not sampling methodology, probably produced these differences. Error types include:

1) parents preferentially presented male children;
2) the observer was lax in insuring that all children age 6-72 months were brought forth;

3) females in the age groups 6-11 months and 48-72 months are more likely to be away from the household for some reason.

Table 4
Sex Distribution of Nepal Survey Population by Percentage

Sex	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	All Age Groups
Male	55.4%	49.9%	51.3%	50.0%	53.3%	56.3%	52.5%
Female	44.6%	50.1%	48.7%	50.0%	46.7%	43.7%	47.5%
Sample Size	(692)[1]	(1265)	(1079)	(1163)	(1124)	(1255)	(6578)

[1]Actual sample size for age group in parenthesis.

C. Weight-for-Height

The distribution of weight-for-height by percentage of NAS reference median by geopolitical units is presented in Table 5. If 80% of reference median is used as the threshold for "wasting" as suggested by Waterlow (11) and Seone (12), then 6.8% of the total rural population surveyed are classified as less than normal weight-for-height. The most severely affected geopolitical subunits by the above criteria are the Far West and Central Development Regions at 7.1% and 7.7%, respectively, below 80% of reference median; the Terai Terrain at 8.6% below 80% of reference median; and the Far West Hills Subregion at 7.6% below 80% of reference median. There is a significant difference between the Hill and Terai Terrains in the prevalence of wasted children. All

Table 5
Weight-for-Height
Percentage of Nepal Survey Population
by % of NAS Reference Weight-for-Height Median
by Geopolitical Divisions

Percent of NAS Reference Median

Populations	<70%	70-74%	75-79%	80-84%	85-89%	90-94%	95-99%	100+%	Total %	Sample Size
Total Rural Nepal	0.5	1.3	5.0	14.9	24.3	24.8	16.7	12.6	100	(6562)[1]
Development Regions										
Far West	0.8	1.6	4.7	15.8	23.6	26.2	16.8	10.5	100	(1734)
West	0.3	1.0	4.4	12.9	23.6	25.0	16.5	16.3	100	(1592)
Central	0.4	1.3	6.0	16.3	24.1	25.7	15.0	11.3	100	(1738)
East	0.3	1.1	4.5	14.5	25.7	22.2	19.2	12.5	100	(1498)
Terrain										
Hill	0.5	1.2	4.1	13.2	22.6	25.4	18.4	14.5	100	(3988)
Terai	0.3	1.6	6.7	17.1	27.4	23.4	14.3	9.0	100	(2156)
Subregions										
Far West-Hill	0.9	1.9	4.7	15.7	23.6	26.1	16.9	10.3	100	(1139)
West Hill	0.3	1.0	4.1	11.9	22.3	26.1	17.8	16.6	100	(1051)
Central-Hill	0.6	1.4	4.9	13.3	20.4	25.4	17.9	16.0	100	(898)
East-Hill	0.2	0.2	2.8	12.2	24.4	23.5	22.0	14.8	100	(900)
Special Group	0.0	0.8	1.0	5.3	17.3	26.7	22.2	26.5	100	(486)

[1]Actual sample size of population in parenthesis.

percentages are calculated from weighted data because of the use of enrichment sampling techniques in survey design.

In the Special Group only 2.9% of measured children are less than 80% of reference median weight-for-height.

The major proportion of children falling below 80% of reference median were from 75 to 79% of the reference median. In the Special Group no children were found to be less than 70% of reference median. On the other hand, only 12.5% of the total rural survey population were greater than 100% of reference median while 22.8% of the Special Group were in this category. In the U.S.A.-NAS population, 50% of the population is above 100% of reference.

Table 6 presents the percentage of survey children falling beneath 80% of NAS reference weight-for-height for the total rural survey and the special group by age.

Table 6
Percentage of Nepal Survey Population less than 80% of NAS Reference Median Weight-for-Height by Age

Population Group	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Sample Size Total
Total Rural Nepal	8.1% (692)[1]	15.2% (1265)	8.9% (1079)	3.4% (1163)	2.4% (1124)	1.8% (1275)	(6598)
Special Group	0.0% (24)	3.0% (66)	4.9% (61)	0.8% (120)	2.2% (135)	0.0% (80)	(486)

[1]Actual sample size for age group in parenthesis.

A significant age difference in percentages beneath the cutoff is noted in rural Nepal. The same trend occurs in the Special Group. The older children have less wasting than the younger children, and infants less than one are spared relatively.

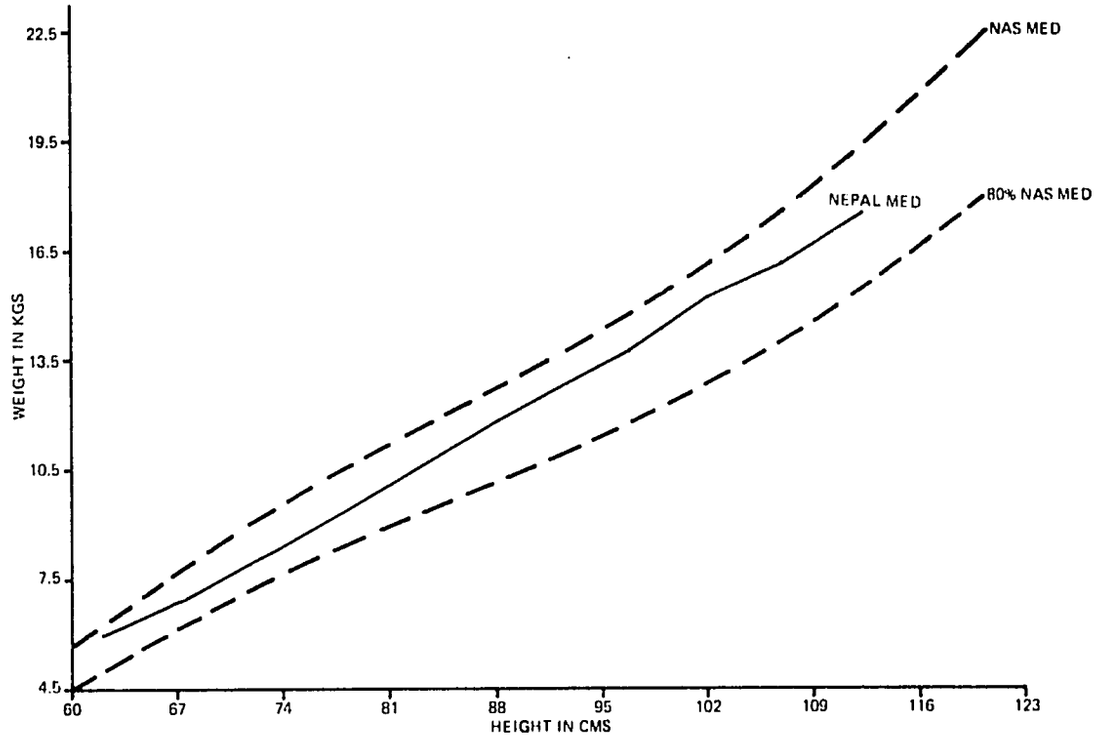
Figure 4 displays by sex the rural Nepal median weight-for-height as a curve compared with the NAS reference population median and 80% of median weight-for-height curves.

D. Height-for-Age

Height-for-age data are presented in Table 7. Ninety percent (90%) of the reference median height-for-age is used as a "stunting"threshold by Waterlow (11). Applying this criterion to the total rural survey data, 51.9% of the survey population is classified as stunted. Selecting the most severely affected geopolitical areas for which sufficient data were collected, the West Development Region has 55.3% below 90% of reference median and the Far West Subregion 56.[illegible]% below 90% of reference median. A comparison of the Hill Terrain, 55.5% below 90% of reference median, and the Terai Terrain, 45.1% below the same level, indicates a significant difference in height-for-age measurements, in contrast to the between-Terrain comparison of weight-for-height percentages falling below the 80% of reference median weight-for-height. Most of those falling beneath the 90%

Figure 4

COMPARISON OF RURAL NEPAL SURVEY POPULATION MEDIAN WEIGHT-FOR-HEIGHT WITH NAS REFERENCE POPULATION – BOYS



COMPARISON OF RURAL NEPAL SURVEY POPULATION MEDIAN WEIGHT-FOR-HEIGHT WITH NAS REFERENCE POPULATION – GIRLS

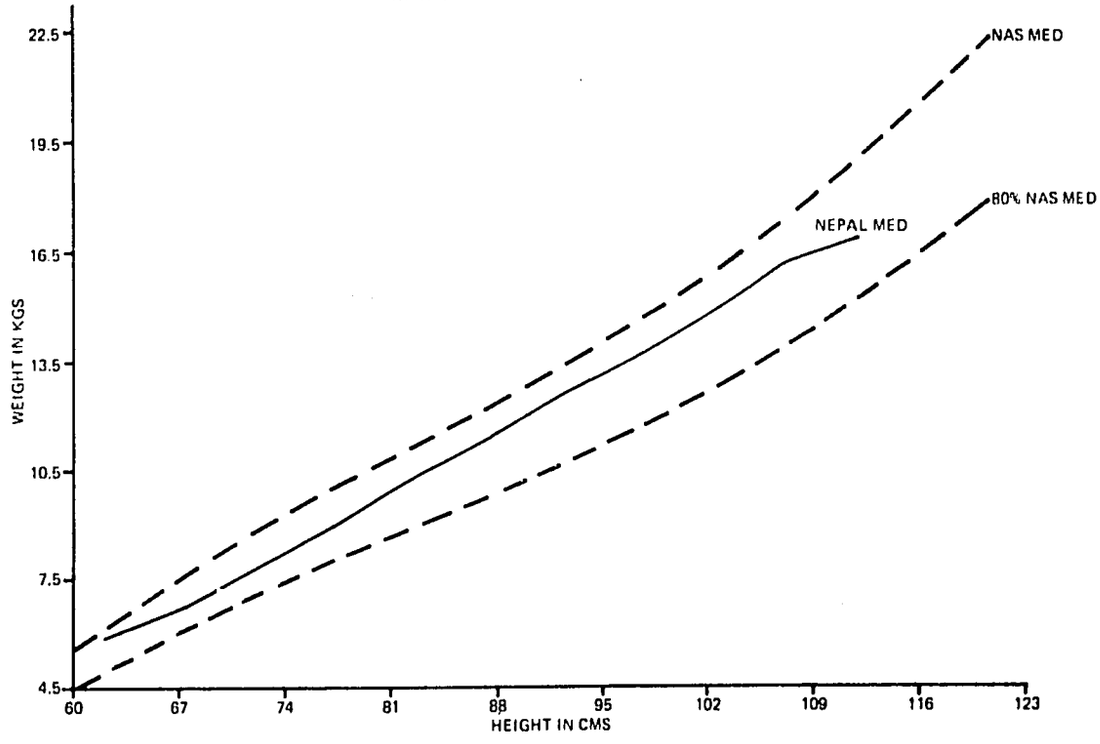


Table 7
Height-for-Age
Percentage of Nepal Survey Population
by % of NAS Reference Height-for-Age Median
by Geopolitical Divisions

Percent of NAS Reference Median

Population	<80%	80-82.4%	82.5-84%	85-87.4%	87.5-89%	90-92.4%	92.5-94%	95+%	Total %	Sample Size
Total Rural Nepal	3.5	4.2	9.3	15.0	19.9	18.6	15.3	14.3	100	(6569)[1]
Development Regions										
Far West	4.0	3.8	9.7	16.6	21.3	16.7	14.6	13.3	100	(1735)
West	4.2	4.6	10.5	15.5	20.4	18.3	13.7	12.8	100	(1593)
Central	2.4	4.3	8.5	14.7	19.6	20.3	16.3	13.8	100	(1741)
East	3.4	4.2	8.6	13.4	18.8	18.4	16.1	17.0	100	(1500)
Terrain										
Hill	3.8	4.5	10.5	16.6	20.2	18.8	13.9	11.7	100	(3992)
Terai	2.6	3.9	6.9	12.4	19.3	19.0	17.2	18.7	100	(2158)
Subregions										
Far West-Hill	4.4	3.7	10.4	17.4	20.9	18.3	14.0	10.9	100	(1139)
West-Hill	3.4	4.7	10.3	16.3	20.5	18.3	14.4	12.2	100	(1051)
Central-Hill	3.2	5.1	10.5	16.0	19.9	20.5	14.0	10.8	100	(901)
East-Hill	4.4	4.8	10.6	16.5	19.0	18.8	13.1	12.8	100	(901)
Special Group	0.4	0.4	1.2	5.3	11.5	17.2	23.8	40.1	100	(487)

[1]Actual sample size of population in parenthesis.

of reference median height-for-age division are in the 82.5%-89.9% of reference median category.

In the Special Group only 18.8% of the children are in the less than 90% of median height-for-age category.

Table 8 presents height-for-age data for those children less than 90% of NAS reference median height-for-age by age groupings.

Table 8
Percentage of Nepal Survey Population less than 90% of NAS Reference Median Height-for-Age by Age

Population Group	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Sample Size Total
Total Rural Nepal	22.7% (692)[1]	47.7% (1265)	52.3% (1079)	58.8% (1163)	62.7% (1124)	55.4% (1275)	(6598)
Special Group	16.7% (24)	12.1% (66)	14.8% (61)	15.0% (120)	24.4% (135)	25.0% (80)	(486)

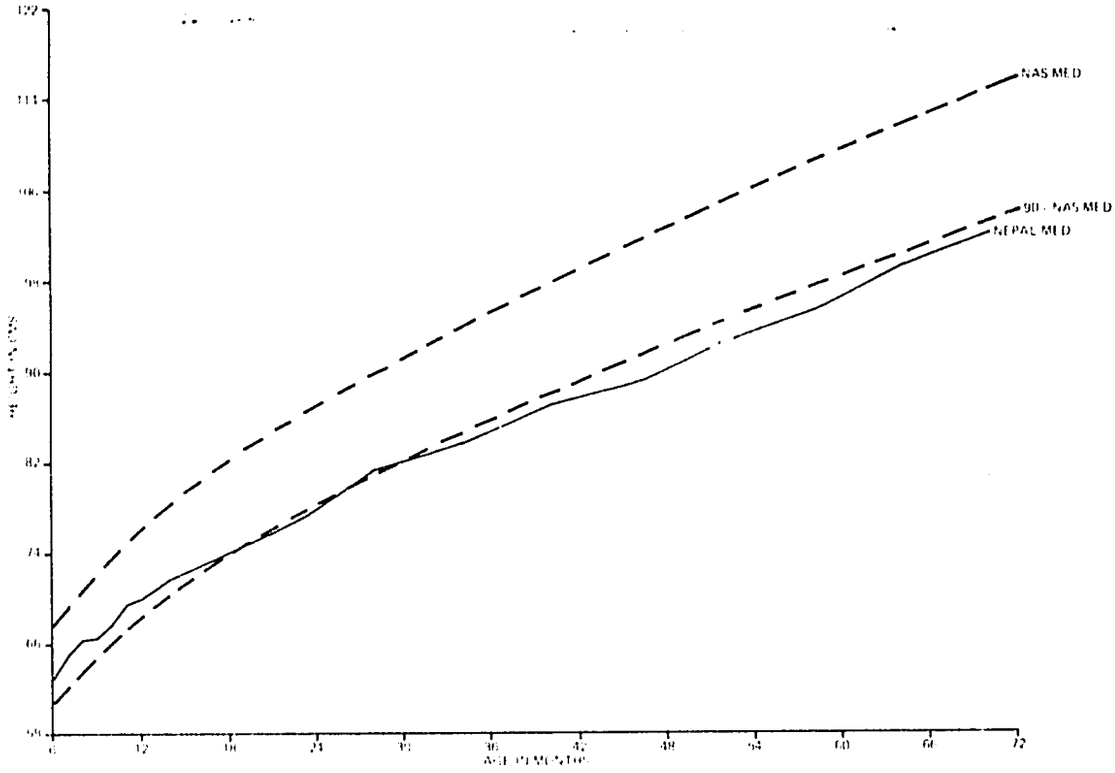
[1]Actual sample size in age group in parenthesis.

In both Total Rural Nepal and Special Group a significant degree of stunting is seen as early as 6-11 months.

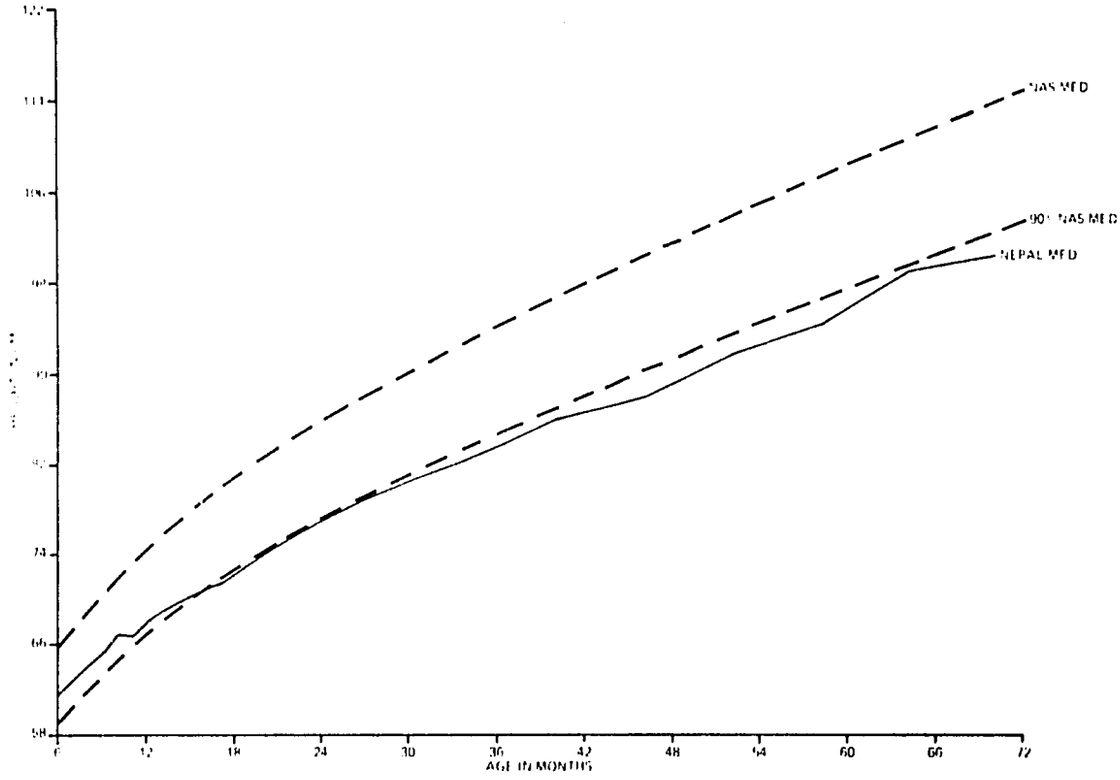
Figure 5 displays by sex the Rural Nepal median height-for age as a curve compared with the NAS reference population median and 90% of median height-for-age curves.

Figure 5

COMPARISON OF RURAL NEPAL SURVEY POPULATION MEDIAN HEIGHT-FOR-AGE WITH NAS REFERENCE POPULATION – BOYS 6-72 MONTHS



COMPARISON OF RURAL NEPAL SURVEY POPULATION MEDIAN HEIGHT-FOR-AGE WITH NAS,REFERENCE POPULATION – GIRLS 6-72 MONTHS



E. Summary of Weight-for-Height and Height-for-Age Data

Data from Tables 7 and 8 are summarized in Table 9. Using the overall rural survey population parameter distributions to compare with geopolitical units, a significant difference in both measurement parameters exists between the Hill and Terai Terrains. If the Terai Terrain is then subdivided into East-Central Terai and Far West-West Terai, the former shows the most marked deficit in weight-for-height and the least deficit in height-for-age of any geopolitical unit. In the Hill Subregions which show an overall poorer status in height-for-age, the East-Hill Subregion shows a relatively low prevalence of weight-for-height deficiency of 3.2%.

F. Weight-for-Age

The distribution of weight-for-age data for Rural Nepal and Subregions is detailed in Appendix H.

Nearly half of the total Rural Nepal survey population is below 75% of reference median (combined 2° and 3° Gomez classification). The Far West Development Region shows the greatest deficit. The Special Group shows less than 1.0% in the combined 2° and 3° malnutrition Gomez classification of weight-for-age (14).

Table 9

Percentage of Nepal Survey Population Below 80% of NAS Median Weight-for-Height or Below 90% of Median Height-for-Age by Geopolitical Division

	Weight/Height Percent <80% of NAS Median	Sample Size	Height/Age Percent <90% of NAS Median	Sample Size
Total Rural Nepal	6.6	(6562)	51.9	(6569)[1]
Development Regions				
Far West	7.1	(1734)	55.5	(1735)
West	5.7	(1592)	55.3	(1593)
Central	7.1	(1738)	49.6	(1741)
East	6.0	(1498)	48.5	(1500)
Terrains				
Hill	5.8	(3988)	55.5	(3992)
Terai	8.7	(2156)	45.1	(2158)
Subterrains				
Far West-West Hills	6.3	(2190)	55.9	(2190)
Far West-West Terai	7.2	(958)	47.8	(959)
East-Central Hills	5.1	(1798)	55.0	(1802)
East-Central Terai	9.3	(1198)	44.0	(1199)
Subregions				
Far West-Hill	7.6	(1139)	56.8	(1139)
West-Hill	5.3	(1051)	55.2	(1051)
Central-Hill	7.0	(898)	54.7	(901)
East-Hill	3.2	(900)	55.4	(901)
Special Group	1.9	(486)	18.8	(486)

[1]Actual sample size of population in parenthesis

Table 10 shows the age distribution of weight-for-age by Gomez classification. The highest percentage for combined 2° and 3° malnutrition Gomez classification is in the 12-23 month age group.

Table 10
Percentage of Nepal Survey Population
by Gomez Classification[1] for Weight-for-Age
(NAS Reference Population)

Malnutrition by Gomez Classes Total Rural Nepal	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Total (6-72)	Sample Size[2]
Normal	9.0%	3.9%	7.6%	8.1%	8.1%	8.2%	7.3%	(695)
First Degree	42.4%	35.2%	44.2%	49.5%	42.9%	42.7%	42.7%	(2575)
Second Degree	41.6%	53.1%	43.9%	38.4%	45.6%	44.4%	44.8%	(2949)
Third Degree	7.0%	7.8%	4.3%	4.0%	3.4%	4.7%	5.1%	(347)
Total Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	(6566)

[1]Gomez Classification (14)

Normal = 90+% of reference median weight-for-age
First Degree = 75-89.9% of reference median weight-for-age
Second Degree = 60-74.9% of reference median weight-for-age
Third Degree = <60% of reference median weight-for-age

[2]Actual sample size for age group in parenthesis.

(A modified classification of Gomez's categories of malnutrition based on weight-for-age was adopted by the nutrition subcommittee of the Indian Academy of Pediatrics in 1972 (15). Details of the classification and the presentation of Nepal data using this classification are in Appendix H.)

G. Arm-Circumference-for-Height and Skinfold-for-Age

The Ten-State Nutrition Survey data are used as the reference for arm-cirumference-for-height measurements. A cutoff of 82.5% reference median, below which is defined as abnormal, was arbitrarily selected. Distribution of the survey population is shown in Appendix H.

The data in Table 11 show increasing percentages below 82.5% of reference median for increasing age, a trend also noted for weight-for-height less than 80% of reference median by age groupings. However, since arm circumference anthropometry in the Nepal Survey is only weakly correlated with other anthropometric indices the strength of trend comparisons is unknown (see Appendix G.)

Table 11
Percentage of Nepal Survey Population less than 82.5% of 10-State Nutrition Survey Reference Median Arm-Circumference-for-Height by Age Grouping

Population Group	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Sample Size Total
Total Rural Nepal[1]	4.1%[2] (692)	7.9% (1265)	5.7% (1079)	5.1% (1163)	5.6% (1124)	5.4% (1275)	(6578)
Special Group	0.0% (22)	0.0% (66)	1.6% (61)	0.0% (120)	1.4% (135)	1.3% (80)	(486)

[1]Percentages calculated from weighted data.

[2]Actual sample size for age group in parenthesis.

The Tanner skinfold-for-age reference population is used for describing the Nepal survey data. Arbitrarily, less than 60% of Tanner reference median is chosen as abnormal. The percentage abnormal in each age group decreases as age increases (Table 12).

Table 12
Percentage of Nepal Survey Population less than 60% of Tanner Reference Median Skinfold-for-Age by Age Grouping

Population Group	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Sample Size
Total Rural Nepal	69.5%	70.2%	42.9%	33.8%	33.5%	46.8%	(2681)

This trend resembles that seen in weight-for-age by age grouping. As in arm circumference data, skinfold measurements correlations with height, weight, and age measurements are weak (Appendix G.)

H. Caste

Distribution of Brahmin and Chhetri populations are shown in Table 13 for Total Rural Country and for Hill and Terai Terrains.

Table 13

Percentage[1] of Nepal Survey Populations by Caste

Area	Caste Brahmin	Chhetri	Other	Sample Size
Total Rural Country	18.4%	21.0%	60.6%	(6573)[2]
Terrain				
Hill	21.9%	29.4%	48.6%	(3988)
Terai	10.4%	7.6%	82.0%	(2165)

[1]Percentages calculated from weighted data.

[2]Actual sample size of population in parenthesis.

Tables 14 and 15 describe percentages of Brahmin, Chhetri, and other by Total Rural Country and Hill and Terai Terrains falling below reference medians for weight-for-height and height-for-age.

Data on caste indicate wasting to be a problem in the Brahmin caste country-wide. The highest prevalence of wasting in any region is in the Hill Brahmins. In the Terai, the category "other people" has the highest prevalence of wasting. The data on stunting showed no differences between caste categories. The difference in stunting already noted to exist between Hills and Terai Terrains is, again, seen when castes are individually compared for Hill and Terai.

Table 14
Percentage[1] of Nepal Survey Population
Below 80% of Reference Median Weight-for-Height
by Caste

Population	Caste Brahmin	Chhetri	Other	Total	Sample Size
Total Rural Nepal	8.3%	5.8%	6.5%	6.8%	(6573)
Terrain					
Hill	10.6%	5.5%	3.8%	5.8%	(3988)
Terai	6.2%	6.3%	9.2%	8.5%	(2165)

[1]Percentages calculated from weighted data.

Table 15
Percentage[1] of Nepal Survey Population
Below 90% of Reference Median Height-for-Age
by Caste

Population	Caste Brahmin	Chhetri	Other	Total	Sample Size
Total Rural Nepal	51.2%	50.6%	52.6%	51.9%	(6573)
Terrain					
Hill	55.4%	50.1%	59.0%	55.5%	(3988)
Terai	35.9%	43.3%	46.4%	45.1%	(2165)

[1]Percentages calculated from weighted data.

I. Pedal Edema

The results of the clinical examination for bilateral pedal edema disclosed only 29 children with this sign for an overall rate of 4.6/1000 children 6 to 72 months surveyed. In 3,457 children below the 90 percent reference median

height-for-age, 27 had bilateral pedal edema, a rate of 7.8/1000 children in this category. The pedal edema rate for the 476 children below the 80 percent reference median weight-for-height was 35.2/1000. In the most severely undernourished category, that is, the 259 children falling below both the 80 percent weight-for-height and 90 percent height-for-age reference medians, the rate was 81.7/1000 children.

While pedal edema is an important clinical sign for the diagnosis of severe protein-energy undernutrition, its prevalence in Nepal is so low that it may not be useful for ongoing surveillance of nutritional status.

J. Anemia Levels as Measured by Hemoglobin Determinations

Table 16 provides mean hemoglobin values individually corrected for the effects of altitude on hemoglobin levels and the percent of hemoglobin values below normal by age groupings. With altitude effects removed, no difference in mean hemoglobin values between the Hill and Terai geopolitical divisions remains.

Table 16

Nepal: Mean Hemoglobin Values (Corrected for Altitude)[1] for Total Country and for Hill and Terai and Percent Below Normal by Age Groupings

Age in Months	Hill gms/100cc	Terai gms/100cc	Total Country gms/100cc	Number of Hemoglobins	Percent of Low Hemoglobins[2]
6-11m	11.1	11.0	11.1	96	18.6
12-23m	11.4	11.2	11.2	223	19.9
6-23m			11.2	319	19.5
24-35m	11.6	11.3	11.4	189	39.2
36-47m	11.9	11.5	11.7	240	25.5
48-59m	11.9	12.2	12.0	238	23.0
60-72m	12.1	12.3	12.2	279	18.8
24-72m			11.9	946	25.7
6-72m			11.7	1265	24.1

[1]In the Nepal survey age groupings, a correction factor of 0.2 gms Hbg for each 2500 ft. altitude interval was systematically used in determining mean hemoglobin values corrected for altitude. (Reference - Sauberlich, H.E., R.P. Dowdy, J.H. Skola: "Laboratory Tests for the Assessment of Nutrition Status." CRC Press, Inc., Cleveland, Ohio, 1971, pp. 114-124.)

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

K. Prevalence of Naturally Acquired Measles by Serological Survey for Antibodies

A total of 1146 sera were available for measles antibodies determinations by the hemagglutination inhibition method. Table 17 shows the age prevalence distribution for the total rural population and for the Hill and Terai sub-populations.

Table 17
Percentage[1] of Sera Positive for Measles Antibodies by Age for Nepal Survey Population

	Percentage Positive by Age						Total Sera
	6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	
Total Rural Country	9.7% (82)[2]	18.2% (197)	32.4% (175)	36.7% (222)	48.3% (215)	52.3% (255)	(1146)
Terrain							
Hills	7.5% (53)	10.9% (121)	27.5% (97)	28.3% (130)	41.1% (123)	48.6% (145)	(669)
Terai	8.5% (28)	22.4% (72)	43.1% (66)	51.7% (74)	57.3% (77)	62.1% (89)	(406)

[1]Percentages calculated from weighted data.

[2]Number of sera in parenthesis.

V. Discussion

The Nepal Nutrition Status Survey was designed and executed on as statistically ideal a basis as was feasible within the constraints of field logistics and money. A systematic approach to assessing observer measurements was used during training and field activities, and after the survey to document the quality of information collected. Age, height, and weight measurements are all highly interrelated in the survey and the accuracy and consistency of measurement of these variables is of high degree (Appendix C). The survey design and techniques of the Nepal Survey methodology are workable and reasonable approaches for obtaining statistically valid baseline data on nutritional status.

The separation of protein-energy undernutrition into components of wasting and stunting suggests the magnitude and genesis of the nutritional problem (10, 12). Wasting requires and may respond to a relatively quickly instituted short-term remedial program. Stunting is an indicator of long-term deficiencies not correctible by short-term remedial programs, and implies the need for an approach to correction emphasizing prevention, education and agricultural innovation. The combination of weight-for-height and height-for-age anthropometric indices provides an indication of the effect of both acute and chronic protein-calorie deprivation on nutritional status, an important factor in establishing the type of response to make.

Protein-energy undernutrition in rural Nepal is a general problem the proportions and makeup of which differ in various geopolitical units, as indicated by the Waterlow categories of normal, stunting, wasting and concurrent wasting and stunting (11) for specific areas (Table 18).

In a country as internally variable as Nepal in terrain, communications, agriculture, etc., the area differences are not unexpected. These same variables may help determine priorities for the type and extent of remedial programs that might be instituted.

Realistic interpretation of total rural Nepal data and subregion data is aided by the data from the Special Group drawn from Kathmandu and Patan cities. While the ethnic composition of the Special Group is not as heterogeneous as the mixed composition of the rural survey group, the anthropometric indices for the Special Group do indicate a relatively superior growth level that one Nepalese subpopulation has obtained given a better socio-economic status. These values may be a realistic attainable target for Nepal as a whole.

If, as Waterlow suggests (11), the concurrent wasting and stunting sector of undernutrition calls for some type of priority action, then 3.8% of Nepal's 1.8 million rural children 6-71 months of age have priority needs (between 57,000 and 80,000 children with 95% confidence) (Table 18). These children are suffering the

Table 18
Percentage Distribution of Children 6-72 Months of Age by Classification of Stunting and Wasting for Nepal for Total Survey Population and Other Geopolitical Divisions

	Percentage				
	Normal	Stunting	Wasting	Wasting and Stunting	Sample Sizes
Total Rural Nepal*	45.3%	48.1%	2.8%	3.8%	(6567)
Development Regions*					
Far West	41.9%	51.1%	2.8%	4.4%	(1735)
West	42.8%	51.5%	2.1%	3.8%	(1593)
Central	46.9%	45.5%	3.5%	4.2%	(1741)
East	48.6%	45.4%	3.0%	2.9%	(1498)
Terrain*					
Hill	42.2%	51.9%	2.1%	3.6%	(3991)
Terai	50.5%	40.7%	4.3%	4.4%	(2157)
Subregions*					
Far West-Hill	40.2%	52.3%	3.0%	4.5%	(1139)
West-Hill	43.1%	51.5%	1.7%	3.7%	(1051)
Central-Hill	42.6%	50.5%	2.7%	4.2%	(901)
East-Hill	43.3%	53.5%	1.2%	2.0%	(900)
Special Group	79.9%	18.2%	1.2%	0.6%	(486)
NAS Reference Population	98.7%	0.4%	0.8%	0.0%	(4947)

*Percentages calculated from weighted data.

long-term effects of chronic protein-calorie undernutrition causing the arrest of linear growth and in addition are showing an acute deficit which has caused a disproportionate weight loss putting them into a critical status. In this undernutrition category, a pedal edema rate of 81.7/1,000 children is also found, indicating kwashiorkor. At best, if compared with the Special Group taken as an attainable target for rural Nepal, 3.2% of rural Nepalese children 6-71 months of age compose the priority target group (between 47,000 and 69,000 children with 95% confidence).

Wasting implies a recent acute imbalance between nutrition need and intake. Without prior knowledge of a short-term famine or acute nutrition disaster affecting the entire of Nepal, we did not expect to find a large percentage of wasted children. However, for total rural Nepal, 6.6% of the survey children are wasted (wasting plus concurrent wasting and stunting). This is more than three times the percent found in the Special Group. The figure of 6.6% includes the unmeasured effects of acute infectious disease, agricultural harvest deficits and other unknown problems occurring to upset the delicate nutritional balance of the population. The Terai and especially the Eastern Terai are markedly worse off by this index. As the data were collected in the few months after the rice harvest and before the next planting, the food supplies generally should not have been depleted.

In Nepal the distribution of wasting by age group indicates that infants and children through 35 months are most seriously affected. This pattern could indicate general maternal inability to provide adequate milk, poor quantity and quality of weaning foods and the young child's inability to compete successfully in the family food chain. The same pattern, but not as severe, is noted in the Special Group (Table 19).

Stunting or the influence of chronic undernutrition is very prevalent throughout Nepal. The problem of stunting (stunting plus stunting and wasting) is highest in the Hill Terrain and lowest in the Central and Eastern Terai (Table 18). The Eastern Terai population is twice that of the Western Terai and is the most agriculturally productive area of Nepal. The Western Terai is agriculturally more productive per population unit than the Hill Terrain.

Stunting is found at a very early age in Nepal. Those initially stunted probably remain permanently behind in linear growth. With each succeeding year, others who fail to obtain adequate nourishment to provide for both growth and day-to-day nutrition needs slip into the stunting category. The survey suggests that longitudinally over the 72 months preceding the survey, nutrition had been generally better in the Terai, especially in the Eastern Terai, than in the Hills (Table 19). Length at birth data are not available to use in interpreting the Nepal data.

Table 19
Age Specific Percentage Distribution
by Classification of Stunting and Wasting
for Nepal Survey Population and Special Group

Age Groups	Percentage				
	Normal	Stunting	Wasting	Wasting and Stunting	Sample Sizes
Nepal Survey[1] Population					
6-11m	71.4%	20.6%	6.9%	2.2%	(692)
12-23m	45.9%	38.8%	6.5%	8.8%	(1265)
24-35m	43.9%	47.0%	3.7%	5.2%	(1079)
36-47m	40.4%	56.2%	0.8%	1.7%	(1163)
48-59m	36.5%	61.0%	0.7%	1.6%	(1124)
60-71+m	43.8%	54.3%	0.7%	1.2%	(1255)
Special Group					
6-11m	83.4%	16.7%	0.0%	0.0%	(24)
12-23m	86.3%	10.6%	1.5%	1.5%	(66)
24-35m	81.9%	13.1%	3.3%	1.6%	(61)
36-47m	85.0%	14.2%	0.0%	0.8%	(120)
48-59m	73.3%	24.4%	2.2%	0.0%	(135)
60-71m	75.1%	25.1%	0.0%	0.0%	(80)

[1]Percentages calculated from weighted data

Weight-for-age has been widely used as an index of undernutrition so the data are included for comparison with other studies. However, weight-for-age obscures the separate contributions of wasting and stunting and is not easily interpretable.

Because an anthropometric reference population common to arm circumference-for-height and weight-for-height is not available, correlations as indicators of interchangeability cannot be calculated. However, the weak individual correlations between actual measurements of arm circumference and weight, height, and age suggest that arm circumference data for Nepal are less accurate and less reproducible than weight data, and not as useable in overall data interpretation (Appendix G). The same problems are apparent when Nepal Survey skinfold data are analyzed. In a population where undernutrition, rather than obesity, is the major problem, skinfold measurements are of very limited value.

The constraints of survey design do not allow for inferences to be drawn on the mountain terrain of Nepal, where only 16 survey sites were located by population proportional sampling. Recognizing the sparse population density of the mountains and the imposing problems of transport and communications, the high cost of obtaining adequate data to meet statistical needs by enrichment sampling was prohibitive. In addition the feasibility

of responding to any nutrition problem recognized was considered by the Nepal authorities less likely. Data from these survey sites are included in the data results for the appropriate development regions. In no region do they make up more than 10% of the total data of a region. The data are also proportionately represented in the total rural Nepal analysis. The anthropometric data on the 419 children surveyed in the Mountain terrain are distributed in categories as follows: normal, 39.6%; stunting, 57.7%; wasting, 0.7%; and concurrent wasting and stunting, 2.4%.

Anemia levels as determined by hemoglobin measurements in young children are predominantly a reflection of long-term dietary iron availability. The effect of increasing altitude is to increase individual hemoglobin values, obscuring the combined analysis of populations at different altitudes. The subtraction of 0.2 gm per 2,500 foot altitude increment above 2,499 feet removes this effect (16). Independent analysis of hemoglobin values related to long-term dietary availability is then possible.

Anemia is a nutritional problem in Nepal. Anemia is defined in the 6-23 month age group as a hemoglobin less than 10 gm/100cc of blood and in the 24-72 month age group as a hemoglobin less than 11 gm/100cc of blood (16). Anemia was observed in 19.5% of the 6-23 month age group and 25.9% of the 24-72 month age group. No significant differences were found between Hills and

Terai. The survey design did not provide enough sera to allow for subregion comparisons.

In rural Nepal, 26.8% of individuals who are chronically undernourished (height-for-age <90% of NAS median) are anemic compared to 21.9% anemia level in individuals considered normal by anthropometric indices. Because of insufficient numbers of specimens, this comparison cannot be extended to the acutely undernourished (weight-for-height <80% NAS median) group of individuals.

Infectious diseases such as measles are among many factors influencing the nutrition of preschool children. Measles can precipitate a borderline nutritional status into acute undernutrition by causing weight loss leading to a weight-for-height ratio of less than 80% of expected and, in the extreme instance, to the appearance of pedal edema. Measles is particularly important because it is universal, and can now be prevented by immunization. Measles antibody determinations are done by a micromethod using blood collected on filter papers. Vaccinations for measles have not been done in rural Nepal.

The survey data show an age related increase of the prevalence of measles antibodies, with slightly more than 50% of 5-year-olds having acquired antibodies. There are different antibody patterns between the Hill and Terai terrains. In the Hills

where travel is difficult, populations isolated, and houses not tightly grouped together, the onset of measles is delayed. In the Terai where travel is easier and populations therefore less isolated and houses more tightly clustered, the young susceptibles are more likely to have opportunities to come in contact with the virus. Therefore in the Terai, there are higher measles prevalences in earlier age groups than in the Hills.

The naturally acquired measles antibody pattern of Nepal is midway between that of West Africa, where prevalence at age 71 months is higher, and that of a Western country. The measurable effect of measles on nutritional failure in Nepal cannot be learned from the survey. Prevalence distribution is part of the information necessary for decision making if a country is contemplating measles intervention by immunization. Prevalence distribution helps determine what age groups should be the target for this relatively expensive vaccine.

The Nepal Nutritional Status Survey defines the "where" and the "extent" of the problem of protein-energy undernutrition and anemia in Nepal for January through April 1975. Within the constraints on interpretation of survey results a baseline of nutrition status for Nepal emerges which the Government of Nepal can use as a guideline in determining methods and priorities of intervention. The present survey results note the Eastern Terai as the area of greatest acute undernutrition and the Hill Terrain as the area of greatest chronic undernutrition. Remedial programs and priorities are unlikely to be the same for both conditions and many other factors should be involved in establishing priorities and designing intervention programs suitable to effect change. Concurrently, plans should be made to assess the effect of intervention. Assessment involves ongoing surveillance and, possibly, occasional limited surveys. The methods are not mutually exclusive, but each has its real limitations, especially, in cost and in the quality of collected data.

The assessment of intervention should attempt to utilize already existing infrastructure. For ongoing surveillance, data on anthropometry, pedal edema, infectious disease, infant mortality, agricultural productivity and food prices can be collected by personnel in existing health clinics, agricultural extension offices and teachers in schools. These data can be systematically

reviewed as indicators of seasonal and yearly trends in the presence or absence of established intervention programs. In those areas where the effects of intervention are expected to be demonstrated over a longer period of time, or in which trends suggested by ongoing surveillance need to be verified, an occasional well-designed survey using anthropometry should provide reliable data for comparison with area results of the 1975 Nepal Nutrition Status survey. Since nutrition will be affected by agriculture, education, economics, and health, changes in nutritional status will have to be interpreted in light of information on the general socio-economic development of Nepal.

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VII. Appendices

APPENDIX A - SAMPLING AND DATA PROCESSING CONSIDERATIONS

Self-Weighting Sampling and Modifications (Enrichment) for Nepal

A self-weighting sample where each of the ultimate sampling units (children 6 months through 71 months of age) contribute equally to universe (country) estimates is desired for data processing because forms are then processed for universe estimation (country-wide) without regard to geographic location in the universe. Self-weighting is only practical when the subregions of the universe, for which statistical inferences are desired, are approximately equal in population size for the 6-71 month age group. If self-weighting sampling technique was applied to a universe composed of subregions of varying population sizes so that the smallest sub-region has sufficient sample sites, then all other subregions have a larger number of sample units than the minimum necessary for estimation purposes for any one sample subregion.

In non self-weighting sampling, the universe estimation requires the use of the inverse of the sampling fraction for each subregion. In Nepal, a self-weighting sample of 146 sample sites was drawn that provided sufficient sample site numbers for statistical estimates in each development region and in the Hill and Terai terrains. To allow for inferences to be made on the Hill sub-regions, the number of sample sites was modified by decreasing the sampling interval by a factor of .5000 for five subregions and by a factor of .6667 for one subregion, in effect "enriching" these

subregions and increasing the total survey sample sites to 221. For data analysis the weights of the individual forms in these subregions were corrected by factors of .5000 (1/2) and .6667 (1/1.5), respectively, for their individual effect on the universe. Essentially rural Nepal estimates are calculated from six subregions in which each form has a factor value of 1; from five subregions in which each form has a factor value of .5000; and from one subregion in which each form has a factor value of .6667.

APPENDIX B - DETERMINATION OF SURVEY SAMPLE SIZE

A number of factors enter into the determination of sampling specifics for a statistical study. These include:

(a) Available financial and physical resources.

(b) Constraints affecting the survey in the field such as time and logistical problems.

(c) Nature of the sample distribution assumed applicable.

(d) Precision desired and the confidence level to be associated with it.

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."

The formula for n is:

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

Past experience with Stuart-Meredith 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 usually 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. Computation of precision estimates for every tabulation provided in the report would require substantial computer time and was not done. Proportions less than 5% do meet standards of statistical reliability in the survey except for subregion estimates.

APPENDIX C - NEPAL SAMPLING PROCEDURE

1. The Nepal survey universe was defined as the rural Nepal population and, therefore, the population of Kathmandu Valley and all town panchayats were excluded.
2. Survey design required 221 sample sites to permit the required inferences to be made.
3. Using the 1971 Nepal Census village line-listing by population, a fixed interval method of population proportionate sampling was applied to the rural Nepal population.
   a. The populations of all villages within the universe was cumulated.
   b. The cumulated total rural population was divided by 146 to obtain a sampling site interval.
   c. A starting number within the bounds of the sampling site interval was randomly selected.
   d. The village including this number in its cumulative population was identified as sample site number 001.
   e. The sample site interval was added consecutively to the starting number 146 times.
   f. With each addition the village with the number in its cumulated population was identified as a sample site.
4. The required 221 sample sites were arrived at by using .5000 and .6667 of the sample site interval in respective subregions where "enrichment" was required to obtain a sufficient number of sample sites for an inference to be made.

5. In the villages chosen as sample sites the first household for each site was selected by either of two methods:
   a. A household list (i.e., tax list or census tract) was obtained. Households were assigned sequential numbers and the first household was identified by taking a random number.
   b. Or,
      i. Geographic groupings of households and the approximate number of households in each group were ascertained from the village leaders. The number of households in each grouping was systematically cumulated. A random number identified the grouping in which the first household was located.
      ii. This procedure was then repeated on subgroups of the identified group of households so that a subgroup unit of 10 or less households was identified. As at least 10 households were required to obtain 30 children, any household in the group of 10 could be done first.
6. 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 6 and 71 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

7. When more than one child in the 6-71 month age group lived in a household, a survey form was completed on each of these children.

8. The second and subsequent households included in the survey were the next geographically closest houses. This procedure was followed until 30 children had been surveyed.

9. Households without children in the 6-71 month age group were assigned household numbers in the sequence encountered.

10. If in a selected household group or village 30 children were not obtained, the geographically closest household group or village was entered at its geographically closest point and the survey unit completed.

11. If a preselected village was found abandoned, then the geographically closest village was used as a sample site.

12. No household number was assigned to an abandoned or temporarily vacant household.

APPENDIX D - REFERENCES AND DATA COMPARISONS

1. Choosing a Reference Population

Data have to be organized before they can be interpreted. For practical purposes the distribution of characteristics is most important. Values to be useful must be categorized into normal or abnormal or similar classifications. In a survey using anthropometric measurements, distribution cutoffs for category inclusion can be arbitrarily based on the survey range or can be arbitrarily decided on by utilizing experience gained from a similar survey as a reference.

Reference populations used in anthropometry are frequently criticized as not being applicable to developing areas of the world. Because of this, problems arise in methods of assessing the deficits in height and weight on a survey population in order to quantitate the size of the problem. In preschool growth studies, the influences of environment, such as nutrition and infectious disease, are of much greater importance than those of race or ethnicity. The differences in growth of preschool children associated with social class are many times those attributable to ethnic factors alone. The probable degrees of the genetic effect on height-for-age and weight-for-age growth indices are approximately 3% and 6%, respectively, among children from different ethnic backgrounds but similar socio-economic class (13). Weight-for-height in pre-pubertal children

indices are for the practical purposes of nutritional surveys independent of age and race and are a direct reflection of nutritional state.

Waterlow suggests that a reference be used as a basis for a value judgment--normal or deficient (4). If used as a reference and not as a standard or target, then the reference values are correctly used as a basis for the interpretation of survey results and not as a set of restrictive diagnostic criteria.

Two or more studied populations or repeated studies on one population can be compared if a reference for comparison is decided on and if the criteria for subject inclusion or exclusion, age determination and measurement methodology are the same. Although several reference populations are available for anthropometry, the so-called Stuart-Meredith populations, based on data collected on a relatively small number of children in Iowa and Boston during the 30's and early 40's, are most commonly utilized as a reference.

Specific limitations of the Stuart-Meredith data base are the small numbers of children involved, the longitudinal rather than cross-sectional gathering of data, the limited socioeconomic and ethnic representation, and the "oldness" of the data. The 10th and 90th percentile were based on so few people

as to severely limit statistical precision in these ranges. In developing areas, a significant proportion of individuals can fall below the 10th percentile, the very area where the Stuart-Meredith data base is statistically the weakest.

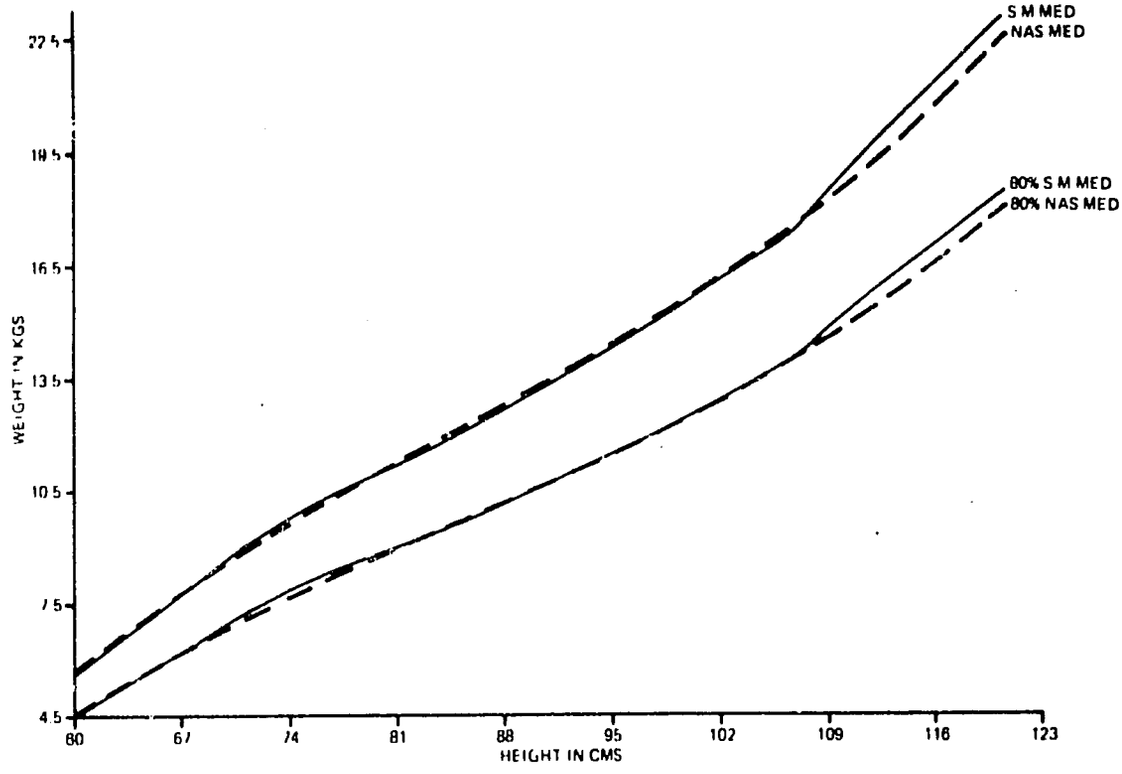
The recent availability of data from large-scale and more representative studies in the U.S. has resulted in more appropriate references for use in population comparisons, known as the National Academy of Sciences (NAS) reference populations for anthropometry. Specifically, the larger number of individuals characterizing the NAS reference population improves the statistical precision of outlying percentiles.

The general acceptance of a reference population for anthropometry is an international need. The choice of which reference to use for a single survey is probably unimportant. However, if multiple surveys are to be compared, it would seem reasonable that a single reference be agreed upon. Again, which reference is decided on for international use is unimportant. We have chosen to describe the Nepal survey findings using the NAS reference population.

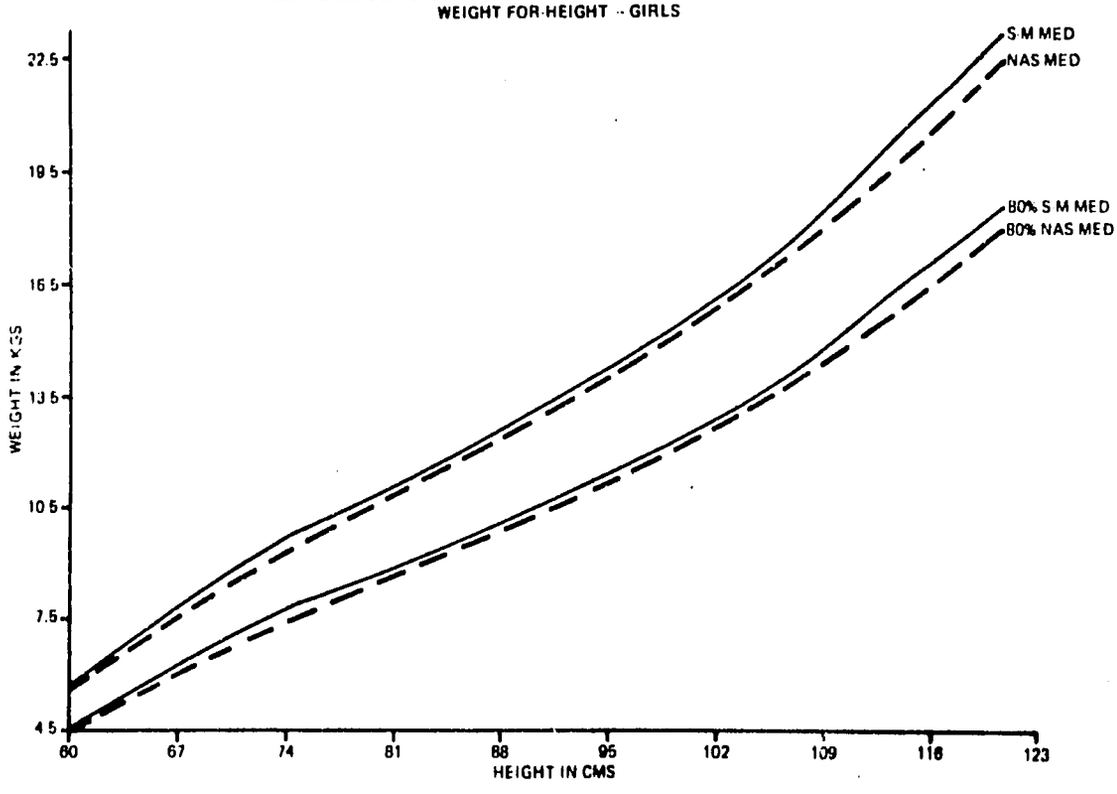
2. **Graphic Comparison of NAS and Stuart-Meredith References for Percent of Median for Weight-for-Height and Height-for-Age Indices. (Appendix D - Figure 1 and Figure 2.)**

Appendix D - Figure 1

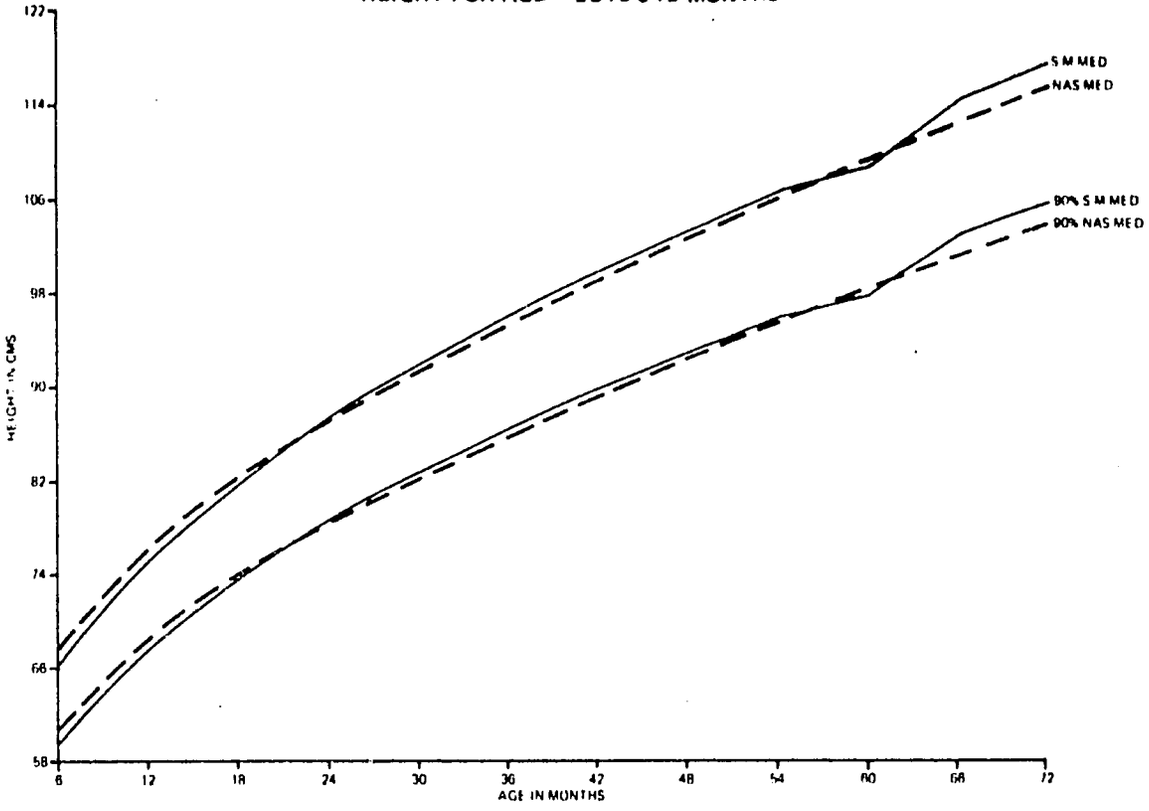
COMPARISON OF NAS AND STUART MEREDITH REFERENCE POPULATION
WEIGHT FOR HEIGHT BOYS



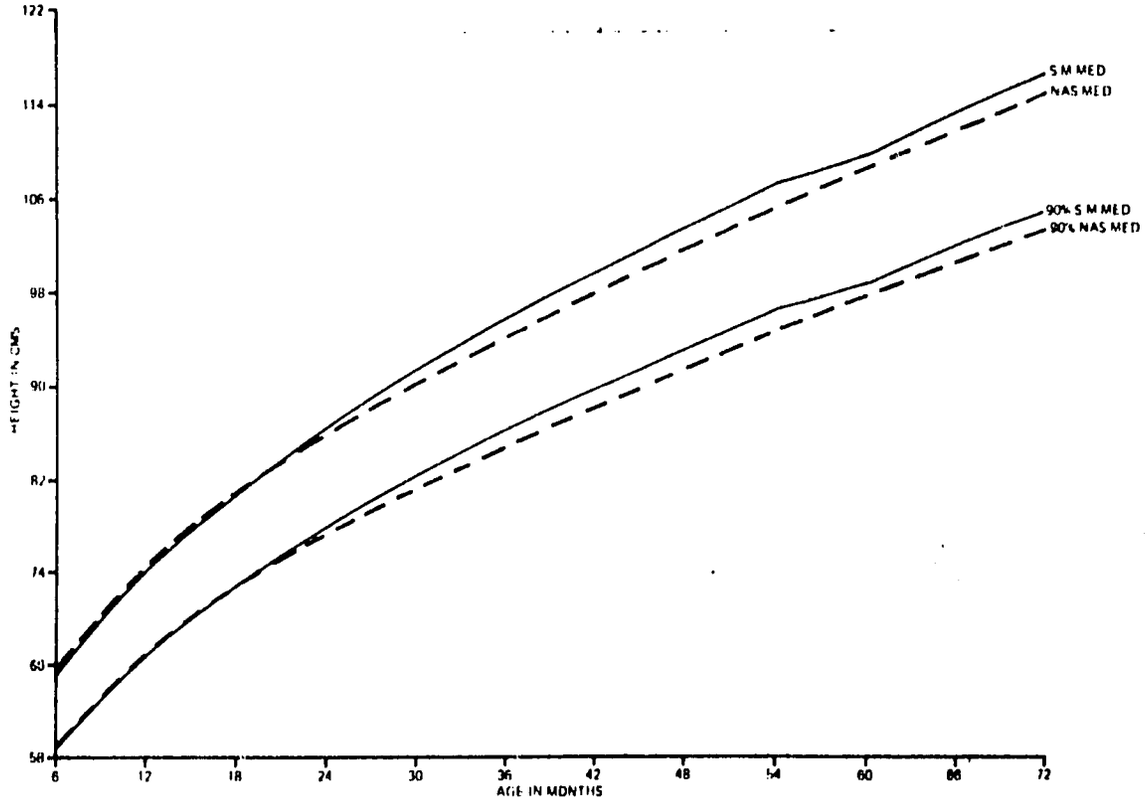
COMPARISON OF NAS AND STUART-MEREDITH REFERENCE POPULATION
WEIGHT FOR HEIGHT -- GIRLS



COMPARISON OF NAS AND STUART-MEREDITH REFERENCE POPULATION
HEIGHT-FOR-AGE – BOYS 6-72 MONTHS



COMPARISON OF NAS AND STUART-MEREDITH REFERENCE POPULATION
HEIGHT-FOR-AGE – GIRLS 6-72 MONTHS



APPENDIX E - PROCEDURES FOR ANTHROPOMETRIC MEASUREMENTS

Principles

Since physical growth is one of the best indicators of the nutritional status of children, its careful measurement is essential for adequate assessment of their nutritional status. Of the many measures of growth, total body length or height, weight and arm circumference are the measurements most frequently carried out and provide useful information. In practice, however, the accuracy and precision of these measurements is often unsatisfactory, so that anthropometric data commonly fail to attain their potential usefulness. Small between-group differences are important, but its significance may be obscured if the measurements have not been made with sufficient accuracy or precision.

There is a deceptive simplicity implied when discussing the doing of weight and arm circumference measurements. It seems to some that the recording of height and weight is so straightforward that it can readily be done with little attention or care. Triceps skinfold measurement can only be described as difficult to perform and practice is extremely important to produce consistency and accuracy. Adherence to the procedures which follow will appreciably minimize the most common sources of error.

A. Equipment

1. Measuring Board

- A combination height-length board with metric scale to 0.1 cm that has been custom made

2. Scale

- Salter hanging scale 25 scale with 0.1 kgm divisions
- Salter pants or seat
- Tripod, quadripod or other system to hang scale from

3. Arm Circumference Tape - Zerfas Tape

4. Skinfold Calipers - Holtain/Tanner-Whitehouse Calipers

B. Procedures

The measurements will be done in the following order:

Height/Length

Weight

Arm Circumference

Triceps Skinfold (performed on 1/5 of the total survey population)

1. Height or Length

The measurer estimates if the child is less or greater than 80 cm in height. Those actually 80 cm or less will then be accurately measured for length lying down; those actually greater than 80 cm are measured for height standing.

a. Length measurements

(1) The measuring board is laid horizontally on the ground or on a table.

(2) With the help of a minimum of two assistants the baby barefoot is placed on the board with the head against the fixed end of the board.

(3) An assistant holds the baby's head in the Frankfort plane and applies gentle traction to bring the top of the head into contact with the fixed end. (See C,3 of this appendix.)

(4) The measurer with the help of another assistant brings the child's knees together and the legs extended fully. The measurer uses one hand to insure that the child's feet are perpendicular to the board and brings the moveable footboard to rest firmly against the child's heels.

(5) The examiner reads the value of the length to the nearest 0.1 cm reading to the next higher 0.1 cm when the length falls midway or greater within an 0.1 cm graduation.

(6) The measurer then records the length clearly in the appropriate blocks on the questionnaire (blocks 42-45).

b. Height measurement

(1) The measuring board is in a vertical position.

(2) With the help of a minimum of two assistants, the child is positioned barefoot on the horizontal platform with his feet together.

(3) One assistant insures that the child stands flat-foot with the knees fully extended. The shoulders and buttocks should be in line with the heels and these should all touch the vertical surface of the measuring board.

(4) The moveable headboard is then brought to rest firmly on the crown of the child's head. The head is held in the Frankfort plane.

(5) As in a. (5) except substitute "height" for "length."

(6) As in a. (6) except substitute "height" for "length."

2. Weight

a. The Salter scale is suspended from a tripod or from a pole held by two assistants.

b. The child is undressed by the parent or guardian.

c. The parent holds the child: the measurer reaches his arms through the leg holes of the Salter pants and draws the legs of the child through the leg holes. He then attaches the Salter pants to the scale.

d. The child in Salter pants hangs freely from the scale. The scale face is read to the nearest 0.1 kgm reading up to the next higher 0.1 kgm when the pointer tip is midway or more within an 0.1 kgm graduation. The reading is made after the child settles down.

e. The measurer then records clearly the weight in the appropriate blocks on the questionnaire (blocks 30-41).

f. The child is then removed from the Salter pants and partially reclothed.

3. Arm Circumference

a. The child is held by the mother or guardian; the left arm and shoulder is bared.

b. With the arm hanging at the side the midpoint between the posterior tip of the acromion process of the scapula and the olecranon process of the ulna is determined using the Zerfas tape. This point is marked on the skin with a pen.

c. The Zerfas tape is looped around the upper arm and the distal free end of the tape inserted through the window and slot from behind.

d. The distal end of the tape is pulled until firm but gentle continuous contact is made with the arm circumference at the marked midpoint. The soft tissues of the arm are NOT to be compressed.

e. The measurer reads the value indicated between the opposing arrows to the nearest 0.1 cm leading to the next higher 0.1 cm when the arm circumference falls midway or greater with an 0.1 cm graduation on the tape.

f. The measurer then records the arm circumference value clearly in the appropriate blocks on the questionnaire (blocks 48-50).

4. Triceps fat-fold (a double layer of skin and subcutaneous fat)

   a. The child is held by the mother or guardian; the left arm and shoulder remain bare.

   b. The marked point directly over the left triceps earlier used in measuring arm circumference indicates the level of the mid upper arm and the level where the fat-fold is measured.

   c. The child's arm should hang loosely. The agent gently, but firmly, picks up the free fat-fold between the thumb and forefinger of his left hand directly over the triceps muscle and in line with the olecranon (posterior elbow). The grasped fat-fold should be immediately above the marked point showing the upper arm midpoint. The fat-fold is held clearly away from the underlying muscle all the time the measurement is being taken.

   d. The Holtain/Tanner-Whitehouse fat-fold calipers are applied gently to the fold of skin and fat immediately below the fingers of the left hand (1-2 cm) and parallel to the arm's long axis. The calipers are left in place after releasing the handle tension for no longer than 2 seconds before reading.

   e. The measurement to the nearest 0.5 millimeter is noted from the caliper's dial. The calipers are gently removed.

f. The measurer then records the value in the appropriate blocks on the questionnaire (blocks 51-53).

C. BEWARE!!

1. Assistants are necessary; in measuring children their strength and mobility cannot be overstated.
2. When measuring the arm circumference pulling the tape end tight enough to indent the skin contour produces INACCURATE READINGS.
3. The Frankfort plane is a plane perpendicular to the body constructed in profile by a line between the lowest point on the margin of the orbit of the eye and the highest point on opening of the ear. As much as 2 cm variation in height or length can be produced by flexing or extending the head out of the Frankfort plane.
4. Children, especially infants, have a tendency to extend their feet while lying or standing. Accurate height or length depends on a measurement from the heel.
5. As the skinfold measurement procedure tends to be uncomfortable, it should be done as the final measurement.

APPENDIX F - PROCEDURE FOR OBTAINING BLOOD SAMPLES

A. Fingerstick Procedure

The procedure requires both team members. The tasks outlined below for both team members are done concurrently.

1. Tasks for Team Member 1

   (a) Clean index finger or middle finger of patient's hand by rubbing with an alcohol swab. Allow area to dry. Turn patient's hand palm upward.

   (b) If you are right-handed, use the thumb and forefinger of your left hand to grip the patient's finger. (Be prepared for a sudden, instinctive withdrawal movement by the patient.)

   (c) If necessary, use a gentle "milking" motion of your fingers to stimulate flow of blood. Be careful to avoid too much pressure; this will cause tissue juices to be mixed with the blood and introduce error.

   (d) Using a dry gauze swab, wipe away the first two drops of blood.

   (e) Allow a drop of blood to form on the fingertip. Holding the pipet horizontally, touch the pipet to, but not into, this drop and allow the pipet to fill by capillary action. Hand to Team Member 2.

2. Tasks for Team Member 2

   (a) Take one unopette container from the sealed plastic bag which has been premarked with the village ID code.

(b) Remove the unopette pipet from its shield and hand to Team Member 1. Use the shield to pierce the plastic cover of the bottle containing the diluting solution.

(Team Member 1 makes sure that the subject's hand is wiped off and the bleeding stopped.)

Team Member 2 proceeds as follows:

(c) Wipe off any excess blood on the outside of the pipet, being careful not to touch the tip which would draw blood out. Contents of the pipet must be mixed thoroughly and quickly with the diluting solution to avoid clotting of the blood.

(d) Loosely insert pipet into the opening of the unopette bottle. Gently squeeze and hold the sides of the container, using your finger to cover the opening of the pipet and then push the pipet down into the neck until it clicks. Release the pressure and remove your finger from the opening. The blood will then be drawn into the container. Squeeze the container several times to rinse out the pipet thoroughly, being careful not to let the liquid overflow the neck.

(e) Placing your finger over the opening in the top of the bottle (leaving pipet in container), invert the bottle several times to mix the blood with the diluting solution.

(f) Write ID# of patient on bottom of unopette container with marking pen. Return unopette to premarked plastic bag. Store bag appropriately then check questionnaire (blank 60).

B. Footstick Procedure (exterior lower lateral side of the sole) Footsticks are essentially the same as fingersticks; a rubbing motion from the toes to the heel on the bottom of the foot will help stimulate the blood flow especially if the baby's foot is cold. Babies may also be stuck in the big toe. Get a firm grasp on the infant's foot with your hand; babies can display great amounts of resistance. Follow the same procedure for cleaning area and collecting sample. Apply a bandaid when finished.

C. The premarked plastic bag containing the used and identified unopettes is kept in the backpack unexposed to light and delivered to the Operations Officer or Project Director.

APPENDIX G - CORRELATIONS BETWEEN ANTHROPOMETRIC MEASUREMENTS IN THE 1975 NEPAL NUTRITIONAL STATUS SURVEY

Data from the Nepal Nutritional Status Survey was used to identify relationships between anthropometric variables and the degree to which anthropometric variables were related in order to (1) assess the accuracy and precision of measurements made, and (2) explore the utility of arm circumference-for-height index in assessing nutritional status and as a surrogate for the weight-for-height index in assessing acute undernutrition. Table 1 presents the matrix of correlation coefficients (r) between age and anthropometric measurement made in the Nepal survey. All correlations are simple (straight line) except triceps skinfold which are based on 2nd degree functions because of the curvilinear relationship between skinfold and weight, height, and age. No appreciable improvement in r was seen for other variables by using a higher than 1st degree function. Table 1 demonstrates strong relationships between age and height, between age and weight, and between height and weight.

Of these highly significant correlations, that between weight and height is the strongest and demonstrates both a close relationship between these two variables in Nepali children 6-71 months of age and a high degree of accuracy and/or reproducibility in the individual measurements. The coefficient of determination (89.7) shows that almost 90% of the variation in weight is accounted for by its regression on height. The same can be said for the relationships

between height and age and weight and age with coefficients of determination of 82.1 and 74.0, respectively. Age, height and weight are all highly interrelated in the Nepali children and the accuracy and/or consistency of measurement of these variables is apparently of a high degree. Most of the variation in height and weight can be explained by their correlation with each other and with age.

Arm circumference measurements were included in the Nepal survey to assess the value of an arm circumference-for-height index in identifying acute undernutrition. It was hoped that, because of the simplicity of equipment needed for arm circumference measurements, it could be substituted for weight measurements.

The correlation coefficient between weight and arm circumference is 0.62 with a coefficient of determination of 38.4 percent. The correlation between arm circumference and height is 0.49 with a coefficient of determination of 24.1 percent. Both are relatively low indicating a weak relationship between arm circumference and height and weight variables in the Nepali children. Because a common reference population for percents of median weight-for-height and arm circumference-for-height does not exist, correlations between these two indices cannot be calculated. However, the individual correlations between actual measurements of arm circumference and weight, height and age suggest that arm circumference is not a good surrogate for weight. The following are possible explanations for this weak relationship.

1. The true relationship between arm circumference and the other variables in Nepali children is weak and arm circumference does not, in fact, reflect nutritional status with the same precision as does weight.
2. Measuring arm circumference requires identifying and measuring the distance between the posterior acromial process and the olecranon process; locating the midpoint between the two processes; positioning the tape perpendicular to the axis of the arm; and estimating the proper degree of tension to apply to the tape. The potential for errors of technique to occur at each measurement step enhances the likelihood of an inaccurate final measurement value. Since the range of normal arm circumferences in children 6-71 months of age is small, slight errors may, in fact, be large percentages of the true value. Weight measurement, in comparison, is a single step mechanical procedure with less chance for the introduction of human error.

Nepal survey triceps skinfold data demonstrate even weaker correlations with age, height and weight than do arm circumference data. The reasons for this are probably the same as those suggested for arm circumference. Skinfold measurements probably do not provide interpretable data in a population where undernutrition is the identified problem.

In summary the accuracy and/or reproducibility of height and weight measurements in the Nepal survey appear to be extremely good with a

high degree of interrelationship between the two as well as with age as shown by the correlation coefficients in Table 1. Arm circumference and triceps skinfold do not demonstrate the same high degree of correlation with age, height and weight.

Table 1

Correlation Coefficients (r) Between Age and Anthropometric Measurements for Children 6-71 Months of Age
Nepal Nutritional Status Survey

Dependent Variable (Y)	INDEPENDENT VARIABLE (X): Age	Height	Weight	Arm Circumference
Height	0.9062 (82.1)			
Weight	0.8603 (74.0)	0.9471 (89.7)		
Arm Circumference	0.4285 (18.4)	0.4912 (24.1)	0.6197 (38.4)	
Triceps Skinfold	0.2341 (5.5)	0.3219 (10.4)	0.2259 (5.1)	0.4259 (18.1)

NOTE: Numbers in parentheses show percent of variation in Y explained by the regression of Y on X.

APPENDIX H - OTHER ANTHROPOMETRIC INDICES USED IN ANALYZING NEPAL DATA

A. Distribution of Nepal Survey Population by Weight-for-Age Percent of Reference Median

Table 1 - Appendix H
Weight-for-Age
Percentage of Survey Population
by % of NAS Reference Weight-for-Age Median
by Geopolitical Divisions

	Percent of NAS Reference Median									
Population	<60%	60-64.9%	65-69.9%	70-74.9%	75-79.9%	80-84.9%	85-89.9%	90+%	Total %	Sample Size[1]
Total Rural Nepal	5.1	8.8	15.2	20.8	20.7	13.9	8.1	7.3	100	(6566)
Development Regions										
Far West	5.5	10.8	16.5	21.9	18.6	12.9	7.3	6.5	100	(1734)
West	4.8	8.3	15.0	21.7	20.9	13.9	7.7	7.7	100	(1594)
Central	4.9	8.7	15.1	21.2	22.0	13.7	8.1	6.3	100	(1740)
East	5.4	7.7	14.4	18.5	20.8	15.2	9.0	9.0	100	(1498)
Terrain										
Hill	5.1	9.1	15.4	20.9	20.9	14.4	7.6	6.5	100	(3990)
Terai	5.4	8.1	14.2	20.8	20.5	13.9	9.1	7.9	100	(2157)
Subregions										
Far West-Hill	6.1	11.2	16.2	22.4	19.3	13.2	6.7	4.9	100	(1139)
West-Hill	3.8	8.1	14.0	22.7	22.3	13.9	7.5	7.7	100	(1051)
Central-Hill	5.1	10.3	15.4	19.1	21.3	15.0	7.9	5.8	100	(900)
East-Hill	5.9	6.9	16.7	18.0	20.3	16.3	8.8	7.1	100	(900)
Special Group	0.0	0.0	0.0	0.8	1.0	5.3	17.3	75.4	100	(486)

[1] Figures in parentheses are actual sample sizes.

B. Weight-for-Age Classification of the Indian Academy of Pediatrics (IAP) 1972 (15) and Nepal Weight-for-Age Data Using the IAP Classification

1. Indian Academy of Pediatrics (IAP) 1972 classifications of malnutrition by weight-for-age percent of reference median:

Normal Road to Health 80+% of reference median weight-for-age

First Degree = 70-79.9% of reference median weight-for-age

Second Degree = 60-69.9% of reference median weight-for-age

Third Degree = <60% of reference median weight-for-age

Table 2 - Appendix H
Percentage of Nepal Survey Population
by Indian Academy of Pediatric's (1972) Classification

Weight-for-Age

Malnutrition by IAP Classes	Age Groups 6-11m	12-23m	24-35m	36-47m	48-59m	60-72m	Total (6-72m)	Sample Size[1]
Normal	31.1%	19.8%	30.9%	34.2%	31.0%	30.5%	29.3%	(1926)
First Degree	40.7%	41.8%	40.9%	41.6%	41.8%	41.8%	41.5%	(2699)
Second Degree	21.2%	30.6%	23.9%	20.2%	23.9%	22.9%	24.0%	(1594)
Third Degree	7.0%	7.8%	4.3%	4.0%	3.3%	4.7%	5.1%	(347)
Total Percent	100.0%	100.0%	100.0%	100.0%	100.0%	99.0%	99.0%	(6566)

[1] Figures in parentheses are actual sample sizes.

C. Distribution of Nepal Survey Population by Arm Circumference-for-Height Percent of Reference Median

Table 3 - Appendix II
Arm Circumference-for-Height
Percentage of Nepal Survey Population
by % of 10-State Nutrition Survey
Arm Circumference-for-Height Median
by Geopolitical Divisions

Population	% of 10-State Reference Median <82.5%	82.5-89.9%	90.0-99.9%	100+%	Total %	Sample Size[1]
Total Rural Nepal	5.8	29.8	50.1	14.2	100	(6432)
Development Regions						
Far West	7.4	31.7	48.3	12.6	100	(1709)
West	4.8	29.0	50.8	15.3	100	(1567)
Central	6.5	30.4	48.8	14.3	100	(1694)
East	4.6	28.3	52.5	14.5	100	(1473)
Terrain						
Hill	5.5	29.4	50.0	15.0	100	(3904)
Terai	7.1	31.2	49.0	12.7	100	(2118)
Subregions						
Far West-Hill	7.2	30.2	49.8	12.8	100	(1117)
West-Hill	4.8	27.7	51.1	16.4	100	(1031)
Central-Hill	5.5	28.9	50.7	14.8	100	(873)
East-Hill	4.6	31.7	48.0	15.6	100	(883)
Special Group	0.8	10.6	49.8	37.8	100	(484)

[1]Figures in parentheses are actual sample sizes.