Nutrition and Health Status Indicators

Suggestions for Surveys of the Standard of Living in Developing Countries

Reynaldo Martorell
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Nutrition and Health Status Indicators

Suggestions for Surveys of the Standard of Living in Developing Countries
The Living Standards Measurement Study

The Living Standards Measurement Study (LSMS) was established by the World Bank in 1980 to explore ways of improving the type and quality of household data collected by Third World statistical offices. Its goal is to foster increased use of household data as a basis for policy decision making. Specifically, the LSMS is working to develop new methods to monitor progress in raising levels of living, to identify the consequences for households of past and proposed government policies, and to improve communications between survey statisticians, analysts, and policy makers.

The LSMS Working Paper series was started to disseminate intermediate products from the LSMS. Publications in the series include critical surveys covering different aspects of the LSMS data collection program and reports on improved methodologies for using Living Standards Survey (LSS) data. Future publications will recommend specific survey, questionnaire and data processing designs, and demonstrate the breadth of policy analysis that can be carried out using LSS data.
Nutrition and Health Status Indicators

Suggestions for Surveys of the Standard of Living in Developing Countries

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I. OBJECTIVES AND CONSTRAINTS

This report reviews the types of indicators of nutrition and health status that would be appropriate for household surveys of the standard of living in developing countries. The data to be collected, it is assumed, would serve five broad purposes:

1. Assessment of the nature, extent and localization of nutrition and health problems in specific countries;
2. Investigation of the interrelationships between health and nutrition data and other data traditionally collected in surveys of living standards such as income, expenditures, and access to public services in order to identify the salient constraints to adequate health and nutrition within and across countries;
3. Design of measures aimed at improving the quality of life;
4. Monitoring of changes in health and nutrition in specific groups and in the country as a whole;
5. Comparison of the quality of life of designated countries at one time and assessment of their relative progress through time in terms of nutrition and health indices of similar reliability and validity.

It is also assumed that a number of constraints will limit the types of indicators that are finally chosen. Three aspects are salient.

a. The study will consist of periodic cross-sectional household surveys of random samples and will not involve assessments over time on the same individuals. 1/

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1/ Small-scale substudies may be carried out if judged essential.
b. The surveys will be carried out by specific developing countries with technical and financial assistance from international organizations but within the characteristic limitations of personnel, budget, infrastructure, and logistics that are found in developing countries.

c. Emphasis is to be placed upon the most prevalent and serious of the nutrition and health problems existing in the country. This strategy leads to a focus on the rural and urban poor.

The cross-sectional approach excludes longitudinal indicators (growth rates, for example) and constrains the analyses of changes to comparisons of population means and distributions of random samples drawn from the same universe. The relative lack of most resources, in turn, calls for an emphasis on assessment techniques which maximize simplicity, feasibility, reliability, and validity and which minimize costs. A focus on problems of the poor means less attention directed to the proportionately smaller upper-income groups' problems which mimic those of overfed and sedentary populations from industrialized nations.

The present document is written with the above objectives and constraints in mind. Further, though a report on health and nutrition would be expected to include discussions of mortality, life expectancy, and other demographic parameters, these issues are left out here because another LSMS paper will deal specifically with them. Finally, the present document emphasizes data collection at the family and individual level with only brief attention given to community variables of health and nutrition.
II. HEALTH AND NUTRITION AS MEASURES OF THE STANDARD OF LIVING

The standard of living is often monitored by means of economic variables such as per capita income, prices and wages, and production and consumption of specific goods. Mortality rates and life expectancy, and other vital statistics, are sometimes used in conjunction with economic indicators. Physical growth, dietary intakes, and other direct indicators of health and nutrition are less frequently used.

There are powerful arguments for monitoring health and nutritional status in surveys of living standards, particularly if the studies are carried out in developing countries. First, nutritional deficiency syndromes and infectious diseases are prevalent in developing countries and are among the major public health problems of developing countries. Clearly, no assessment of the quality of life would be complete without including health and nutrition data. Secondly, health and nutrition problems while largely economically determined also have economic consequences that must be taken into account in explaining the growth of countries. 1/ Malnutrition, for example, leads to increased susceptibility to infection, higher morbidity and mortality rates, greater demand for health services, and increased medical expenditures. Low work productivity and diminished intellectual and social competence are other effects of obvious economic importance.

In spite of technical advances in the health and nutrition sciences and substantial economic investments, the great majority of people in most developing countries continue to exist in a state of poor health and nutrition. Particularly distressing is that large segments of society remain in wretched poverty in some developing countries where the rate of aggregate

1/ This was in fact the theme of Berg's book, The Nutrition Factor.
growth has been impressive. This had led to a re-analysis of development policies and to considerations of equity. In some instances, adjustments in development policies have been made with the aim of alleviating poverty and improving the health and nutritional status of the lowest socioeconomic groups. The fact is that economists have been asked to give advice on the most cost effective way of achieving good health and nutrition, the "economics of intervention" as Selowsky (1978) calls it. There would seem to be a need, therefore, for health and nutrition data to assess the nature of problems, to aid in the formulation of policies, and to evaluate the success of these actions.

III. DIET, INFECTION, AND NUTRITIONAL STATUS

Inadequate dietary intakes and high incidences of infectious disease (Figure 1) are the main biological factors which ultimately determine nutritional status in developing countries. These "input" factors are themselves the end result of broader causes including poverty, ignorance, and the absence of public services. For example, the characteristically low income levels of developing nations limit the kinds and the amounts of food available for consumption. Low incomes also increase the likelihood of infection through such mechanisms as lack of shoes, inadequate shelter and housing, and limited facilities and supplies for personal hygiene. Misconceptions or ignorance about the nutritional needs of special groups such as infants and women during pregnancy and lactation and about the importance of simple hygienic procedures are examples of educational factors. Lack of public services including potable water, waste disposal systems, and
Figure 1
Diet, infection, and nutritional status
preventive and curative medical care are major determinants of disease.

A. Dietary Limitations

Diets may be deficient in either quantity and/or quality (i.e., inadequate nutrient composition). Views about the nature of the deficiencies are not entirely clear as illustrated by the continuing debate concerning the relative importance of deficiencies in protein or energy intake as causes of malnutrition. Prior to the 1970s, deficiencies in the quantity and quality of protein were emphasized. Today, most experts believe energy, or rather, the quantity of food is far more important a limitation than the amount and quality of protein in most diets (Sukhatme, 1974; Payne, 1975). Though clinical signs of protein deficiency are observed in developing countries, these are thought to be related to energy deficiency; that is, portions of the ample supply of protein appear to be broken down for their energy value and not used for tissue repair and synthesis. Scrimshaw (1977) believes protein requirements were underestimated by the FAO/WHO in their 1973 report, and further criticizes the fact that the report did not take into account the effects of infection (i.e., see Figure 1). A 1977 re-analysis of the situation by noted nutritionists points out the limitations of the evidence but still views the FAO/WHO protein-energy requirements as the "best guess" (Beaton, Calloway, and Waterlow, 1979).

The original name in Spanish for protein-energy malnutrition was sindrome pluricarential, meaning "multiple-deficiency syndrome." This name underscores the fact that protein-energy dietary deficits and their resulting clinical signs tend to be accompanied by clinical signs of deficiencies in vitamins, notably vitamin A, and in minerals, especially iron. Bengoa (1973) divides the principal nutritional problems of developing countries into three groups: Most common are protein-energy malnutrition, nutritional anemia,
endemic goiter, ariboflavinosis, and dental problems. Also found over most of the developing world but less frequently are xerophthalmia and rickets. A final group includes problems like pellagra, beriberi, and scurvy which are limited to very specific areas.

Nutritional problems occur more frequently in young children because of their higher nutritional needs, greater susceptibility to infection, and because others determine what they eat. Increased nutritional requirements of pregnant and lactating women make them the second group most likely to be malnourished. For example, FAO/WHO (1973) recommends an extra 150 kcal/day in the first trimester of pregnancy, 350 kcal/day in the second and third trimesters, and 550 kcal/day during the first six months of lactation. The recommendations for the period of lactation assume the mother will be breaking down 4 kg of fat deposited during pregnancy; however, poor women in developing countries are not likely to achieve the recommended levels of intake and weight gain during pregnancy (Martorell, 1980). Numerous dietary surveys indicate that intakes will be several hundred calories below recommended levels, and below as well in many other nutrients. Weight gains during pregnancy average around 5 to 7 kg, 40 to 60 percent of the normal and there is little or no fat accumulation. Low-birthweight babies (less than 2.5 kg) will be several times more frequent than in well-nourished mothers - a matter of serious concern, for such babies are most likely to die during the first year of life. Breast milk production is notably reduced, often by 200 or more ml to levels below 500 ml/day, although nutrient composition is usually not affected. The ability of poorly nourished mothers to maintain such milk production levels depends, however, on maternal tissue depletion. Of great concern is the decline in the incidence and duration
of breast-feeding which has been taking place in many areas throughout the world (Jelliffe and Jelliffe, 1978). Among the many adverse outcomes that result is the child's loss of a nutritionally balanced meal which, more often than not, cannot be matched in quality by the local diet. The loss of the anti-infective properties of breast milk will often be compounded by unsanitary feeding practices, especially when bottle feeding is involved. Frequent diarrhea, marked weight loss and eventual death may then result.

Diets may be inadequate either because not enough food is available for consumption or because infection reduces appetite (Mata et al., 1977; Martorell et al., 1980b). The presence of common morbidity symptoms has been shown to significantly reduce energy and protein intakes in preschool Guatemalan children (Table 1). Average consumption of the children studied fell below the FAO/WHO (1973) energy requirements for their age and body weight by about 225 calories. The average effects associated with the summary variable (diarrhea, apathy, vomiting, fever, or being so sick as to be confined to bed), -175 calories, are thus large relative to the energy gap and should have major biological significance for children who are frequently ill. The mean effect on the population as a whole, however, is dependent upon the percent of children who are sick. In the population studied, 23 percent of the children were sick with one or more of the items included in the summary variable every day. Therefore, the population mean effect is 40 calories per day (.23 x -175) and illnesses included in the summary variable can be said to account for 18 percent (40/225) of the dietary energy deficiency.  

\[1/\] Probably an underestimate because of methodological considerations (see Martorell et. al., 1980b).
## Table 1

Average reduction in intake associated with the presence of specific symptoms in Guatemalan preschool children

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Energy (kcal/day)</th>
<th>Protein (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average effect</td>
<td>Average effect</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>p</td>
</tr>
<tr>
<td>Summary variable</td>
<td>-175</td>
<td>-4.8</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Respiratory illness</td>
<td>-67</td>
<td>-1.0</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>.007</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>-160</td>
<td>-3.0</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Apathy</td>
<td>-175</td>
<td>-5.1</td>
</tr>
<tr>
<td></td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*From Martorell et al. (1980b). Based on data on 477 children.*

*Defined by diarrhea, apathy, vomiting, fever, or being so sick as to be confined to bed.*
Additional factors which limit dietary intakes have to be taken into account in the case of young children. In some areas, the bulk of the diets may overtax the gastric capacities of young children and put a ceiling on energy intakes. Food monotony, the absence of variety in smell, taste, color, and consistency, is a factor of unknown but probable significance. The importance of cultural patterns in determining dietary intakes has already been noted.

B. Effects of Infection on Nutritional Status

Many studies have shown that people in developing countries are exposed to a much greater infective load than in industrialized nations. Studies in Guatemala have shown that 15 to 40 percent of the newborns show signs indicative of fetal infection (Mata et al., 1977). By comparison, in populations where sanitary conditions are adequate, fetal infection is rare. The prevalence of infectious disease is also very high in young children in developing countries as shown in a study of Guatemalan children 1 to 3 years of age (Martorell, 1979). Upper respiratory symptoms were by far the most common with a point prevalence of 30.5 percent, while other common symptoms were skin infections (8.9 percent), diarrhea (8.5 percent), illness induced apathy (8.5 percent), conjunctivitis (7.0 percent) and fever (3.2 percent). Taking into consideration these and all other symptoms, more than half of the 1-to-3 year old children studied were sick every day.

1/ Elevated IgM levels in cord blood.

2/ The percent of children suffering from a particular symptom on any one day.

3/ Intestinal parasites, a common occurrence in these villages, were not detected through the methodology used.
All illnesses have marked effects on nutrient metabolism and utilization (Figure 1). A variety of infectious agents, including bacteria, rickettsia, and viruses, produce similar alterations in many aspects of nutrient metabolism (Beisel, 1977). Foremost among these changes are disturbances in protein metabolism. Infections bring about protein catabolism and, if the illness is severe and prolonged, lead to a depletion of the lean body mass stores. There are also similar urinary losses in the other major intercellular elements: potassium, magnesium, and phosphorus. Diarrhea and vomiting, if frequent and severe, will rapidly lead to electrolytic imbalance.

A second mechanism through which illnesses affect nutrient availability is by limiting absorption. Loss through vomiting may be marked, and absorption may be limited by the so-called "intestinal hurry" of enteric disturbances: that is, the food does not remain long enough in the gastrointestinal tract for nutrients to be adequately absorbed. Diarrheal diseases are also accompanied by malabsorption of sugars, nitrogen, fats, and micronutrients (Rosenberg et al., 1977).

A third kind of mechanism, particularly applicable to malaria and worm infestation, is that the microorganisms which cause disease also utilize significant nutrient amounts for their own growth and reproduction and thus compete with the needs of the host.

Poor nutritional status, in turn, impairs the body's defense against disease (Suskind, ed., 1977), making individuals more susceptible to infection and, in effect, creating a vicious circle (Figure 1). Not all components of the defense mechanism are equally affected; malnutrition appears to depress the integrity of the cell-mediated immune system markedly, but it hardly affects the humoral immune system. Maternal malnutrition has a detrimental impact also on the ability of the infant to respond to infections, a fact which may explain the higher infant mortality rates for low-birthweight babies.
C. **Outcomes of a Poor Nutritional Status**

A poor nutritional status will result in many adverse effects. Outcomes commonly measured in surveys are: death, growth retardation, reduced physical activity, and clinical signs of malnutrition (Figure 1). Individuals adapt to the diminished cellular availability of nutrients by improving nutrient absorption and retention, by limiting physical activity, by reducing the rate of growth (children), and by utilizing body stores of nutrients. In situations of scarcity, the nutritional resources are primarily targeted to vital functions like circulation, respiration, and maintenance of body temperature (basal metabolic needs). Depending upon the severity of the nutritional problems, individuals may exhibit telltale clinical signs (e.g., bleeding gums in scurvy) and biochemical abnormalities measurable in tissue samples (blood, urine, liver, etc.). Death is the end result when the stress brought on by infection and poor dietary intakes is beyond the coping mechanisms of individuals.

IV. **AREAS OF STUDY**

Health and nutritional status can be monitored by measuring either the causes or the outcomes of nutritional deficiencies. This section considers in detail the parameters recommended for measurement in each of seven areas (anthropometry, birthweight, clinical examinations, biochemistry, food and nutrient intake, breast-feeding, illness). Because so little is known about it, a section on physical activity is not included in this report.  

1/ While the literature on the effects of malnutrition on growth is vast, there is a paucity of information on physical activity in malnourished populations. In particular, little is known about the extent to which activity decreases in mild and moderate malnutrition or about the priority with which reductions in activity, growth, or other outcomes take place. In part, the lack of data may be a result of the methodological difficulties of measuring energy expenditure, especially in children (United Nations University, 1979). New methodology based upon measurements of heart rate are promising because the equipment is light and inobtrusive (Andrews, 1971; Bradfield, 1971). As in the case of dietary intake measures, several determinations through time would be required to ascertain the level of "usual" physical activity.
A. **Anthropometry**

Nutritional status is operationally defined in terms of its outcomes. At the severe end of the scale, one can usually describe nutritional status for specific nutrients in terms of specific signs and symptoms. For example, kwashiorkor (severe protein-energy deficiency) involves changes in skin and hair, edema, and abnormal biochemical indices of protein status. Severe vitamin A deficiency can be diagnosed through ocular lesions and biochemical indicators such as serum retinol levels. In moderate and severe degrees of deficiency, however, the effects are subtle and the signs and symptoms harder to define, with one exception. Deficiency of any essential nutrients will impair physical growth; in fact, one way of defining the essentiality of a nutrient in laboratory animals is by its effect on growth.

Growth is a sensitive measure of malnutrition throughout the entire range of severity because it quickly reflects deteriorations or improvements in health and nutrition. But growth is not a specific measure of nutritional status, and there is little that anthropometry can tell us about the causes of nutritional problems. Other measures of outcomes (e.g., clinical signs, biochemistry) or causal factors (e.g., diet, infection) are necessary to complement the information provided by growth measurements.

1. **Growth as an Indicator of Nutritional Status**

The mild and moderate stages of nutritional deficiencies have generally been defined in terms of anthropometric measurements, particularly weight for age as in the Gómez et al. (1956) classification of protein-energy
The results of applying the Gómez et. al. (1956) classifications to data for Central American children is shown in Table 2. The distribution is typical of that reported for other populations and has been described as an iceberg, with the tip being severe PEM, involving visible signs (i.e., kwashiorkor, marasmus) and a small portion of children, and the hidden massive base the more numerous categories of mild and moderate PEM. When references are made in the literature about the prevalence of PEM malnutrition in children, more often than not these refer to the anthropometric classification of Gómez et al. (1956).

Numerous studies have shown that socioeconomic indicators of poverty such as income, land tenure, occupation, and education are associated with anthropometric measures (Valverde, 1979; Valverde et al., in press). Of interest is a study by Floud and Gregory (1980) who compared the height of London boys with real wages and prices over the period of the industrial revolution in England. Some of the results from this study are shown in Figure 2 and although the authors caution that their analysis of the data is not yet complete, their findings do show a striking correspondence between height and average wages.

1/ The reader is reminded that multiple nutritional deficiencies, rather than just protein and calories, are responsible for "protein-energy" malnutrition.
Table 2
Prevalence of malnutrition in Central American children less than five years of agea.

<table>
<thead>
<tr>
<th>Descriptive category</th>
<th>Gómez classification b</th>
<th>Number of children</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>grade 3</td>
<td>86,212</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>(&lt;60% weight for age or edema)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>grade 2</td>
<td>538,473</td>
<td>21.3</td>
</tr>
<tr>
<td></td>
<td>(61-74% weight for age)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>grade 1</td>
<td>1,176,656</td>
<td>46.6</td>
</tr>
<tr>
<td></td>
<td>(75-90% weight for age)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total malnutrition</td>
<td>grades 1, 2, 3</td>
<td>1,701,341</td>
<td>71.4</td>
</tr>
<tr>
<td></td>
<td>(&lt;90% weight for age)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aBased on INCAP/INCCD (1972, Table 25).

bSevere, moderate, and mild malnutrition refer to the Gómez categories of weight for age (Gómez et al., 1956). Weight for age for any child is actual weight divided by ideal weight, times 100. Ideal weight is the 50th percentile value of normal children the same age as the index child.
Figure 2
Comparison of heights of Marine Society boys with prices and real wages of London artisans

Composite index of heights of Marine Society boys.
1761 = 100 (mean of estimated mean heights of 14, 15, and 16 year olds; data lagged seven years).

Index of real wages of London artisans.
1900 = 100

Index of prices
1900 = 100

1/ Floud and Gregory (1980)
Income is associated with measures of nutritional status as shown in a study carried out in Guatemalan coffee plantations (Valverde et al., in press). The annual family per capita income in agricultural families was divided into four categories as shown in Table 3. The percent of children less than 5 years of age found to be either moderately (grade 2) or severely (grade 3) malnourished (see Table 3 for a definition of the Gómez classification of weight for age) was less in higher income families.

A study from Costa Rica related the heights of first graders to illiteracy, housing, and sanitation characteristics. 1/ The data were disaggregated by county, of which there are 79 in the country, and the prevalence of children with stunting in height 2/ was compared to the socioeconomic characteristics of the area. The correlation between percent of stunted children was .62 with percent of illiteracy, 3/ .46 with percent of families with substandard housing, .55 with percent of houses without piped water, and .61 with percent of households without toilets (n = 79 and p < .01 for all correlations). Clearly, nutritional status is partly dependent upon socioeconomic status.

Anthropometric measures have also been shown to be highly sensitive to changes in the two immediate causes of malnutrition, infection, and dietary

1/ The heights were measured in a 1979 national survey involving 53,000 first graders. The socioeconomic data are from the 1973 population and housing census.

2/ Less than 90 percent of ideal height for age.

3/ Percent illiteracy in the county was defined as percent of persons over 10 years of age who could not read or write.
Table 3

Relationship between family income and weight for age in Guatemalan children

<table>
<thead>
<tr>
<th>Category of annual per capita income</th>
<th>Percent with weight for age under 75 percent</th>
<th>Children under three years of age</th>
<th>Children three to five years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Less than 200</td>
<td>55</td>
<td>47.3</td>
<td>45</td>
</tr>
<tr>
<td>200-299</td>
<td>109</td>
<td>46.8</td>
<td>96</td>
</tr>
<tr>
<td>300-399</td>
<td>103</td>
<td>38.8</td>
<td>76</td>
</tr>
<tr>
<td>Over 400</td>
<td>112</td>
<td>37.5</td>
<td>78</td>
</tr>
<tr>
<td>Total</td>
<td>379</td>
<td>42.0</td>
<td>295</td>
</tr>
</tbody>
</table>

aData from Valverde et al. (in press).

bGiven in U.S.A. dollars. Mean and median values were 372 and 317, respectively.

cIncludes grades 2 and 3 (moderate and severe malnutrition) of the Gómez classification (see Table 3).
A recently completed food supplementation program in Guatemala shows, for example, that children who consumed over 200 kcal/day (and accompanying protein, vitamins, and minerals) from a supplement had by 3 years of age made up 36 percent of the retardation in height observed in baseline values (Martorell et al., 1980a).

Physical growth measures not only reflect the causes of malnutrition but other outcomes as well. The data in Table 4 exemplify the fact that few other factors predict infant mortality in developing countries as well as maternal size. The data are drawn from a study of residents of large coffee plantations in Guatemala (Martorell et al., in press). While exhibiting great socioeconomic homogeneity because of similar occupations of the men (salaried agricultural workers) and similar incomes and houses, the variability in stature among mothers was a strong predictor of infant mortality in their children. After dividing the distribution of stature into terciles, it was found that infant mortality was 209/1000 for the shortest, 140 for the intermediate group, and 99 for the tallest group. The relationship between maternal stature and infant mortality is probably due to the fact that taller mothers, in these and other poor communities, have heavier babies.

Anthropometric measures in children are predictive of mortality rates. The relationship between birthweight and infant mortality is well known (Chase, 1962; Mata, 1978). After birth, weight and other measures continue to be predictive as well. For example, the data in Figure 3 show that the probability of death in the first 3 years of life in Punjabi children is

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1/ See Martorell et al. (1976a), and Habicht and Butz (1979) for a review of the literature on food supplementation experiments and growth, and Martorell (1980) for a similar review on studies of infection and growth.
Table 4

Maternal height and infant mortality in the Pacific lowlands of Guatemala\textsuperscript{a}

<table>
<thead>
<tr>
<th>Terciles of height</th>
<th>Lower</th>
<th>Middle</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>136.7</td>
<td>142.0</td>
<td>148.2</td>
</tr>
<tr>
<td>Range</td>
<td>126.3-140.2</td>
<td>140.3-144.7</td>
<td>144.8-158.6</td>
</tr>
<tr>
<td>Number of mothers</td>
<td>127</td>
<td>124</td>
<td>129</td>
</tr>
<tr>
<td>Number of children born to each group</td>
<td>603</td>
<td>509</td>
<td>545</td>
</tr>
<tr>
<td>Number of dead by 1 year of age</td>
<td>137</td>
<td>75</td>
<td>58</td>
</tr>
<tr>
<td>Crude infant mortality\textsuperscript{b}</td>
<td>209</td>
<td>148</td>
<td>99</td>
</tr>
<tr>
<td>Adjusted infant mortality\textsuperscript{c}</td>
<td>205</td>
<td>150</td>
<td>101</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From Martorell et al. (in press).

\textsuperscript{b}ANOVA : $F = 8.7$, $p < .001$.

\textsuperscript{c}Adjusted for age and parity by ANCOVA; ANOVA : $F = 7.9$, $p < .001$. 
FIGURE 3

Probability of death by nutritional status for Punjab children aged 1-36 months (Kielmann & McCord, 1978)
associated with weight for age. The relationship does not appear to be linear as mortality rates are minimal for children with moderate degrees of weight retardation (i.e., over 70 percent weight for age) but increase dramatically thereafter.

The mechanisms linking growth retardation and mortality may be traced to less effective immunological defense mechanisms and hence more susceptibility to infection among growth retarded children. Figure 4 shows the relationship between weight for age and the lymphocyte stimulation index. The stimulation index is an in vitro indicator of the ability of lymphocytes to grow in number (i.e., mitosis) after exposure to a stimulus.\footnote{Lymphocytes respond mitotically to phytohemagglutinin. The uptake of radioactive thymidine, measured as counts per minute by a liquid scintillation counter, is the measure of mitotic rates. The stimulation index is the number of times thymidine uptake is increased in cultures of stimulated lymphocytes over that of cultures of unstimulated lymphocytes (Chandra, 1979).}

As shown in Figure 3, the stimulation index improves with increasing percent weight for age. The inference from this analysis is that better growing children would be better prepared against many infections.

2. Measures of Wasting and Stunting

The process of adaptation to malnutrition, as pointed out earlier, includes reductions in energy intake and in growth. Two related aspects are involved in the process of adaptation through growth reduction: deceleration or cessation of growth per se and loss of fat and muscle reserves. In the terminology introduced by Waterlow (1972), these two growth effects are known as stunting and wasting, respectively. The hypothetical response of stunting and wasting to the range in energy intake adequacy, from very deficient to excessive, is shown in Figure 5.
Figure 4
Percent weight for age and the lymphocyte stimulation index in Indian children†

Drawn from data in Chandra, 1979. The stimulation index in well-nourished children (>80% weight for age) is 105 ± 11.

††Number of times cell division increases after stimulation with phytohemagglutinin.
Response of anthropometric indicators in varying levels of energy intake 

(a) Measures of stunting

(b) Measures of wasting

*Part (a) is a modification of a figure in Yarbrough et al. (1978, p. 201).*
As part (a) of Figure 5 shows, growth in linear measures is normal when energy intake is either normal or excessive. As energy becomes limited, linear growth decelerates, the slope becoming steeper as energy intake deficiencies become severe. Finally, at a point when energy needs are very deficient (i.e., when energy intake falls short of basal metabolic requirements), all linear growth ceases.

Changes in anthropometric indicators of mass/length relationships as a result of energy deficiencies are shown in part (b) of Figure 5. If energy intake is excessive relative to expenditure, obesity will result. Normal mass length relationships appear, however, to be maintained when intake is normal or moderately deficient. Only when the available energy, after allowing for physical activity, is less than required for basal metabolic needs, does the mass/length relationship begin to decrease, as in successful weight reduction programs for adults.

There is evidence to show that the curves in Figure 5 are a true reflection, at the population level, of the response of anthropometric indicators to the range of protein-energy malnutrition. Faced with chronic deficiencies of nutrients, children appear to reduce their rate of linear and mass growth without altering normal mass for length relationships. This is shown in Figure 6 where the weight-for-length ratio of chronically malnourished Guatemalan children appears to be similar to that of well-nourished children from the United States for the age range of birth through 6 years. Wasting begins only when malnutrition becomes so severe that body reserves are utilized for basal metabolic functions over extended periods. In some

1/ There is evidence suggesting that obese children are slightly taller than normal children. These effects are, however, small.
Figure 6

Weight-height relations in Guatemalan and Denver children from birth through six years†

†From Yarbrough et al. (1974).
areas, seasonal variations in food availability and in the prevalence of infection may, for similar reasons, lead to varying degrees of wasting.\(^1\)

Figure 5, part (a) also shows that response or sensitivity of linear growth is not linear throughout the range of nutritional status. There comes a point, as in the privileged classes of the United States when the seemingly inevitable secular changes in height grind to a halt. At this stage, measures of linear growth at the population level are no longer informative. Data from food supplementation experiments offer proof of the nonlinearity of the relationship. When children are divided as to the degree of prior growth retardation (i.e., as a measure of nutritional status), the impact of food supplements is greatest on those with worst status (Rao and Naidu, 1977). The impact of food supplementation on growth rates also varies by the degree to which growth rates are depressed at particular ages during the preschool period (Martorell and Klein, 1980). Thus, at ages when children are growing poorly, the impact is large whereas, at ages where growth rates are normal or nearly so, the impact is minimal.

A study of Indian children underscores the appropriateness of focusing on preschool children in anthropometric surveys (Satyanarayana et al., 1980). Boys ranging from 17 to 18 years of age were divided into four groups based upon height at 5 years of age. As shown in Table 5, growth in height from 5 to 17.5 years of age was similar in all groups suggesting that stunting is a function of events occurring in early childhood. Weight gains from 5 to 17.5 years, on the other hand, did differ by group with shorter children at 5 gaining the least.

\(^1\) The response depicted in Figure 5 might be appropriate for populations whose diets are lacking in energy or in energy and protein (i.e., to the point of maximal protein sparing). If energy were plentiful and protein lacking, providing only energy and maintaining physical activity constant would increase weight for length without stimulating growth in length. Food intake patterns that provide enough energy but not protein are not as common in the world as those that are limited by energy.
Table 5

Size at 17-18 years in Indian boys as a function of size at 5 years of age\textsuperscript{a}

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number (yrs; 1965)</th>
<th>Initial point</th>
<th></th>
<th>Current point</th>
<th></th>
<th>Growth between 5 and 17.5 years (over 150 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age (yrs; 1965)</td>
<td>Height (cm)</td>
<td>Weight (kg)</td>
<td>Age (yrs; 1978)</td>
<td>Height (cm)</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td>I</td>
<td>23</td>
<td>5.04</td>
<td>105.0</td>
<td>17.43</td>
<td>164.5</td>
<td>46.1</td>
</tr>
<tr>
<td>II</td>
<td>25</td>
<td>5.22</td>
<td>99.8</td>
<td>17.45</td>
<td>160.1</td>
<td>42.4</td>
</tr>
<tr>
<td>III</td>
<td>30</td>
<td>5.14</td>
<td>95.6</td>
<td>17.41</td>
<td>157.0</td>
<td>42.0</td>
</tr>
<tr>
<td>IV</td>
<td>14</td>
<td>5.16</td>
<td>88.5</td>
<td>17.39</td>
<td>149.0</td>
<td>34.8</td>
</tr>
<tr>
<td>Pooled S.D.</td>
<td>0.32</td>
<td>3.21</td>
<td>1.27</td>
<td>0.28</td>
<td>6.40</td>
<td>5.30</td>
</tr>
<tr>
<td>F ratio</td>
<td>1.16</td>
<td>85.45</td>
<td>30.32</td>
<td>0.30</td>
<td>16.12</td>
<td>11.84</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From Satyanarayana et al. (1980).
3. **Methodology of Anthropometry**

   a. **Minimum Anthropometric Battery**

   The two most important and most widely used anthropometric measures are total body length (height) and weight, and as Garn (1979, p. 274) notes, "these two measures are to be included even in the minimal nutritional appraisal, and under any circumstances...". Length and weight, in combination with age and sex, yield indicators of both stunting and wasting and allow one to evaluate and monitor the nutritional status of individuals as well as populations.

   Examples of the various purposes for which length and weight are useful are shown in Table 6. Indicators of wasting (i.e., weight for length) provide the simplest way of identifying individuals requiring immediate medical and nutritional attention. Longitudinal records of length and weight changes are valuable additional information in assessing the health and nutritional status of individual children. On the other hand, monitoring changes in populations is best done, not in terms of indicators of wasting, but of stunting, primarily height or length for age. The reasons for the inappropriateness of indicators of wasting for monitoring changes in populations has already been cited: most children in chronically malnourished populations are able to maintain normal weight/length relationships. Improvements over time in measurements of stunting can therefore take place without changes in measures of wasting as has occurred in rural Guatemalan children as a result of a food supplementation program (Martorell et al., 1980a).\(^1\)

   Weight combines information about stunting and wasting and is hence a

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\(^1\) WHO reported the reverse to have happened in a child population participating in a food aid program (WHO, 1979).
Table 6
Uses of total body length (height) and weight in the evaluation of nutritional status in malnourished populations

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Measure</th>
<th>Special requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To select individuals in prompt need of medical attention</td>
<td>Weight/length (acute PEM)</td>
<td>Age not required</td>
</tr>
<tr>
<td>To monitor the development of children</td>
<td>Growth velocities in length and weight</td>
<td>Age-sex specific norms (i.e., length and weight charts); frequent examinations of the child are required</td>
</tr>
<tr>
<td>To identify high risk pregnancies upon first examination</td>
<td>Height, weight, weight/height</td>
<td>Data on best possible cut-off point required for each particular area</td>
</tr>
<tr>
<td>To monitor nutritional status during pregnancy</td>
<td>Weight changes</td>
<td>Gestational age and norms for weight changes during pregnancy. Mother must be examined periodically during pregnancy</td>
</tr>
<tr>
<td>Population level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To select zones or groups with greater nutritional problems</td>
<td>Length for age (chronic PEM) and weight/length (acute PEM)</td>
<td>Age and sex required</td>
</tr>
<tr>
<td>To monitor changes in nutritional status to evaluate the impact of specific interventions</td>
<td>Length for age</td>
<td>Comparable data through time required</td>
</tr>
<tr>
<td>To monitor secular changes</td>
<td>Length for age</td>
<td>Comparable data through time required</td>
</tr>
<tr>
<td>To monitor seasonal changes in nutritional status in groups</td>
<td>Weight/length; growth velocities for various times of the year are appropriate but more difficult to obtain</td>
<td>Comparable data through time required</td>
</tr>
</tbody>
</table>

1Weight for length for the monitoring of obesity.
mixed indicator. Although the value of weight charts in monitoring the health of infants has been amply demonstrated, as Morley (1976) points out, the charts are not always used properly:

But in so many countries which are making use of weight-for-age charts for the surveillance of individual children, a red line is included at the '60 per cent of the Harvard mean.' As a result the health workers consider that children above this line must be satisfactory even if the child has not gained weight over a period of six months (Morley, 1976, p. 52).

Inversely, an older child whose weight is low with respect to age but not to length may be incorrectly diagnosed as in need of immediate nutritional treatment when in fact he may have overcome his nutritional problems long ago. Overfeeding such a child will not make him appreciably taller, only obese.

Length and weight need to be complemented by anthropometric measures of body composition (i.e., muscle and fat). The simplest way to assess fatness is through the measurement of skinfolds and the two most widely preferred sites are over the triceps muscle and over the subscapular region.

Arm circumference in combination with triceps skinfold provide valuable information about relative deficiencies in muscle and fat stores. Arm circumference and triceps skinfold are the basis for estimating two useful measures, arm muscle and arm fat areas. These two area measures were used in a study of malnourished children in Guatemala to show that while arm muscle and arm fat areas were low in the study subjects in comparison to the norms, relative to total body length, arm muscle area was adequate but arm fat area was notably deficient. On the basis of these and other data, the authors inferred energy, and not protein, was more likely to be deficient in the diets of these children (Martorell et al., 1976b).
b. **Target Groups**

Data on all members of the household would obviously allow one to make inferences about the nutritional status of all age-sex groups. If limitations of personnel and time are overwhelming, data collection can be targeted to the "high risk" groups: (i) children less than 5 years of age and (ii) pregnant and lactating women.

Anthropometric data on adult men would be useful for LSMS studies to investigate relationships between nutritional status and economic parameters such as productivity. Also, data about the father would be invaluable when exploring genetic-environmental issues in child growth.

c. **Personnel Selection and Training**

The personnel selected to measure children should have completed secondary school. While some less well-educated individuals may perform adequately, measurement errors will be less of a problem with high school graduates who can also be involved with quality control procedures. On the other hand, more highly educated personnel (e.g., physicians) may find the task of maintaining constant measurement procedures boring and may for this reason not be as reliable. Also, women are preferred for it may not be proper in some cultures for men to measure women, and children may be more relaxed if examined by women.

The training of anthropometrists obviously requires a person with experience in measuring in order to demonstrate the proper techniques. In addition, a manual or handbook describing all procedures, ideally including simple illustrations should be available during training.

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1/ Of interest is the relative contribution of height, weight-for-height, measures of lean body mass, anemia, and dietary intakes to work productivity.
The period of training should last as long as it takes to achieve acceptable levels of reliability and accuracy: Reliability can be understood as the degree to which the measurer is able to reproduce measurements while accuracy refers to the degree to which the measure approximates "true" values. Habicht (1973) suggested simple procedures for training personnel.\(^1\) Typically, subjects are measured twice by each student and by the supervisor. From these data the error variance of each student is estimated and compared to that of the supervisor to monitor reliability; systematic differences between students and between each student and the supervisor are then used to monitor accuracy. At specified levels of performance as suggested by Habicht (1973), students are judged to be ready for data collection.

Concern with measurement error should continue throughout the duration of the study and should involve three types of exercises. At periodic intervals, the supervisor and the anthropometrists should meet to discuss problems encountered in the field, to review measurement procedures, to calibrate instruments and to repeat the initial training exercises in order to monitor reliability and accuracy. Secondly, replicate measures by each anthropometrist should also be carried out under field conditions. The actual measurement process, particularly if the examination only includes five measures as recommended in this report, takes very little time; it is getting to the subject or getting the subject to come to the measurement center which is generally time consuming. Thus it is highly recommended that each subject be measured twice by the anthropometrist. As suggested in Figure 7, the first set of measurements should go on the front of the form and the second

\(^{1}\) These procedures are recommended by WHO in a manual for use in developing countries (WHO, 1979).
The anthropometry form

FRONT SIDE

Identification
Card number
Subject number
Sex
Family or household number
Family status: father, mother, second child, etc.
Location: village, area, etc.
Birth date: day, month, year
Exam date: day, month, year

First set of measures
- Length (cm)
- Weight (kg)
- Arm circumference (cm)
- Triceps (mm)
- Subscapular (mm)

REVERSE SIDE

Second set of measures
- Length (cm)
- Weight (kg)
- Arm circumference (cm)
- Triceps (mm)
- Subscapular (mm)
on the reverse side in order to maximize the independence of each set of observations. If possible, other data (e.g., clinical signs), could be collected in between each set of values to further improve measurement independence. Double measurements provide ongoing reliability estimates under field conditions and, as explained later in the quality control section, result in better data. Finally, the supervisor will need to visit periodically the various anthropometrists at their working sites. On such occasions, the supervisor should also measure a small number of subjects (i.e., five subjects). At the end of the survey, a sufficient number of cases would be available to determine accuracy under field conditions for each anthropometrist (i.e., 50 subjects).

Table 7 shows measurement error data from an INCAP longitudinal study for the five variables recommended in this report. Error estimates derived from standardization exercises are, as expected, less than those encountered under field conditions. Comparing the field measurement error variance with the population variance for each variable shows that the five measures chosen have high reliabilities. The error variance for other measures such as chest circumference, for example, represents over 50 percent of the population variance (Martorell et al., 1975a).

d. Measurement Techniques

The most widely accepted techniques of measurement are those proposed by the International Biological Programme (Weiner and Lourie, 1969, pp. 8-12). These are provided below:

f. Stature (measured with a stadiometer or anthropometer; children 2 years or older):
Table 7

Measurement error standard deviation† in an INCAP longitudinal study (preschool children)‡‡

<table>
<thead>
<tr>
<th>Measure</th>
<th>Standardization exercises</th>
<th>Field condition replicates (one week apart)</th>
<th>Field error variance as percent of population variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total body length</td>
<td>0.34 cm</td>
<td>0.42 cm</td>
<td>1.1%</td>
</tr>
<tr>
<td>Weight</td>
<td>0.02 kg</td>
<td>0.29 kg</td>
<td>5.6%</td>
</tr>
<tr>
<td>Arm circumference</td>
<td>0.18 cm</td>
<td>0.24 cm</td>
<td>5.8%</td>
</tr>
<tr>
<td>Triceps skinfold</td>
<td>0.47 mm</td>
<td>0.59 mm</td>
<td>12.8%</td>
</tr>
<tr>
<td>Subscapular</td>
<td>0.27 mm</td>
<td>0.31 mm</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

†The measurement error standard deviation was estimated by \( \sqrt{\frac{1}{2n}(a - b)^2} \), where a and b are first and second observations respectively and n is the number of subjects measured.

‡‡From Martorell et al. (1975a).
The subject should stand on a horizontal platform with his heels together, stretching upward to the fullest extent, aided by gentle traction by the measurer on the mastoid processes. The subject's back should be as straight as possible, which may be achieved by rounding or relaxing the shoulders and manipulating the posture. The marked Frankfort plane must be horizontal. Either the horizontal arm of an anthropometer, or a counter-weighted board, is brought down on the subject's head. If an anthropometer is used, one measurer should hold the instrument vertical with the horizontal arm in contact with the subject's head, while another applies the gentle traction. The subject's heels must be watched to make sure they do not leave the ground.

ii. Supine length (measured with infant measuring table; children younger than two years of age):

Measured with the infant lying supine. One measurer holds the infant's head in the Frankfort plane and applies gentle traction to bring the top of his head into contact with the fixed headboard. A second measurer holds the infant's feet, toes pointing directly upward, and also applying gentle traction, brings the movable footboard to rest firmly against the infant's heels.

iii. Upper arm circumference (measured with a tape):

The subject's arm hangs relaxed, just away from his side, and the circumference is taken horizontally at the marked level. ¹

iv. Skinfold thicknesses (measured with skinfold caliper):

The skinfold is picked up between thumb and forefinger and the caliper jaws applied at exactly the level marked. The measurement is read 2 seconds after the full pressure of the caliper jaws is applied to the skinfold; if a longer interval is allowed the jaws may 'creep' and the reading be inaccurate.

(a) Over triceps:

The skinfold is picked up at the back of the arm about 1 cm above the level marked on the skin for the arm circumference and directly in line with the point of the elbow, or olecranon process.

(b) Subscapular:

The skinfold is picked up under the angle of the left scapula. The fold should be vertical, or pointing slightly downwards and outwards.

¹ The horizontal mark on the left arm is measured half way between the inferior border of the acromion process and the tip of the olecranon process.
v. Weight (measured with a scale):

Weighing should be done preferably in the nude, or with the subject clothed only in lightweight shorts (which may be provided by the investigator). In the latter circumstance the measurement can be corrected accordingly by adjusting the machine to read zero when a sample garment is placed on it. In all other circumstances, including when trousers are worn, the weight of a representative garment should be entered on the form, for subtraction later. The presence of visible oedema should be recorded.

Age is essential for interpreting anthropometric data. Age data are easy to obtain when records are available or when mothers recall birthdates reliably. In such cases, the date of birth and the date of examination should be recorded and hasty age calculations in the field should be avoided.

It would be a mistake to systematically exclude children of unconfirmed ages as these most likely will be of poorer nutritional status. However, the problem of estimating age in such cases is a difficult one. Some options are available if the child is very young as Jelliffe notes:

 Sometimes, the mother may not know the child's age, but may be able to recite the month of birth, and occasionally the day as well. If this is so, the mother will often recall details of the youngest child only, not those of older siblings (Jelliffe, 1966, p. 58).

The examiner in the above situations can estimate the year of birth confidently if the child is an infant or toddler.

The use of dental eruption data as an aid in estimating age in the first two years of life has also been proposed. However, there is considerable interindividual variability in eruption times and normative data are not available for many groups.

Estimating the age of children older than 2 years of age is the difficult aspect of the problem. Jelliffe offers some advice:
Often the only practicable method may be to construct a locally relevant calendar. . . based on events in the preceding years, including agricultural, climatic and political occurrences, as well as natural or man-made disasters. . . However, such a calendar takes weeks to prepare and pre-test in the field, while its use in survey circumstances is laborious, time-consuming, and least satisfactory with the unsophisticated communities for which it is intended. Calendars will plainly have to be specific for different communities (Jelliffe, 1966, p. 59).

All other data should be collected even when age proves impossible to estimate. Assessments of wasting, as noted earlier, do not require age to be known.

e. Equipment

The Ninth Handbook of the International Biological Programme (Weiner and Lourie, 1969) as well as Zerfas (1979) discuss the selection of equipment and list the addresses of some instrument distributors.

The lightest and least expensive piece of equipment will be the tape needed for measuring arm circumference. Cloth and paper tapes are not recommended because they wear out and stretch easily. Fiberglass or steel tapes are preferable.

A number of calipers are available for measuring fat folds. The two most widely used are the Lange (U.S. made) and the Harpenden (British made) models; either of which is suitable. These two calipers possess rectangular jaws and exert a constant pressure of 10 gm/sq. mm. Prices range between $150 and $200 for most calipers.

The measurement of weight, height, and supine length presents special problems. If subjects are to be measured at their home, the equipment chosen should be light and sturdy. Where subjects are asked to come to a central station or designated location, the bulk and weight of the equipment is of less concern. Two of the most widely used scales which are suitable
for fixed locations are the Detecto baby (up to 16 kg) and adult (up to 140 kg) scales (beam balance). Suitable for use in house-to-house surveys is the British-made Salter scale (spring scale; up to 25 or 50 kg) which can be hung from a tree branch or a house beam. This scale has been used successfully in surveys such as those conducted by the Center for Disease Control (CDC) in El Salvador. Currently, the portable weighing model 235 sells for £21. Field worthy but heavier scales (i.e., 19 pounds) are available for measuring adults (Weiner and Lourie, 1969). Common bathroom scales are not reliable and are not recommended for weighing infants and young children though they are suitable for cross-sectional surveys in adults.

Precise, sturdy instruments for measuring stature in fixed locales include the Harpenden Stadiometer ($694 per unit). This instrument is impractical (100 pounds in weight) for the type of survey research which is generally carried out in developing countries. Some weight scales, such as the Detecto scales, have built-in stadiometers; but again, they are not suitable for house-to-house surveys. A portable stadiometer, suitable for house-to-house surveys, is available in the Harpenden line of instruments (Harpenden Pocket Stadiometer, model 98-605, $46). Where reasonably straight walls are found in homes, a scale (i.e., fiberglass tape) can be taped to the wall and with the use of a flat board to press against the top of the head, after positioning the individual correctly, height can be measured with surprising accuracy.

Length of children can be easily measured with portable boards, usually made out of wood. Inexpensive models have been developed by UCLA and CDC (Zerfas, 1979), WHO (1979), and by INCAP which can easily be replicated by local carpenters. Infants' boards have a fixed vertical end against which
the child's head is positioned and a movable end which is positioned against the soles of the feet. A fiberglass tape is attached along the flat board. Sturdy infant measuring tables are also available commercially; these are, however, more expensive, very bulky and more appropriate for fixed locales. For example, the Harpenden infant measuring table weighs 20 pounds and costs $658. Perspective Enterprises\(^1\) has, however, developed a lighter (8 pounds) measuring board for around $70.

f. Quality Control

Anthropometry, as other areas of the survey, needs to be monitored by a supervisor who, depending upon the size and complexity of the survey, may have more than one area of responsibility. The supervisor, as noted earlier, should meet periodically with the anthropometrists to reread the manuals and to review the measuring techniques; periodic visits to the field are also recommended.

Data flow charts need to be prepared. Forms must be inspected shortly after collection to make sure all information is recorded properly. A record of names and dates of measurements should be kept at the field site and the number of forms sent periodically to the central offices for data processing should be counted and recorded. After the data are punched, the original forms should be filed for safekeeping. The punched data should be analyzed as soon as possible to monitor reliability (from duplicate measures) and to scan for outliers.

In scanning for outliers, values can be checked against the appropriate age-sex group distribution. For example, a value may be labeled as an outlier if it is more than two or three standard deviations above or below the mean. In addition, if two measurements are obtained as recommended in

\(^1\) 7466 Thrasher Lane, Kalamazoo, Michigan.
this report, the differences between paired values can be compared to the measuring standard deviation. Values which differ, say, by three times or more the measuring standard deviation, would be suspect. Ideally, one should re-measure the subjects whose values are questionable. Where this is not feasible, suspect values should be divided into those which are clearly impossible and into those which are unlikely but plausible. The former should be deleted from the data files. Decisions as to what to do with unusual but plausible information are always difficult and arbitrary. If the quality of data is high, only a small percent of values (i.e., less than 1 percent) may be involved and little information would be lost if these values are deleted. Another strategy is to code suspect but plausible information so as to investigate their effect on key data analyses. Whatever is done, criteria and procedures should be specified and made available to those using the information.

A final note on quality control. To some, the supervision and quality control procedures suggested here may appear excessive and time consuming. They are certainly not. One impact of quality control procedures is that they foster a careful attitude on the part of field workers. To see all "this fuss" devoted to numbers (which may be largely meaningless to them) develops a sense of pride and responsibility. Otherwise, workers come to believe one is interested primarily in numbers, quality not being an issue.

Physical Growth Norms

Some types of anthropometric studies do not necessarily require the use of a norm or reference against which to compare the data collected.

1/ A recent book edited by Jelliffe and Jelliffe (1979) contains articles by Garn, by Zerfas, and by Nichaman. These three articles outline the most common types of errors which lead to outliers.
(e.g., investigations of urban/rural differences, studies of secular change, etc.). Where one wishes to quantify the severity of nutritional problems and/or to ascertain the pace of progress in nutritional status in a relative sense, norms become necessary (e.g., estimating the percent malnourished).

The question as to whether growth data on children of European origin from developed nations are appropriate as norms for developing countries has been heatedly debated. A seemingly obvious solution would be for data on the well nourished of each country, or even better for each ethnic group within a country, to serve as the norm for their ethnically appropriate group. This suggestion is not always practical because high quality data on sufficient numbers of the well nourished do not yet exist for all ethnic groups. Moreover, some ethnic groups in some countries are so overwhelmingly poor and malnourished that a "well-nourished" group may not even exist.

What is more interesting is that when data from well-nourished, preschool children of diverse ethnic groups are compared to the European norms, differences are usually rather small, particularly when viewed against the very large differences between the poor and the well nourished in each ethnic group (Habicht et al., 1974; Martorell et al., 1978). It would appear, therefore, that growth data derived from European populations are justified as "norms" for developing countries, that is as rough approximations and not as targets. Finally, the use of a similar norm by workers in developing countries facilitates the comparison of published results.

1/ Appropriate to this point are the remarks of Waterlow et al. (1977, P. 491) who in proposing NCHS data as norms for developing countries state: "if it felt that in a particular population even well-nourished children are shorter in stature than children of the North American reference population, then it might be reasonable to set the target for height as 95 percent of the reference height rather than 100 percent. Decisions of this kind have to be taken locally, and it is not possible to make international recommendations about them."
Differences among the various international norms are slight as shown in Figure 8 where the 50th percentiles of the most widely used norm of the past, the Iowa-Harvard data (Stuart and Meredith, 1946), are plotted against the newest norms, those derived from the National Center for Health Statistics (NCHS) surveys (Hamill et al., 1979). The latter have been recommended as the norms to use by a team of leading scientists from Europe, the United States, and the World Health Organization (Waterlow et al., 1977). Their proposal is likely to gain wide acceptance among researchers.

Norms for arm and skinfold values are not yet available from NCHS. When they do become available, note of the fact that U.S.A. children are heavier and fatter than those in other European populations (i.e., British children) should be taken into account.

h. Analysis

For many years, the preferred method of reporting anthropometric data has been in terms of the Gómez et al. (1956) classification of weight for age as for example in Table 2 of this report. The problem with this approach is that weight for age does not distinguish between current (acute, wasting) and past (chronic, stunting) malnutrition as pointed out in previous sections.

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1/ WHO (1979) has published a data analysis manual for height and weight data. Numerous illustrative tables and figures from a simulated analysis of a World Food Programme in the country of "Barico" and the "Kimani" project are included. Readers are encouraged to review this publication.
The 50th percentile of the Iowa Standards (Stuart and Meredith, 1946) plotted on the National Center for Health Statistics percentiles (Hamill et al., 1979).
The use of length for age and weight for length is instead being recommended today (WHO, 1976b; Waterlow et al., 1977; WHO, 1979) in reporting cross-sectional data for nutritional monitoring or surveillance. Data on arm circumference, triceps skinfold, arm and fat areas and subscapular skinfold should also be reported. When norms of comparison from NCHS become available, the same reporting procedures discussed below for weight for length and length for age should be followed.

Waterlow et al. (1977) propose that data be reported for separate age categories in order to examine changes in the prevalence of malnutrition by age. For the first year of life they suggest groupings by three months (0-2.99, 3.0-5.99, 6.0-8.99, 9.0-11.99) and for older children, they suggest groupings by one year (1.0-1.99, etc.). The recommended sample sizes are 100 children in each age group; failing this they recommend expanding the age classifications. WHO (1979) proposes seven larger age groupings: infants (0-5.9 and 6-11.9 months), preschool children (12-23.9, 24-47.9 and 48-71.9 months), and school children (72-95.9 and 96-119.9 months).

A common procedure is to report the number of observations falling between specific percentile values of the norm (i.e., between 50th and 60th percentile values, 60th and 70th percentile, etc.). This method is inappropriate for data on stunting indicators from developing countries because many subjects, often as many as 90 percent, will have values that fall below the 5th percentile. Many researchers in the past have therefore expressed the observations as a percentage of the mean or median value for
age. For example, percent weight for age is the actual recorded weight divided by the 50th age-sex specific percentile weight value in the norms, the result multiplied by 100. The Gómez et al. (1956) category already mentioned thus becomes:

<table>
<thead>
<tr>
<th>Malnutrition</th>
<th>Percent weight for age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&gt;90</td>
</tr>
<tr>
<td>1st degree</td>
<td>90-76</td>
</tr>
<tr>
<td>2nd degree</td>
<td>75-60</td>
</tr>
<tr>
<td>3rd degree</td>
<td>&lt;60 (or edema)</td>
</tr>
</tbody>
</table>

There are at least two problems, one minor and one major, with the use of percent of mean or median values. First, percent of median values are not, as the seemingly equal units of measurement would suggest, equivalent across age. For example, with respect to the NCHS norms, 95 percent of median height corresponds to the 8th percentile at 12 months of age but to the 12th percentile at 48 months of age. Differences of this magnitude are not generally important. Of greater concern is the fact that percent of median values are not equivalent across measures, the differences in this case being large. For example, for girls and once again in reference to the NCHS norms, 90 percent of median corresponds to the 13th percentile for weight for length at 95 cm but to less than 1 percentile at 36 months (approximately the age when girls achieve a median length of 96 cm) (Waterlow et al., 1977). Failure to take this into account has led to fallacious statements such as: "measure 'A' appears to be more retarded than measure 'B' because the percent of median value is less for 'A' than for 'B.'"
The use of standard deviation scores or Z-scores is an elegant and yet simple solution to the problems noted in the case of percent of median value. Standard deviation scores are equivalent across age and across measures. Waterlow et al. (1977) have proposed methods of classification based upon Z-scores in the hope that they "will be widely acceptable and thus make international comparisons possible." They include Z-score grids such as in Figure 9 and suggest that data be presented in summary tables by Z-score categories (i.e., by half or one standard deviation groupings). Waterlow et al. (1977) also propose that cross-tabulations of stunting (length for age) and wasting (weight for length) be presented. In addition to Z-score tables, tables of means (medians) and standard deviation in the original units (cm or kg) and in Z-score units should be presented for all sex-age groups. Differences between groups can then be tested by means of distributional tests (i.e., chi square). The Z-score values can also be utilized, as a continuous variable, in analyses relating growth data to other variables (i.e., land tenure). Summary scores for a family or groups of families can also be obtained by averaging the Z-scores of individuals.

B. Birthweight

A joint FAO/UNICEF/WHO report entitled "Methodology of Nutritional Surveillance" (WHO, 1976b) recommends the use of birthweight, specifically the percent of babies with weights less than 2.5 kg, as an indicator of maternal nutrition.

Birthweights obviously cannot be collected through cross-sectional household surveys. However, birthweight data can be obtained through
Figure 9

Girls, 2 to 10 years, stature by age, standard deviations, reference population†

†From Waterlow et al. (1977).
collaborative arrangements with the ministry of public health or other responsible government section. Already some countries have implemented data collection systems whereby all babies born in hospitals, rural maternity wards, and even at home in the rural areas are weighed. To weigh babies in the rural areas, the cooperation of auxiliary nurses in the rural health posts and of local midwives is essential. Scales with easy to read dials and workers with proper motivation and training are required. Every effort should be made to weigh the newborns within 24 hours after birth. Weights should be collected up to 72 hours but the time of collection should be recorded. In addition to birthweight, sex of the child and birth characteristics (i.e., live or still-born, singleton or twin, etc.) need to be recorded. Where birthweight data collection systems do not exist but where they are feasible, efforts should be made to help governments design and implement them.

Rather than just the simple report of the percent of low birthweight babies which is recommended by FAO/UNICEF/WHO (WHO, 1976b), the distribution of cases by 500 g or, if the sample size allows for it, 250 g, intervals is preferable. Multiple births and stillbirths should be excluded from the summary tables.

C. Clinical Examinations

Clinical signs are associated with all common nutrient deficiencies. An extensive discussion of clinical signs may be found in a report from a WHO Expert Committee on Medical Assessment of Nutritional Status (1963). This document also contains a complete list of clinical symptoms and full discussions about the interpretation of each one. A shorter list, suitable for rapid clinical surveys, has been proposed by Jelliffe (1966) and is shown in Table 8. Jelliffe's list has guided many nutrition surveys in developing countries.

Information on the prevalence of clinical signs is significant in
### Table 8

A simple schedule for rapid clinical surveys*  

<table>
<thead>
<tr>
<th>Body area</th>
<th>Clinical sign</th>
<th>Probable deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hair</td>
<td>Dyspigmentation</td>
<td>Protein-calorie</td>
</tr>
<tr>
<td></td>
<td>Easy pluckability</td>
<td>Protein-calorie</td>
</tr>
<tr>
<td></td>
<td>Sparseness</td>
<td>Protein-calorie</td>
</tr>
<tr>
<td>Face</td>
<td>Moon-face</td>
<td>Protein-calorie</td>
</tr>
<tr>
<td>Eyes</td>
<td>Bitot's spots</td>
<td>Vitamin A</td>
</tr>
<tr>
<td></td>
<td>Conjunctival xerosis</td>
<td>Vitamin A</td>
</tr>
<tr>
<td></td>
<td>Pale conjunctiva</td>
<td>Iron</td>
</tr>
<tr>
<td>Mouth</td>
<td>Angular stomatitis</td>
<td>Riboflavin</td>
</tr>
<tr>
<td></td>
<td>Cheilosis</td>
<td>Riboflavin</td>
</tr>
<tr>
<td></td>
<td>Swollen, bleeding gums</td>
<td>Vitamin C</td>
</tr>
<tr>
<td>Thyroid gland</td>
<td>Goitre</td>
<td>Iodine</td>
</tr>
<tr>
<td>Skin</td>
<td>Oedema (bilateral)</td>
<td>Protein-calorie</td>
</tr>
<tr>
<td></td>
<td>Follicular hyperkeratosis</td>
<td>Vitamin A</td>
</tr>
<tr>
<td></td>
<td>(type 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pellagrous dermatosis</td>
<td>Niacin</td>
</tr>
<tr>
<td>Skeleton</td>
<td>Epiphyseal enlargement (wrist)</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Rickety rosary</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Persistently open anterior fontanelle</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Harrison's sulcus</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Bossing of skull</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Knock-knees</td>
<td>Vitamin D</td>
</tr>
<tr>
<td></td>
<td>Bow-legs</td>
<td>Vitamin D</td>
</tr>
</tbody>
</table>

general nutrition surveys in that such data highlight, unlike anthropometry, specific nutritional deficiencies. However, clinical data have important limitations. With few exceptions (i.e., thyroid enlargement and iodine deficiency), most signs are not very specific and as a result the interpretation of clinical data is difficult. Some clinical signs, for example, are common to more than one nutrient deficiency while others may result from non-nutritional factors. Nonetheless, in combination with dietary data and biochemical parameters, clinical data are a valuable adjunct in the diagnosis of nutritional problems. Another aspect to consider is that prevalences of clinical signs, even in areas where the underlying problems are endemic, are likely to be quite low for the simple reason that most of the signs appear only at the extremes of severity of deficiency syndromes. Also, skilled personnel is necessary (either physicians, nurses, or paramedical personnel) and rigorous training is required to standardize measuring techniques.

In order to reduce survey costs, data collection should be restricted to only those signs indicative of nutritional deficiencies known to be high in the area. For example, where vitamin A deficiency is particularly severe, data on the prevalence of Bitot's spots, conjunctival xerosis, and night blindness should be collected. Or, where iodine deficiency is a serious problem, health and nutrition surveys should attempt to ascertain the prevalence of goiter, as well as that of motor-mental retardation and cretinism.

Recent clinical surveys of vitamin A deficiency from Sri Lanka (Brink et al., 1979) and Indonesia (Sommer et al., 1980) are illustrative of the advantages and limitations of clinical data. In the survey carried out in Indonesia, 5925 preschool children were examined in a house-to-house rural field survey while 13,450 children 6 through 71 months were included in the countrywide survey in Sri Lanka. The presence of Bitot's spots and conjunctival xerosis were
assessed by an ophthalmologist in the Indonesia survey and by trained paramedical personnel in Sri Lanka. Both surveys also questioned parents (Sri Lanka) or the person accompanying the child to the examination center (Indonesia) about the occurrence of night blindness in children older than two years of age. The prevalence of night blindness was 4.6 percent and 1.0 percent in Indonesia and Sri Lanka, respectively. The prevalence of Bitot's spots and conjunctival xerosis was 2.2 percent in Indonesia while that of Bitot's spots in Sri Lanka was 1.1 percent. The low prevalences illustrate the rarity of clinical symptoms.

At the same time the substantially greater prevalences found in Indonesia confirm that vitamin A deficiency is a greater problem there than in Sri Lanka. According to WHO criteria (WHO, 1976a, p. 31), the reported prevalences of Bitot's spots with conjunctival xerosis indicate that a problem of "public health magnitude" exists in Indonesia but not in Sri Lanka, two areas showed substantially higher prevalences (as high as in Indonesia) and on this basis the Sri Lanka Ministry of Health redirected the distribution of vitamin A capsules.

Vitamin A deficiency is a serious public health problem in Indonesia and strong arguments exist for including data collection on clinical signs of vitamin A deficiency in health and nutrition surveys planned for the area. Similarly, a rationale for other types of clinical signs could be advanced for other areas of the world (e.g., iodine deficiency signs in the Andean region of South America).

1/ Objective assessment of night blindness is a difficult undertaking under field conditions and notoriously so when dealing with young children; hence the significance of the use of reports by parents and relatives. Interestingly, local, common terms exist for night blindness in Indonesia ("Buta Ayam" and "kotokkeun" in Indonesian and Sundanese, respectively) as well as in Sri Lanka ("Thamas andhykaraya" and "Mallai-kann viyadi" in Senhalese and Tamil, respectively). Sommer et al. (1980, p. 887) point out that their Indonesian study suggests that "a properly elicited history of night blindness can be almost as specific and far more sensitive an index of vitamin A deficiency and early xerophthalmia than the presence of Bitot's spots. . . ."
D. Measures of Food and Nutrient Intake

Outcome variables such as growth rates in children are used to measure health and nutritional status. Input variables, such as food and nutrient intake, are complementary in that they serve to identify the causes of poor status.

The design of programs aimed at improving nutrition and health requires information on both output and input measures. For planning purposes, food and nutrient intake data for all regions and groups of the country would be desirable so as to identify those pockets of the population where specific dietary deficiencies are concentrated. Unfortunately, food and nutrient intake data are difficult to obtain and are thus available, on a systematic basis, only for a few countries, mostly developed nations.

1. Food Balance Sheets

In the absence of country-specific food consumption data, groups such as the FAO and the World Bank rely on food balance sheets. The intent of food balance sheets is to estimate the amounts of foods available at the retail level for human consumption. Usually, the amounts of foods are expressed as calories or grams of protein available per person with the use of tables of food composition and census data.

The factors that go into the preparation of food balance sheets are outlined in Table 9. An article written in 1961 by Helen C. Farnsworth, appropriately entitled "Defects, uses and abuses of national food supply and consumption data," is generally regarded as one of the best and most
Table 9

Factors that go into the preparation of food balance sheets 1/

<table>
<thead>
<tr>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Domestic production</td>
</tr>
<tr>
<td>2. Net imports or exports</td>
</tr>
<tr>
<td>3. Net changes in year-end stocks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seed</td>
</tr>
<tr>
<td>2. Industrial nonfood use (counting alcoholic beverages as nonfood)</td>
</tr>
<tr>
<td>3. Animal feed</td>
</tr>
<tr>
<td>4. Waste on farms and in distribution up to the retail level</td>
</tr>
<tr>
<td>5. Processing or extraction rate losses of foods like cereals</td>
</tr>
<tr>
<td>6. Net food supply at the retail level</td>
</tr>
</tbody>
</table>

1/ After Farnsworth (1961).
complete critiques of food balance sheet methodology. Specifically, she points out:

Ideally, for each food commodity, each of the nine supply and utilization estimates and also the population and nutrient conversion figures should be both independent and trustworthy. Ideally, also, the sum of the three supply elements should in every case precisely equal the sum of the six utilization elements. Alternatively, eight of the nine balance sheet elements might be independently and reliably estimated, with the ninth determined as a residual that could be adequately tested and found reasonable.

In actual fact, however, not even the dozen or so countries with the most highly developed statistical services fully meet either of these ideal standards. Even these countries never attempt to collect statistical reports on all food production, intentionally avoiding the difficulties and the heavy costs of obtaining data on minor crops, minor producing areas, and/or home gardens. Moreover, these countries usually limit stock records to major commercial and government holdings of a few primary food commodities; they rarely have more than the crudest, most incomplete records of the foodstuffs fed to animals or of the amounts lost and wasted on farms, in transport, and in storage; and their direct information on non-food industrial use is often confined to earlier census data supplemented by annual reports from a selected sample of large industrial firms. Indeed, even the current population estimates for such countries may well be wrong by one or two per cent... 

Disturbing as such statistical shortcomings may be in the construction of food balances for highly developed countries, they shrink almost to insignificance compared with the distorting defects and inadequacies of food statistics and population estimates of many underdeveloped countries (Farnsworth, 1961, pp. 181-182).

While improvements over the years in the quality of the data undoubtedly have taken place, her criticisms, particularly about the data from developing nations, still stand.

Food balance sheet data provide us with estimates of the amounts of food potentially available to individuals. Food balance sheet data, particularly when available on a periodic basis, provide a measure of the success of agricultural policies and, when viewed against population size
and its rate of growth, give a general impression of the adequacy of the food supply. The most serious limitation of food balance sheet data is that they do not provide information about the distribution of food within the country. 1/

2. Food Consumption Surveys

Food consumption surveys are desired because of the marked inequalities in food distribution in developing countries. Food consumption surveys are those which generate estimates of actual food and/or nutrient intakes by households and individuals within a household. Through such surveys, those groups (whether defined by ethnic origin, class, geography, demographic characteristics or combinations of these) with the most pronounced nutritional deficiencies can be identified.

a. Household Food Surveys

Burke and Pao (1976) provide descriptions of the various types of household food surveys. The variation in methods are great and as so many authors have pointed out, the purposes of the study have to be kept in mind when choosing the most appropriate methodology.

---

1 In the absence of food consumption data, some have allocated the known total consumption figure across income groups in the population (Reutlinger and Selowsky, 1976; FAO, 1977; Selowsky, 1978). For example, FAO fitted a beta-distribution to the per caput calorie availability, set the lower bound of the distribution at 1000 calories (adjusting downwards in populations with smaller body weights), estimated the standard deviation from a function relating per caput intake and per caput income and expenditure, set the upper bound as the food balance sheet mean plus three standard deviations, and then estimated the percent of the population with intakes below a critical limit (120 percent of the basal metabolic rate) for specific countries and regions of the world.
Some types of household food surveys are described in Table 10. Surveys of purchases and acquisitions, the "food accounts method," are best suited where food is purchased daily and where storage is minimal. The food account method would not be suitable where storage is minimal; consequently, it would not be suitable in "supermarket-refrigerator" cultures or in subsistence agriculture areas. The "inventory-record" method is more suitable where both changes in household stocks and food acquisitions are important. The list-recall method, as the name implies, relies on the ability of the homemaker to recall all quantities acquired of a specific list of foods and is an alternative, therefore, to the "purchases and acquisition" method. Finally, the "food preparation record" method relies upon an observer who weighs and measures all of the food supplies used in meal preparation. This methodology has been used with success in such areas as rural Guatemala by INCAP; personnel requirements are, however, very large.

There are many variations to the methods listed in Table 10 and in some surveys, combinations of more than one method are used. Generally, data are gathered for seven consecutive days.

The amount of food available for consumption is sometimes expressed in terms of "man" consumption equivalents. Women and children of various ages are multiplied by factors to yield food consumption units. Such procedures assume that food is distributed within the family according to nutritional needs (i.e., the basis for the factors).

Records of all food wasted and spoiled, food given to pets, food taken out of the home and of food amounts actually consumed by individuals are
### Table 10

Types of household food surveys

<table>
<thead>
<tr>
<th>Type</th>
<th>Procedure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Purchases and acquisitions</td>
<td>Homemaker is asked to record all food acquisitions.</td>
<td>Assumes no changes in household inventories. Best where homes have limited storage facilities, especially refrigeration and where shopping occurs daily or several times a week. Requires at least two visits at the beginning and end of the period.</td>
</tr>
<tr>
<td>2. Inventory-record</td>
<td>Beginning and ending inventories are taken; in addition, homemaker is asked to record all food acquisitions.</td>
<td>Appropriate where changes in household stocks are expected and where homes have large storage capacities. Requires at least two visits, at the beginning and end of period.</td>
</tr>
<tr>
<td>3. List-recall</td>
<td>Using a list of major foods, homemaker is asked to recall amounts of foods purchased or acquired.</td>
<td>Relies completely on recall. At least one visit is required.</td>
</tr>
<tr>
<td>4. Food preparation record</td>
<td>Supplies to be used in meal preparation are weighed and measured by an observer each day.</td>
<td>Appropriate where diets are simple, home production important and weight and volume units are not standardized. Requires daily visits.</td>
</tr>
</tbody>
</table>

1/ After Burk and Pao (1976). Usually information is obtained for a seven-day period.
collected in some household food surveys. With these complementary data, the
surveys described above do yield true "consumption" data at the household
level.

b. Measures of Individual Food and Nutrient Intake

Methods for determining the food and nutrient intake of individuals are
just as varied. The time period studied, the measurement techniques used, the
food items emphasized, and the determination of nutrient composition may all
vary as shown in Table 11. The period of assessment in surveys may vary from
a few hours (i.e., for a specific meal) to a full week. The measurement tech-
niques may range from the very detailed, where an investigator weighs and re-
cords all foods consumed, to those that rely on recall reports from indivi-
duals. Data on the amounts of specific ingredients used in the preparation of
composite dishes are usually obtained in detailed surveys but not in more
general assessments where households are assumed to use a "standard" recipe.
In very specific surveys, only the data on the consumption of a few foods
(i.e., those rich in calcium) may be obtained. Also, nutrient intake estimates
may be derived from chemical analyses or from food composition tables.

The degree of subject cooperation and of personnel, equipment and sup-
plies required to carry out a dietary investigation obviously varies according
to the choice of methods. The items in Table 11 are listed in decreasing order
of expense and difficulty. Thus the most difficult survey to carry out would
be one for seven days, with recording and weighting by an investigator of
ingredients as well as foods "as consumed," and finally, with the collection of
food samples for chemical analyses of nutrient content.

1/ Detailed methodological descriptions may be found in Marr (1971). Additional
information, sample questionnaires, and suggestions for analyses are given by
Table 11

Variable approaches in assessing short-term individual food and nutrient intake

<table>
<thead>
<tr>
<th>Time period studies</th>
<th>Measurement techniques</th>
<th>Food items measured</th>
<th>Determination of nutrient composition of diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 7 day</td>
<td>1. Record with weighing and accurate volume measures</td>
<td>1. Detailed amounts of ingredients used in the preparation of composite dishes and amounts actually consumed (i.e., served minus plate waste)</td>
<td>1. Chemical analysis of samples (all nutrients)</td>
</tr>
<tr>
<td>2. 3 day</td>
<td>a. by investigator</td>
<td>2. Households assumed to use standard recipes; amounts actually consumed recorded as noted above.</td>
<td>2. Bomb calorimetry (energy) plus food composition table</td>
</tr>
<tr>
<td>3. 24-hour</td>
<td>b. by subject or homemaker (e.g., diary with weighing)</td>
<td></td>
<td>3. Food composition tables</td>
</tr>
<tr>
<td>4. specific meal</td>
<td>2. Record in terms of household units; may involve the use of food models</td>
<td>3. Data collection limited to selected foods (e.g., the staples; only rich in vitamin C, etc.)</td>
<td>a. for specific food (i.e., ingredients)</td>
</tr>
<tr>
<td></td>
<td>a. by investigator</td>
<td></td>
<td>b. for standard recipes</td>
</tr>
<tr>
<td></td>
<td>b. by subject or homemaker (diary)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Recall</td>
<td>a. by subject</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. by homemaker</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Surveys may also be designed to estimate the usual intake of individuals which may be variably defined as intake during months, years, or even the entire lifespan. One approach, as used in longitudinal studies, is to estimate usual intake from a series of short-term estimates at periodic intervals during the long-term period in question. For example, the usual intake during pregnancy may be assessed by means of monthly "three-day weighed record" surveys. Other approaches include the "history" or "Burke" method which seeks to determine the usual dietary habits (i.e., butter on toast, milk and sugar in coffee, etc.) and food consumption (i.e., usual breakfast) of individuals. The Burke method is generally recognized as difficult in that it requires a great deal of cooperation from the subject and considerable training and experience on the part of the investigator. An alternative method is the dietary frequency, where the individual is asked to recall the frequency (i.e., number of times per week) with which particular foods (i.e., milk and milk products) are consumed by individuals. Unlike the Burke method, the dietary frequency cannot yield average daily nutrient intake estimates.

c. Anthropological Studies of Food Habits and Beliefs 1/

Nutrition and health problems are also affected by cultural factors. These factors may, for example, determine how food is distributed within the family (e.g., adult males fed first), and what to or what not to consume while suffering from particular ailments, at particular ages (e.g., infancy) or at physiological stages (e.g., pregnancy). It is widely accepted that

1/ A separate section is set aside below for a discussion of breast-feeding practices.
cultural factors are an important cause of health and nutritional problems and that there is much to be gained by implementing sound public education programs. The ubiquitous radio may be the most inexpensive and appropriate medium for reaching dispersed, illiterate populations.

Cultural factors are aspects deserving attention at the level of program planning and implementation. What may look good on the drawing board may be rejected because of cultural barriers. By the same token, a program's chances of success may be enhanced if woven into the local matrix of customs and beliefs.

It is strongly recommended that anthropological studies of food habits and beliefs be included when assessing the causes of food and nutrition problems and when designing and executing health and nutrition interventions. Survey methodology (i.e., standardized questionnaires) as well as the classical ethnographic approach should be used.

3. Advantages and Limitations of the 24-hour Recall Survey

Taking into account the constraints within which surveys of food consumption would have to be gathered in surveys of the standard of living in developing countries (see Section I), the 24-hour recall survey appears as the most promising method for obtaining data on the household and its individuals. The 24-hour recall survey is simpler, cheaper, and more feasible than other dietary methods and provides data that are useful for population assessments of health and nutritional status and for monitoring changes over time.

With careful methodology (see next section for specific recommendations) the 24-hour recall survey will yield reliable mean estimates of the nutrient intakes of groups. As noted by Beaton et al. (1979, p. 2546): "In comparison
to other techniques it is generally agreed that for large groups of subjects, well-conducted 24-hour recalls provide estimates of group average intakes that are comparable to those obtained with more cumbersome techniques."

What single 24-hour recall surveys do not provide are estimates of the usual intake of individuals or of the true variance in usual intake in the population. Figure 10, reproduced from Salvosa et al. (1979), illustrates these points in an elegant way. The solid line joins the values obtained from 47 separate 24-hour recall surveys of a Filipino boy over a period of some 320 days. The 47 values range from a high of nearly 2000 calories to a low of around 650 calories and the mean for all values is around 1320 calories. Means of consecutive values become increasingly better estimates of the child's usual intake as the number of surveys used to estimate the mean (i.e., 5, 10, 15, and 20) is increased.

The variance in intake observed in data from single 24-hour recall surveys is thus made up of true variance in usual intake, day-to-day variation in intake and error variance. It is inappropriate therefore to ascertain the proportion of individuals at apparent nutritional risk from single 24-hour recall surveys (Garn, 1978). In similar fashion, the specific individuals with low intakes, say of vitamin A, cannot be identified using data from single 24-hour recall surveys. An individual, for example, who may have had a low intake of vitamin A on the day of the survey, may habitually have high intakes most days to the point of having ample liver retinol reserves. Indiscriminate use of the 24-hour recall survey will thus lead to an overestimation of
Figure 10

Intake of energy on different days by one boy

From Salvosa et al. (1979)
the percent of subjects with nutritional problems and to a misclassification of the status of specific individuals. Finally, it is evident that single 24-hour recall results will not correlate well with aspects likely to be a result (i.e., growth) or a cause (i.e., income) of usual dietary intakes.

In spite of these limitations, 24-hour recall dietary data are extremely valuable in population assessments. The data can, of course, be used to identify those groups with the poorest intakes as well as their particular nutrient deficiencies. At the group level, dietary data can be related to other group characteristics. For example, mean caloric intake during pregnancy in the various regions of the country should be expected to correlate with the prevalence of birthweight or with average family incomes in each area.

4. Methodology of the 24-hour Recall Survey: Some Suggestions

a. General Characteristics of Diets in Developing Countries

The dietary methodology needs to be "fine-tuned" to the particular culture setting where it is to be carried out. There are, however, some common elements to the diverse cultural areas of the developing countries that are to be noted. In most cultures of poverty the diet is monotonous with one or two staples providing most of the protein and calories. It becomes essential therefore to concentrate upon measuring the amounts of the staples consumed. Another general characteristic which requires methodological attention is the lack of standard weight and volume measures. Also significant is the fact that in most rural and even in some poor urban areas, most of the food consumed is prepared at home. Cooking is likely to be a major activity for the homemaker and the
amounts of food available to the family and the portions given to each member are likely to be clearly remembered a day later by the homemaker. She can thus be relied upon for a great deal of information about food intake in the household. These final aspects certainly facilitate data collection.

b. Personnel

The dietary interviews should be conducted by natives of the particular culture as it is absolutely essential that they be familiar with the nuances of local food habits. The interviewers, because they will be dealing mostly with women subjects, should be women. They need not be trained dietitians however. Secondary school training is desirable and facility with arithmetic is essential. Above all, interviewers must be courteous, sensitive individuals; it is these qualities, more than others, that influence the quality of the data obtained.

c. Approach to the 24-hour Recall

The substantive part of the interview should begin with a detailed inquiry about the kinds and amounts of foods used in meal preparation for the household in the previous 24 hours. Secondly, questions about recipes used in preparing all dishes and beverages should be asked. Next, information about food left over or otherwise not used for consumption should be obtained. It is only at this stage that questions about the food intake of individuals should be asked.

1/ The advent of cheap pocket calculators, with which interviewers should be provided, has made the task of estimating weights and volumes easier.
The inclusion of household food consumption data in surveys targeted to individuals helps the homemaker to remember and also permits some errors to be detected as, for example, when foods prepared for the family are not reported for particular individuals. Thus, the above approach yields better individual data as well as useful household information.

Questions about kinds and amounts of food consumed by individuals, both during and between meals should be asked. Efforts should be made to interview the homemaker and each of the household members together. Children should be questioned directly about fruit consumption between meals, particularly at seasonal peaks of availability.

d. Household Measurements and Food Models

To cope with the lack of standard household weights and measures, the dietary interviewer should be provided with a scale, beakers for measuring volumes, and spoons and/or other eating utensils of various sizes. In determining volumes, the interviewer should ask to see the glass bowl or cup and inquire as to the level to where it was filled. Where necessary and possible, the container should be filled with water to the level indicated and the water poured into a measuring beaker to determine the volume. Similarly, the interviewer should ask to see items such as bowls and spoons (or other such utensils) reported in the interview and attempt to match them with members of the series she should be carrying. Alternatively, the homemaker could be shown the array of "spoons" or "bowls" and be asked to pick the "one most like it" and also be questioned as to the extent to which it was filled.

Models may be useful for ascertaining sizes and weights of portions, particularly of the staple foods. Corn, for example, is the staple in rural
Guatemala where the bulk of consumption is in the form of round cakes or "tortillas." Inquiring only about the number of tortillas consumed would be a mistake for the weight varies considerably between families as shown in Figure 11 where a range from 19.6 to 94.4 g is observed. Because the variation in weight was largely a function of the diameter and not the thickness of the tortilla, as shown in Figure 12, it was possible in studies conducted by INCAP to design a set of disc models from which informants could choose the one best approximating their tortilla. Field tests compared actual tortilla weights with estimates derived with the use of models and revealed that the weight of tortillas was estimated within acceptable limits.

e. Nutrient Data Bank

Though there are errors, sometimes substantial ones, associated with the use of food composition tables, the alternative, the collection of food samples for laboratory analysis of nutrient composition, is impractical and expensive. The errors can be minimized, as Marr (1971) points out, by selecting food composition tables that are appropriate to the geographical area being studied. In other words, the tables used must list the nutrient composition of the actual food varieties consumed in the area and of the recipes typical of the area. Laboratory analyses will be required if the nutrient composition of important local foods is not available.

f. Quality Control

The dietary survey team should be led by a supervisor who trains interviewers and ensures that field procedures, as stated in the dietary manual, are being followed. The supervisor should also review on a systematic basis a proportion of the dietary forms to check if they are being properly filled out. These should be used as a backup for situations where the informant does not know the recipe.
FIGURE 11 Percent Distribution of Tortilla Weights (n=336 family-day observations)†

†From Valverde et al. (1980).
FIGURE 12  Plot of Diameter (mm) against Weight (g) of Tortilla (n=84)†

†From Valverde et al. (1980).
On a periodic basis, the supervisor should accompany each of the interviewers on a portion of the household visits. Recording of the information should be done by both for later comparison. Discrepancies between the two forms and observed deviations from the specified methodology should be discussed and clarified, but in an open nonthreatening manner.

It is also desirable that substudies be carried out, during the pilot stages as well as during the actual survey, to ascertain the degree to which the 24-hour recall compares to other, more time consuming but more exact methodologies. For example, the 24-hour recall could be compared to the "record-with-weighting" method; also, food samples could be analyzed in the laboratory and differences between values obtained using food composition values and direct chemical analyses should be documented.

The forms from the field should be handled as recommended for anthropometric data. As soon as the data are punched, the values should be checked for outliers, both on the low and the high sides. Some of the very low values (some may even be zero values) may be from subjects ill at the time of the interview. These values should not be deleted. After checking the forms for errors, an upper limit should be used to delete impossible values.

g. Analysis of Dietary Data

Food composition tables contain information about energy and many nutrients including protein, fat, carbohydrate, water, calcium, phosphorous, iron, vitamin A, thiamine, riboflavin, niacin, and ascorbic acid. With the use of these tables, food consumption data can be easily expressed in terms of desired and available nutrients (e.g., information about trace minerals is not generally available). Other useful indicators are protein derived from vegetable
and animal sources, percent of calories derived from protein (PC%) and percent of calories derived from utilizable protein (NDpCal%). Values should be summarized for age-sex specific groups (children of various ages, women and men) and separately for pregnant and lactating women.

In using dietary data either to assess the nature of nutritional problems, to identify the worst-off groups or to design nutrition interventions, it should be stressed that their value is greatest when combined with anthropometric, clinical, and biochemical data. Together, the data often make sense; separately, they sometimes do not.

For some purposes, the analysis of dietary data need not require the use of standards (i.e., FAO/WHO requirement for protein and energy). There may be an interest, for example, in determining the extent to which food and nutrient intakes are dependent upon income or in documenting seasonal variations in intakes. Yet for many purposes, a reference standard will indeed be necessary.

There are many ways in which dietary standards can be used. Assume, for example, that there is an interest in comparing intakes of the various groups (i.e., by region, ethnic origin, religion, social class, etc.) that may compose a country. While these analyses could be carried out with actual nutrient intake values, the interpretation of group differences will still require some sort of yardstick to assess their importance. Nutrient data may, for example, be expressed as a percent of the age-sex requirement (or allowance) yielding statements such as "the mean intake of group A is 120 percent while that of group B is 80 percent of requirement (or allowance) values." These relative comparisons enable planners to select the groups with the most serious dietary problems. In many instances, the "worst-off" groups may have nutrient deficits so low as to overwhelm the sources of error inherent in the dietary standards.

1/ Utilizable protein refers to protein intake adjusted for protein quality (i.e., chemical score, net protein utilization [NPU]).
It would also be interesting to estimate the percent of individuals by region who have "unacceptable" energy or nutrient intakes. However, in a previous section, it was emphasized that single 24-hour recall data do not measure actual intakes. Hence, it would be inappropriate to use 24-hour recall data for these purposes. 1/

In the case of children, the question arises as to whether actual or ideal body weight should be used in estimating requirements, particularly energy. As far as short-term planning (i.e., designing a food supplementation program, assessing the adequacy of the current food supply), it is recommended that ideal weights be used for children under five and actual weights thereafter. Elsewhere we have argued that older children retain only a very limited capacity for "catching up" (Martorell et al., 1979). The data presented earlier in Table 5 underscore the fact that children who are stunted at 5 years of age will become stunted adults. On the other hand, stunted children whose fortunes change for the better during infancy or shortly thereafter, show a remarkable ability to catch up in growth (Winick, 1975).

1/ It is beyond the scope of this document to deal with the discrepancies between the World Bank's and the FAO's estimates of the prevalence of energy deficient diets in the world (Reutlinger and Selowsky, 1976; Reutlinger, 1980; FAO, 1977) nor with models of protein and energy deficiency (Sukhatme and Margen, 1978; Srinivasan, 1980). Some points are, however, worth noting. Percent of "deficient" diets should never be equated with percent "malnourished"; rather, outcome data (i.e., clinical, anthropometric, and biochemical data) are needed to assess malnutrition. In the case of energy, patterns of energy expenditure would be desirable when assessing adequacies of intake. While single 24-hour data are only appropriate for estimating means, the data can be used to assess the relationship between income and intakes at the group level and to ascertain how aggregate consumption is distributed across groups. These results may then be taken into account when estimating the percent of deficient diets from food balance sheet data.
Nutritionists will also be interested in nutrient interrelationships. For example, in identifying the causes of anemia in a particular region, the intake of iron, as well as folate and $B_{12}$, would need to be examined. Further, attention would also be paid to factors which enhance (e.g., heme iron, animal protein, vitamin C) or inhibit (e.g., fiber phytate) iron absorption and to factors which modify utilization (e.g., infections such as hookworm and malaria, menstruation). Another example is the use of NDepCal% values in investigating whether the diet provides enough protein in relationship to energy (Payne, 1975). Also, in assessing the adequacy of local diets for young children, consideration of the weight and bulk of the usual diet would be important; and, in designing appropriate weaning foods, inexpensive, digestible and nutrient dense local foods would need to be identified.

E. Breast-Feeding

The introduction of bottle feeding in developing countries poses a serious public health threat. Because of the importance of breast-feeding for the nutritional well-being of the child, and the ease with which prevalence data can be obtained, it is highly recommended that a few simple questions on the subject be appended to the dietary questionnaire.

For all children less than three years of age, at least the following questions should be asked:\footnote{Examples of more extensive questionnaires are given in den Hartog and van Staveren (1979).}

1. Is the child currently breast-fed? (Answers: yes, no, don't know.)

2. If no longer breast-fed, how old was he/she when completely weaned?
   (Answers: 00 means never breast-fed, other answers coded to the nearest month.)
iii. Why was breast-feeding stopped? (Most common answers should be precoded.)

iv. Has bottle feeding ever been used? (Answers: yes, no, don't know.)

v. If yes, at what age was it introduced? (Answer: code age.)

Data from the National Survey of Family Growth conducted by the National Center for Health Statistics of the United States show that through such simple questions trends in breast-feeding can be easily monitored (Hendershot, 1980).

F. Biochemistry

Measuring the levels of nutrients or their metabolites in body fluids (i.e., blood or urine) or in body stores (i.e., liver, bone marrow) allows for more precise definition of the nature of the nutritional problems in a particular region. Where costs, laboratory facilities, trained personnel, and logistics are not limiting factors, health and nutrition surveys should and do not include many biochemical tests. For example, the biochemical tests carried out in blood during the second HANES (Health and Nutrition Examination Survey) of the National Center for Health Statistics of the United States were the following: hemoglobin, hematocrit, protoporphyrin, total iron binding capacity, serum ferritin, zinc, copper, red cell folates, serum folates, B₁₂, albumin, vitamin A, vitamin C, and serum lipids (cholesterol, triglycerides, and high density lipoprotein).

Unfortunately many factors make the systematic collection of biochemical indicators in developing countries impractical. There are the obvious problems of lack of laboratory facilities, skilled technicians, difficulties of proper handling of samples in the field (i.e., refrigeration), costs and so on. For those who have been involved with survey research, the panic caused by the drawing of blood, particularly in children, is a matter of serious consideration.

Perhaps one way to approach the problem of whether to include biochemical indicators in the health and nutrition surveys contemplated by the World Bank
is through the answers to three questions: (a) What is the least objectionable sample which could be obtained in such surveys? (b) What information would such a sample give? and (c) Is this information useful?

Collecting casual urine samples (the collection of 24-hour samples would be a formidable feat) is easier in males for obvious reasons, but still requires considerable effort, time, and personnel. The information that can be obtained from a urine sample (thiamin, riboflavin, nicotinic acid, urea, creatinine) is considerably less, and less useful than that which is possible from a blood sample. Small blood samples (i.e., 0.5 ml) can be easily collected in capillary tubes by a finger-prick. The samples can then be packed in ice in styrofoam boxes and taken, hours later, to a central station for processing. The simplest determination that can be made after centrifuging the capillary tube is hematocrit. Hemoglobin can be measured through a variety of simple techniques. The sera can be tested for vitamin A (retinol) levels as well as for numerous other aspects (i.e., carotene, vitamin C, B₁₂, folate, calcium, protein, albumin, specific amino acids, lipids, etc.).

Though capillary tube samples can be obtained easily, the limitations already mentioned (i.e., equipment, personnel, etc.) would remain. For nutritional surveillance purposes, a Joint FAO/UNICEF/WHO Expert Committee recommends hemoglobin as the only "biochemical" parameter to measure (WHO, 1976b). Hemoglobin determinations are also included among the indicators listed in a simplified field assessment of nutritional status in developing countries proposed by AID (1977). These recommendations reflect the important public health problem which nutritional anemias constitute in developing countries, particularly in pregnant women. Vitamin A deficiency is also a serious public
health problem in many areas, and the determination of serum retinol could be considered in such areas if proper facilities were available. Serum retinol and hemoglobin, like many biochemical indicators, are insensitive in mild and moderate degrees of deficiency.\(^1\) Iron deficiency anemia, for example, is a process which first affects the body stores. Progressively, as the stores dwindle, erythropoiesis becomes deficient and hemoglobin values begin to fall.\(^2\)

While biochemical tests do exist to monitor iron status at mild (serum ferritin) and moderate stages (transferrin saturation and free erythrocyte protoporphyrin), these require sophisticated technology.

In conclusion, biochemical test determinations are difficult and expensive to carry out in developing countries. Where a particular nutritional deficiency is a major public health problem, biochemical data may be obtained through specific substudies.

G. Illness

The earlier sections of this report emphasized that infection is a major cause of nutritional problems in developing nations. Clearly, surveys of nutritional status would be incomplete without morbidity information.

Many health surveys, such as the Health and Nutrition Examination Survey (HANES) of the U.S. National Center for Health Statistics, rely upon information provided by respondents in combination with physical examinations by medical personnel. Data thus gathered are ideal for monitoring health and nutritional status in populations over time. Unfortunately, health surveys of this nature require specialized personnel, equipment, supplies and time.

\(^1\) See Cook and Finch (1979) and Baker and DeMaeyer (1979) for a discussion of nutritional anemia assessments and the report of a joint WHO/USAID meeting (WHO, 1976a) for a complete presentation of vitamin A and xerophthalmia assessments.

\(^2\) Where iron deficiency anemia is a serious problem, hemoglobin values have been shown to be predictive of physical fitness and work capacity in men (Viteri, 1976).
Fortunately, however, in many countries the data collected by the epidemiological section of the health ministry can be useful for identifying the relative prevalence of causes of morbidity. These data include such aspects as pediatric admissions for nutritional deficiencies, reports of child communicable disease (i.e., measles, whooping cough) and reports of chronic conditions (i.e., malaria, tuberculosis). The word "relative" is emphasized because the data are rarely derived from random surveys; rather the sources of information are usually patient reports from hospitals, clinics and rural health facilities.

Clinic data are likely to underestimate the true prevalence of health problems and may vary considerably in quality in the various regions of the country. Nonetheless, clinic data will identify the major causes of morbidity and their relative importance. With proper attention to the potential for bias, clinic data can be broken down by region and analyzed in conjunction with the survey data.

It is highly recommended that those responsible for the coordination of the surveys of living standards collaborate with the epidemiological division in improving the data collection system, and in the editing, summarization and analysis of data. This option is considerably cheaper than implementing special surveys. At the same time, upgrading the country's information system would provide valuable assistance.

In addition to the data that can be obtained from the epidemiological division, it is recommended that a few simple questions about diarrhea be asked of all children less than 3 years of age. The questions recommended are:

1. Has your child had diarrhea in the last two weeks?1/
2. What was the number of stools on the worst day?

1/ Onset and termination of each episode of diarrhea should be recorded to estimate duration. Some questions are patterned after those suggested in a WHO/SEA (1979) document.
iii. Were the stools mucous (slimy) or watery?
iv. Did you see blood in the stools?
v. Was the diarrhea accompanied by fever?
vi. Was the diarrhea accompanied by vomiting?

vii. During the episode of diarrhea, did the child lose his appetite?

The questions listed above are aimed at estimating the prevalence and severity of diarrheal diseases in children under 3 years of age. Mothers' reports of their children's illnesses have been found to yield reliable and valid data in rural Guatemalan populations.1/ Recall morbidity surveys of diarrheal diseases have been shown to provide data that are significantly related to physical growth, an indirect test of validity. A period of two weeks is recommended because the degree of underreporting (memory loss) would be substantial for greater periods. The questions on morbidity suggested here could be appended to the dietary survey or to any of the other household surveys.

The morbidity data obtained from mothers' reports is similar to that obtained from single 24-hour recall surveys in that measures of the usual illness pattern of individuals are not obtained. Rather, data on the mean prevalence (day sick/days survey) in the population at that particular time are obtained. Seasonal effects on diarrheal and respiratory infections are significant and a factor to consider in designing data collection and in comparing prevalences from the various areas of the countries.

1/ See Martorell et al. (1976c) for information about underreporting, and Martorell et al. (1975b) for data on reliability and validity.
H. Community Information

In addition to family and individual variables of health and nutritional status, information at the community level 1/ should also be collected. Examples of topic areas and target questions specifically in the area of nutrition and health are as follows:

i. Nutrition programs
   - What nutrition programs are available in the community (i.e., food supplementation, iodized salt, community garden)?

ii. Health and facilities
   - What medical facilities are available (i.e., clinic, health care personnel, traditional healers)?
   - What is the coverage of the vaccination program?
   - What other preventive medical programs are available?

iii. Environmental sanitation
   - Where does the water used for drinking and cooking come from?
   - What is the quality of the water and how much is available?
   - Where do people defecate?

iv. Family planning
   - What is available in terms of family planning and to what extent are these resources used?

v. Education
   - What formal and informal education programs are available (i.e., primary school, maternal and child health classes)?

1/ Information at higher levels (e.g., governments' allocations to health) are also desirable. These considerations, however, fall outside the scope of this document.
The above list is suggestive of the kinds of community variables that should be collected. Other important information would be contained in the agricultural production and marketing surveys which are assumed to accompany the health and nutrition surveys.

V. CONCLUDING REMARKS

A. Specific Recommendations

The main purpose of this document is to suggest indicators of nutrition and health status which are suitable for household surveys of the standard of living in developing countries.

A summary of the specific recommendation in each area and a brief description of the advantages and limitations of the indicators proposed are shown in Table 12. As noted earlier, the single best way to measure health and nutritional status and to monitor changes in populations through time is by means of anthropometry. However, while high in sensitivity, anthropometry is not informative of the causes of health and nutrition problems.

It is strongly recommended that dietary intake data be collected. The dietary method recommended is the 24-hour recall survey which provides data that allow for those groups with the worst mean diets to be identified, a task which cannot be done by means of food balance sheets. Anthropological studies of food habits and beliefs are also proposed.

It is strongly recommended that collaborative arrangements be made with the appropriate government divisions to collect data on birthweight and on morbidity. Birthweight is indicative of maternal nutrition during pregnancy and is predictive of infant mortality. With regards to morbidity data, it is suggested that the national systems of data collection and reporting be upgraded
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<tr>
<th>Area</th>
<th>Specific recommendation</th>
<th>Advantage</th>
<th>Limitation</th>
</tr>
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<tbody>
<tr>
<td>A. Anthropometry</td>
<td>Collect height, weight, arm circumference, triceps and subscapular skinfolds on all members of selected households.</td>
<td>Anthropometry is most useful for assessing the nutritional status of individuals and populations and for monitoring changes over time. Highly sensitive to health and nutritional changes.</td>
<td>The causes of nutritional problems cannot be identified through anthropometry. Lack of specificity for nutrients.</td>
</tr>
<tr>
<td>B. Birthweight</td>
<td>Establish collaborative project with appropriate government division to collect birthweight data.</td>
<td>Sensitive indicator of maternal nutrition during pregnancy and important predictor of infant growth and development.</td>
<td>Data are difficult to obtain for home deliveries in the rural area.</td>
</tr>
<tr>
<td>C. Clinical examinations</td>
<td>Limit data collection to problems of major public health concern.</td>
<td>Clinical examinations identify the most seriously malnourished.</td>
<td>Some clinical signs are not very specific. Standardization may be difficult.</td>
</tr>
<tr>
<td>D. Measures of food and nutrient intake</td>
<td>1. Food consumption by the household and individuals should be collected through 24-hour recall surveys. 2. Anthropological studies of food habits and beliefs.</td>
<td>1. These surveys provide reliable and valid mean estimates of the dietary characteristics of populations. 2. Useful in assessing the causes of problems and in planning interventions.</td>
<td>1. Single 24-hour recall surveys do not properly rank the intake of individuals nor do they estimate usual intakes. 2. Sophisticated personnel required to collect and interpret the data.</td>
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<tr>
<td>E. Breast feeding</td>
<td>Include simple questions for children less than 3 years of age on breast feeding status.</td>
<td>Easy way of monitoring duration and prevalence of breast feeding.</td>
<td>Only qualitative information is obtained.</td>
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<tr>
<td>Area</td>
<td>Specific recommendation</td>
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<tr>
<td>F. Biochemistry</td>
<td>Limit data collection to problems of major public health significance.</td>
<td>Most tests are highly specific for nutritional deficiencies.</td>
<td>Many tests are sensitive only in the extremes of severity. Specialized personnel and sophisticated equipment are required. Difficult to collect properly under difficult field conditions.</td>
</tr>
<tr>
<td>G. Illness</td>
<td>1. Obtain clinic data from epidemiology division.</td>
<td>1. Identifies relative importance of health problems.</td>
<td>1. Clinic data are biased. Requires cautious interpretation. 2. Seasonal variation must be considered in data collection design. Does not estimate usual illness pattern of individuals.</td>
</tr>
<tr>
<td></td>
<td>2. Include simple questions about diarrheal diseases for children less than 3 years of age</td>
<td>2. Ranks areas of the country in terms of prevalence.</td>
<td></td>
</tr>
<tr>
<td>H. Community health and nutrition factors</td>
<td>Collect data on the characteristics of nutrition programs, health care facilities and the environmental sanitation situation of the community.</td>
<td>Useful in explaining the community’s problems and in identifying its needs.</td>
<td>Resources and use of them vary greatly by household.</td>
</tr>
</tbody>
</table>
where necessary and that these data be used to identify the important health problems of the country. Caution in data interpretation is advised, given the characteristic biases of clinic data.

Because infants and young children are more likely to exhibit health and nutrition problems of a serious nature, it is recommended that a few survey questions would seek to estimate the prevalence and duration of breast-feeding, the use of bottle feeding and the prevalence of diarrheal diseases.

Information on clinical signs and biochemical indicators should be collected for problems of major public health significance. Perhaps these data could be collected in small-scale surveys and in cooperation with appropriate government divisions. Though biochemical and clinical indicators are sensitive only at the severe stages of deficiencies, they serve to confirm the existence of problems which could only be predicted with dietary and illness data. The needs for specialized personnel and in the case of biochemistry, sophisticated equipment, are likely to be serious limitations in some countries. It is highly recommended that if biochemical indicators are desired that micro-methods which rely on finger-prick blood samples be used preferentially.

There is a strong seasonal dimension to nutritional deficiencies and infectious diseases in developing countries, the wet season typically being the time when prevalence and severity of many problems are greatest (Chambers et al., 1979). Survey research is more difficult to carry out at this time due to swelled rivers, deteriorated roads and other similar obstacles. It is, thus, strongly recommended that seasonality be taken into account in designing the surveys. One satisfactory approach would be to extend data collection over a full-year cycle. That is, the temptation to hire many field workers to finish the interviews during the dry season should be resisted.
B. Gaps in Research and Methodology

A workshop was convened by SEARO (South East Asia Regional Organization, WHO) in June 1979 to formulate a comprehensive "research-cum-action" program in nutrition for the region (WHO/SEA, 1979). The program emphasized actions which could be implemented at the community level, even with the prevailing socioeconomic constraints, and focused on the problems of infants and young children. Though intended for South East Asia, the recommendations are also valid for other regions. Specific projects, survey instruments, design considerations, and other advice were provided in five priority areas:

i. Identification, development, evaluation and propagation of nutritionally adequate, inexpensive, locally available and culturally acceptable recipes for weaning foods for infants and young children in poor communities;

ii. Investigation of interactions of infections and undernutrition at the community level, including studies of the inter-relationship between the problem of diarrheal diseases and malnutrition;

iii. Investigation of maternal malnutrition and its impact on the condition of the offspring and identification of action at the community level to offset these effects;

iv. Identification, development and application of methods, at the community level for preventing vitamin-A deficiency (including, especially, nutritional blindness) anemia and goitre;

v. Identification of a minimal "nutrition component" of a package of basic health services for poor communities and operational research designed to develop the most effective and suitable strategies for the "delivery" of such a minimal nutritional program at the community
level, in the context of current constraints with regard to trained manpower and resources (WHO/SEA, 1979, pp. 3-4).

An FAO/UNICEF/WHO Expert Committee on "Methodology of Nutritional Surveillance" (WHO, 1976b) proposed specific projects in three general areas: causal relationships, significance of nutrition and health status indicators, and operational research. To these, a fourth category, development of methodology, should be added.

Causal relationships that merit study according to this Expert Committee are the following:

i. the relation between household food stocks at the end of the harvest period and the nutritional status of family members during the ensuing months;

ii. the effect upon family nutritional status of competition between production for export and production for household consumption; and

iii. the effects of family income and the cost of subsistence upon ... undernutrition.

Other causal relationships deserving study are the relative importance of infection, culture (i.e., food customs and beliefs) and poverty (i.e., lack of food per se) in causing nutritional problems. Also, the nutritional effects of government policies, whether these were intended to alter nutrition or not, is an area about which little is known.

The significance of health and nutrition status indicators, the second area of the FAO/UNICEF/WHO Expert Committee, is listed as the highest priority area in nutrition by the National Academy of Sciences (U.S.A.) in their 1977 study World Food and Nutrition Study, the Potential Contributions of Research (NAS, 1977). Three issues appear to this author to be salient:
i. identifying simple anthropometric indicators (i.e., relative importance of stunting and wasting indicators) for selecting those children more susceptible to infection and at considerably higher mortality risk;

ii. isolating the significance for birthweight and milk production of the various maternal nutritional status indicators (i.e., pre-pregnant weight, weight changes in pregnancy and lactation, height, weight for height, and nutrient intake); and

iii. isolating the relative importance of current measures of nutritional status in men (i.e., low energy intakes, weight for height, anemia) from the long-term effects of undernutrition during childhood (i.e., stunting, small muscle mass) in limiting work productivity for tasks usually undertaken in developing countries.

The efficiency of planning, organization, sampling, data collection, data flow, and data analyses and presentation are aspects of operational research that deserve attention. The cost of survey research, from the planning stage to the publication of results, is another area deserving investigation.

Better field methodology is needed for evaluating breast milk intake 1/ and for measuring energy expenditure, particularly in young children. Field worthy and inexpensive biochemical procedures for determining nutrient levels in body fluids and tissues need to be developed as well.

1/ The most widely used procedures call for the baby to be weighed before and after each feeding. In most societies feeding is on demand and measuring breast milk intake, particularly at night, is practically impossible.
C. Uses of the Health and Nutrition Data

The information that would be collected through the specific recommendations listed in Table 12 would provide a comprehensive look at health and nutritional status and allow for the formulation and implementation of a food and nutrition policy. Some specific ways in which the data could be used at the national level are shown in Table 13. In addition to these uses, the international donor community may require health and nutrition data to assess the relative needs of countries and to monitor relative progress, particularly where specific steps have been taken to alleviate the extent and seriousness of nutrition and health problems.
Table 13
Some Uses of Health and Nutrition Data in Developing Countries

<table>
<thead>
<tr>
<th>Uses</th>
<th>Exemplary tasks</th>
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<tbody>
<tr>
<td>1. Assessment of the nature, extent, and localization of nutrition</td>
<td>Calculate the prevalence and estimate the relative importance of health and nutrition problems.</td>
</tr>
<tr>
<td>and health problems.</td>
<td>Determine which groups are more afflicted by the more serious problems.</td>
</tr>
<tr>
<td>2. Identify the causes of salient health and nutrition problems.</td>
<td>Multivariate data analysis to single out causal factors.</td>
</tr>
<tr>
<td>3. Design of measures aimed at improving health and nutritio-</td>
<td>Assessment of resources and selection of cost effective measures.</td>
</tr>
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<td>ional status.</td>
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</tbody>
</table>
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