Simplified field assessment on nutritional status in early childhood; practical suggestions for developing countries

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A simple, inexpensive approach to the field assessment of nutritional status is proposed to determine the location and extent of protein-energy malnutrition and anemia in a defined geographic area. The approach has two principal features, a simple statistical method for randomly selecting the population samples to be studied, and a suggested core of objective nutritional indicators, uniformly measured, in young children. The method limits basic measurements to body length and weight, hemoglobin concentration, and pretibial edema. The need to adequately train indigenous paraprofessionals as assessors and to periodically control their measurement accuracy is stressed. The paper advocates the cross-tabulation form proposed by J.C. Waterlow for cross-classifying height-for-age and weight-for-height to estimate prevalence and severity of past and recent undernutrition. It suggests methods for comparisons with reference data. The Waterlow method makes the degrees of long-term stunting and shorter-term wasting in a population more readily discernable. In addition to providing baseline indications of where and to what extent common nutritional problems may exist in various regions of a nation, the assessment method, repeated periodically, will indicate changes with time, and thus it may be used to evaluate the effectiveness of remedial intervention. If the assessment demonstrates that protein-energy malnutrition is a public health problem, a supplemental ecologic analysis of possible causal factors may be indicated so that appropriate remedial programs can be instituted.
MANUAL FOR

SIMPLIFIED FIELD ASSESSMENT

OF NUTRITIONAL STATUS IN DEVELOPING COUNTRIES

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SIMPLIFIED FIELD ASSESSMENT
OF NUTRITIONAL STATUS IN EARLY CHILDHOOD:
PRACTICAL SUGGESTIONS FOR DEVELOPING COUNTRIES

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ABSTRACT

This paper proposes a simple and inexpensive method for the field assessment of certain objective indicators of nutritional status in children of preschool age. It emphasizes the need for statistically valid sample selection, and presents a design for randomly selecting 30 children from each of 30 village sites from each region for which quantitative inferences are to be made. The primary purpose being to estimate the prevalence of protein-energy undernutrition and anemia, the method limits basic measurements to body length and weight, hemoglobin concentration and pretibial edema. The presentation stresses the need to adequately train indigenous para-professionals as assessors, and to periodically control their measurement accuracy. It advocates the approach of Waterlow for cross-classifying height-for-age and weight-for-height to estimate prevalence and severity of past and recent undernutrition, and suggests methods for comparisons with reference data. The paper acknowledges that the method is limited to an estimate of location and magnitude of common childhood malnutrition, and recommends that it be supplemented, as appropriate and feasible, by detailed ecological analysis to elucidate causation and guide remedial action.
INTRODUCTION

The need for effective programs to improve global nutrition and health becomes evermore urgent. Information regarding the magnitude of the problem of malnutrition, the identification of population groups in greatest need of assistance, and the effectiveness of programs aimed at improving nutritional health can best be obtained by objective and periodic assessment of the nutritional status of representative communities.

In the past, national nutrition surveys have often been excessively costly and complex, as well as unrepresentative of the total population because of poor sampling techniques. Consequently, the translation of survey results into practical programs for nutritional improvement has usually been unsatisfactory. Because of these constraints, the replication of the surveys to measure program effectiveness has rarely been possible. Simpler methods must be developed and field tested which can provide maximum useful data with minimum expenditure of money, complex equipment, highly trained personnel, and time.
The outlines of such a simplified system are presented in this paper. The system utilizes certain key indicators of malnutrition to assess the magnitude of protein-energy malnutrition (PEM) and anemia in early childhood. The relatively few measurements recommended in this method can be performed by para-professional personnel who have been specially trained. The results can be quickly analyzed and made available for practical program planning and evaluation.

This method is not a comprehensive nutritional assessment of an entire population and cannot be expected to detect all cases of malnutrition, nor all of its correlates, within a community or a country. It is not designed to identify and measure the many ecologic factors associated with PEM. Such analysis requires greater sophistication, the determination of many economic, sociological, dietary, agricultural and other variables, and could be undertaken at a later stage in the development of nutrition improvement programs. The purpose of this simplified method is more to answer the question, "What is the magnitude and geographic extent of the problem?" than "What are its various causes?" It will generate valid and useful data bearing upon the prevalence of the most common nutritional problems of young children in developing nations, and thus provide indication of where, among whom, and what kind of nutritional problems require remedial action.
Since the physical growth of young children is no commonly threatened in the developing world by the interaction of infectious diseases and dietary deficiencies, simple body measurements of children between 3 months and 5 years of age constitute the core of the method. Since anemia also is widespread, determination of hemoglobin should be performed on a subsample of the children. These basic measurements may be supplemented by appropriate demographic, socioeconomic, laboratory, or clinical data based upon preliminary knowledge of the population to be studied and within the constraints of money, equipment, personnel and time. For example, if deficiencies such as hypovitaminosis-A are believed to be a public health problem, appropriate supplemental studies may be performed on a selected subsample.

Although this methodology is based upon direct assessment only of young children, Bengoa, et al (1), have shown that malnutrition in these early years may serve as an indicator of the probable level of nutritional status of the entire community. Rapidly growing children are at greatest risk of developing PEM, but that risk is lower, both under 3 months of age because of the still relatively high prevalence of breast-feeding in rural areas of developing countries, and over 5 years of age because of the greater host resistance
to infection and more varied dietary intake. In certain urbanized communities where traditional breast-feeding practices have declined, children younger than 3 months of age may optionally be included in the sampling frame and, for comparison, a subsample of younger babies should also be included from the countryside. For these small infants, weight alone, without length measurement, which is particularly difficult to perform accurately at this age, may be measured. Also, where information is available in regard to the peak incidence of PEM, it may be desirable to further limit the upper age limit of the children studied. Limiting the assessment to this narrow age range, in which male/female differences in most body measurements are minimal, facilitates statistical analysis of the data. For most analyses, the sexes can be combined, with a smaller number of children needing to be examined at each specific age level.

METHODS

The distinctive features of this simplified assessment are the statistical methods for representatively selecting the population to be studied, and the recommendations for employing a minimum core of objective nutritional indicators, uniformly measured. The recommendations provide reasonable assurance that valid comparisons can be made between defined subgroups within the total population. These sampling methods
and nutritional indicators are presented briefly in the following two sections, followed by suggestions on training the survey teams in performing accurate and reproducible measurements, and on logistics of conducting the survey. Finally, suggestions are presented on methods for data processing, feedback of results, utilization of results for preventive action, and evaluation of action.

The original methodology, employed in an assessment of nutritional status of displaced persons in South Vietnam in 1973 (2), has been revised and subsequently used in national nutrition assessments of Nepal (3), Sri Lanka (4), Liberia (5), Lesotho (6), and Togo (7).

Sample selection

General sampling recommendations, based upon field experience, consultations with authorities in sampling methodology, and a manual of sampling methods (8), are as follows:

1. Within a region for which reliable information is required, at least 30 sample sites are to be selected, using a population-proportional technique. For comparisons between one region and another to be valid, at least 30 such sites are required within each. Every effort must be made to examine the exact sites selected, and not to substitute others which may prove more convenient or cooperative.
2. Within each sample site, population proportional selection methods are employed, if possible, to select the first household. Thirty children of the appropriate age are then selected from this household and those nearby, rather than attempting to study all of the children. The minimum of 900 children so selected in each region (30 children per sample site x at least 30 sites) will constitute a representative sample of the total number of children of the specified age range in that region.

3. It may be desirable to oversample by a fixed amount certain high-risk groups or certain subregions to permit more thorough and detailed description of the nutritional status of a particular population group or geographic area. Such a decision will be dictated by careful study of available demographic, geoclimatic and clinical data during the pre-planning phase. The nature of such an augmented sample must be clearly recognized, and appropriate statistical adjustments be made in the analysis and presentation of data, so as to ensure comparability of results.

4. It may be desirable to adjust upward the number of clusters selected in more populous regions to facilitate population-proportional weighting and computer processing of the data, for nation-wide estimations.
5. For those measurements which are to be performed on only a part of the sample, as with hemoglobin determination and certain other tests, the same systematically chosen subsample, here 20 percent, should be employed for each measurement.

Assessment methods

In the sample selected for study, the following set of measurements, indicative of nutritional status of these children, constitute the core of key indicators. Those underlined are recommended to be done in all situations. The role of other optional measurements in the assessment methodology will be discussed, and their use dictated by the particular situation.

In outline form, these indicators are:

1. From mothers, or those who may substitute as mothers of the children examined:
   a. basic identification (total sample)
   b. selected demographic and socioeconomic data (total sample)
   c. height of mothers (subsample)

2. From selected children, approximately 3 months to 5 years of age:
   a. body measures
      (1) length or height (total sample)
      (2) weight (total sample)
      (3) mid-upper arm circumference (subsample)
(4) triceps fatfold thickness (subsample)

(5) Head and chest circumference (all under 2 years old, and subsample of others)

b. clinical screening

(1) bilateral pretibial edema (total sample)

(2) selected signs associated with specific nutrient deficiency, such as hypo-vitaminosis A, as indicated by the local situation (total sample).

c. laboratory determinations*

(1) hemoglobin

(2) additional determinations such as plasma or serum vitamin A as indicated by the local situation may be done on an appropriate subsample.

Further discussion of these suggested indicators, under the same subject headings, is presented in:

1. From mothers

   a. Basic identifying data should be coded to include, in addition to the region, site, family and child, the child's position in the family. His or her name (not to be coded), sex and age complete the identifying data. Each child's age should be carefully ascertained, confirmed as feasible by

*In addition to the indications noted, performance of these determinations is dependent upon the availability of adequate technical capability.
existing records, popularly known astrological signs, or specially constructed local events calendars. The record should make clear whether the recorded age is a crude or a reliable estimate, so that appropriate categorization may be made for analysis of growth indices requiring accurate age.

b. Depending upon local geographic, ethnic and socioeconomic conditions, further selected, relevant data may be collected, as feasible.

c. If time permits, and where an accurate instrument for measuring the height of adults is available, an estimate of the maternal contribution to stature of children can be made. Garn and Rohmann (9) have shown that this may help to evaluate the relative impact upon growth retardation of familial and environmental factors.

2. From children:

a. Body measures

(1) Length or height. Supine length should be measured on all children 2 years or less of age, or if accurate age is unknown, children 85 cm or less in length. For children older than 2 years, or taller than 85 cm, standing height should be measured. In either case the measurement must be that of the child in full extension aligned with the measuring instrument, and with feet bare and head positioned so that the child's gaze is directed perpendicular to its body alignment.
For measurement of length, to accomplish proper positioning of an often uncooperative child, the measurer must be assisted by a full-time helper. The measuring instrument must have a fixed right angle headboard and a freely movable right angle footboard which slides along a clearly legible scale. One person holds the child's head in alignment with the body with the line of vision straight up and applies gentle traction to bring the top of the head into contact with the fixed headboard ensuring that it is maintained there. The other person holds the child's feet with the toes straight up and pushes down on the knees to fully extend the legs. With the other hand he brings the movable footboard firmly against the heels, reading the measurement when the position is optimum.

For measurement of height the child should stand on a horizontal bare floor or platform with feet close together, with heels, buttocks and back of shoulders touching the wall or a vertical surface of a measuring device, and with the line of vision straight ahead. He should be told to "stand up straight and tall and look straight ahead." A block squared at right angles against the wall should then be brought into firm contact with the crown of the head. When an assistant is available, this person should place one hand against the child's knees to detect any flexion of the legs and the other hand on the feet to detect any lifting of the heels. The measurement is read when the position is optimum.
Plans of two suitable, portable and durable boards which can accurately measure both length and height, and which have been used successfully in the field, are appended.*

(2) Weight. For children of this age, the Salter hanging scale,** which weighs up to 25 kg, marked at 0.1 kg intervals, has proven to be eminently satisfactory in field work. It can be hung from a tree branch or a door frame, but in desert conditions a portable tripod will be useful. Reliable and inexpensive beam balances which are now available may also be used. Accuracy of all scales should be checked periodically by weights of known mass. This may be done using large plastic bottles or jugs, which are easily transportable empty, and, filled with water in the field, always contain an exactly known volume.

(3) Mid-upper arm circumference (AC). Jelliffe and Jelliffe (10) have shown that this measure can provide an independent assessment of the severity of undernutrition, as manifested by wasting of muscle. As usually performed, its validity has been questioned because of the relatively

*Unpublished document.

**Use of trade names is for identification only and does not constitute endorsement.
large standard error of its measurement. With the use of
insertion-type tapes developed by Zerfas (11), together
with adequate training and quality control of the measurers,
satisfactory precision and accuracy are possible. The
mid-point of the upper arm must be accurately located, and
the tape applied snugly, but not too tightly.

(4) Triceps fatfold thickness (Tri FF). To
estimate the contribution of subcutaneous fat to the AC
measure, and to provide an objective indication of children's
caloric reserve, as described by Gurney, et al (12), the
measurement of Tri FF may be considered. This consideration
will be governed by the availability of an appropriate instru-
ment such as the new Tanner-Holtain caliper,* and the ability
to control, satisfactorily, measurement accuracy. This
measurement must be made on the posterior aspect of the upper
arm, directly upward from the olecranon process of the ulna,
at the mid-point as marked for the AC measurement.

(5) Head and chest circumference (HC & CC).
These measures can be performed with more satisfactory
accuracy than either AC or Tri FF. In most populations, HC
is normally greater than CC up to one-half year of age, and
less than CC after age 1. In severe PEM, CC may remain
smaller than HC up to 2 years or more. Maline, et al (13),
have recently presented evidence to suggest that the greatest

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usefulness of these measures, particularly of HC, may be to
detect, in children as old as 5 years, undernutrition which
may have occurred before age 2.

b. Clinical screening

(1) Pretibial edema. In diagnosing the type of
PEM, it is of critical importance to establish the presence
or absence of edema. This sign should be elicited with great
care and consistency by applying bilateral firm thumb pressure
over the lower tibiae for three seconds. Resultant bilateral
pitting signifies edema of systemic origin. None or question­
able pitting is to be graded 0, slight but definite pitting
as 1, and moderate to marked pitting, 2.

(2) Other signs. Much more difficult than
training for the detection of edema is the training necessary
for nonmedical workers to recognize Bitot's spots and other
eye signs consistent with hypovitaminosis A, or other clinical
signs of specific nutrient deficiency. Although difficult,
collection of such data should be considered when a high index
of suspicion exists in regard to these or other significant
micronutrient deficiencies in the population.

c. Laboratory determinations

(1) Hemoglobin (Hgb). Anemias due to iron
deficiency, and often other causes, are common throughout the
world, and their detection in a subsample of children is
recommended in all cases. Miale (14) has shown that Hgb,
as measured by the photometric determination of cyanmethemoglobin, is preferred over hematocrit since it is a more direct reflection of the oxygen-carrying function of blood, and since the specimens can be more readily handled in the field and more reproducibly determined later in a central laboratory.

(2) Other determinations. If a high prevalence of such conditions as hypovitaminosis A is suspected, laboratory measurement of this or other micronutrients may be indicated, when feasible. In field situations, however, problems of proper handling of specimens, and accurate performance of laboratory procedures are considerable, and usually militate against inclusion of such complex determinations in a simplified nutritional assessment of this kind.

Ensuring measurement accuracy

Since anthropometrics are the core of the simplified assessment methodology, sufficient time and effort must be taken for carefully training the para-professional personnel in simple anthropometry, and systematically checking their precision and accuracy at periodic intervals.

Group differences in body measurements which may be small but biologically meaningful are frequently obscured because of unacceptably large measurement errors which go unrecognized and uncorrected. To the degree that such errors can be minimized, the usefulness of anthropometric data, and of clinical
and laboratory data as well, will be maximized. Toward this end, a set of standardized but simple exercises has been developed for training in basic anthropometry, and for quality control of measurement accuracy in the field. These exercises include prepared forms for recording and quickly analyzing the data of standardization tests, which have been adapted from those proposed by Habicht (15). They have proven feasible and extremely useful.

Laboratory data as well are useful to the extent that their precision and accuracy are known. Each technologist's performance should be tested periodically, at unannounced and irregular intervals. In addition to the capability and care of the technologist, factors such as proper collection, refrigeration, storage, and transport of specimens are crucial.

Assessment logistics

In the initial phases of planning it is essential to answer the following complex question: "To accomplish the nutritional assessment satisfactorily, how many teams, of what size, and with what equipment, must be transported to and from which villages, at what rate and over what period of time?"
Each situation calls for a balanced consideration of a host of variables of geography, time and weather; of personnel, equipment, supplies and money. Such consideration will determine the logistic solutions which are most appropriate in a given situation. Although many details of plan and procedure must necessarily vary, certain principles remain relevant in all situations. Some of these will be mentioned.

Sampling requirements will dictate the number of sites to be visited, whether 30 or some multiple of 30. Experience indicates that each team should spend 2 days at each site, to have time to explain the assessment to the village leaders, to learn accurate details of the information sought, and to find the children selected for examination. Each team must therefore be equipped to remain overnight in or near each village.

The number of teams required to complete the assessment will be inversely proportional to the time for its completion. It is preferable to have fewer teams, and to take a longer time, in order to minimize the degree of interteam measurement bias, and to create a cadre of experienced examiners who can be employed permanently in periodic assessments. Seasonal factors will also determine the timing and duration of the assessment.
Adequate transportation is always difficult and costly. With problems of bad weather and worse roads which are common in many countries, the teams may be required to do considerable hiking, which is costly in time and salary, while saving in motor fuel. For the most part, the mainstay of transportation is likely to be a number of sturdy vehicles of the jeep or landrover type.

Data handling

Examination forms should be designed to facilitate subsequent computer analysis. Before sending the forms to the local data processing center, probably in the capital city, all forms should be edited for error and completeness in the field by the project director. Insofar as feasible, local statistical personnel and computer facilities should be employed. The Center for Disease Control (CDC) has developed a comprehensive computer program for handling the anthropometric and hematologic data input from these surveys on an IBM 370/145 computer. Software for this program is available at no cost to qualified facilities. The program usually can be translated into appropriate language for a local computer, but in past experience it has been advantageous to send a duplicate computer tape or set of cards to a reference computer facility for dual processing. The interpretation of anthropometric data, and the choice of reference populations for making appropriate comparisons of
children's growth are problems whose complexity is often unsuspected. One might think that the analysis of children's height and weight should be reasonably simple, with methods long since agreed upon. Such, however, is not the case.

Of the several anthropometric indices in common use, weight-for-age (Wt-for-Age), as advocated by Gomez, et al (16), has been used most commonly. It is of particular value in evaluating the growth of individual children over time, but in comparing groups of children examined only once, Wt-for-Age is not able to distinguish long-term stunting in linear growth, particularly of bones, from shorter-term wasting of other body tissues, mainly muscle and fat. A child, or a group of children, with low Wt-for-Age may be low by virtue either of low height-for-age (Ht-for-Age; stunting) or low weight-for-height (Wt-for-Ht; wasting), or some combination of both. The implications of the two conditions may be quite different.

Seone and Latham (17) have recommended that the two indices, Ht-for-Age and Wt-for-Ht, be determined and presented separately. From them, one can arithmetically derive Wt-for-Age if desired, but from Wt-for-Age alone one cannot derive the other two.

Other problems in presenting anthropometric data include the choice of a reference population for making comparisons with the study population, and whether to compare the two populations by centile levels of Ht-for-Age and Wt-for-Ht,
or by determining the percentage of persons in the study group whose values for either index are below an arbitrary percentage of the reference population's median (50th centile) value.

Objections have been raised against using reference populations, such as those of Tanner (18) or Stuart and Meredith (19), for comparison in international studies. These commonly employed reference populations of children, predominantly middle-class Caucasians from Britain or the United States, are considered by some critics to be inappropriate for comparison with children of other socioeconomic and ethnic backgrounds. In response to such criticism, it is important that the reference population be considered not a "standard" but simply a measurement tool which provides a baseline for comparison among diverse groups, with no implication of "normality" (20). For such relative comparisons to be more useful to the country involved, measurements may be made on a small group of children, with perhaps 100 in each year of age, chosen deliberately from the "elite," well-nourished segment of the population. Such a special selected group would not be representative of the whole subgroup nor composed of as many children as required for a true reference population, but Walker and Richardson (21) have shown that their observed Ht and Wt can validly indicate the growth potential of the ethnic group under study.
The decision whether to present anthropometric data by centiles, or by percent of a study population below an arbitrary percent of a reference median value, will depend mainly upon the nature of the study population. Centiles are usually more appropriate for data from industrialized nations, where observed distributions of values are similar to those of available reference populations. The percent of a population below a certain percent of a reference median value (for Ht-for-Age this is usually selected at 90 percent of median, and for Wt-for-Ht, at 80 percent) is more appropriate for less-developed nations, where observed median values in many rural regions and urban slums may be well below the 5th, or the 3rd, centiles of Western reference populations (22). Standard deviation (SD) units may also be utilized as cut-off levels; minus 2.5 SD for instance being less than the 1st centile.

It has been found particularly useful to present Ht-for-Age and Wt-for-Ht data as percentages of the study population above and below 90 percent and 80 percent, respectively, of reference median values, in a cross-tabulation form proposed by Waterlow (23). With this technique the degrees of long-term stunting and shorter-term wasting in a population are readily discernable. The limitations of such a presentation must be recognized, especially when attempting to draw etiologic inferences. Exactly how long in the past undernutrition may
have been operative in causing stunted growth cannot be determined by data from one examination. The effect of causative factors other than undernutrition, such as infectious diseases, cannot be determined from simple anthropometrics alone, and interpretation of results should be confined mainly to the distribution and degree of abnormal growth, without speculating upon its causes.

Feedback of assessment results should be made promptly to the sponsoring health and governmental agencies whose task it is to develop realistic plans for indicated remedial action. What type of action program may be most appropriate and where it should be implemented will depend upon the nature of these results, further investigation into etiology, and the availability of needed resources.

Reassessment of the study villages may be considered to evaluate the effectiveness of subsequent intervention programs. Such reassessment would constitute one form of nutritional surveillance, but repeated surveys should not be considered the sole form of nutritional surveillance. In other situations different forms of surveillance may be more feasible and equally useful. It is important to reiterate that this simplified assessment of nutritional status can provide valid and relatively inexpensive answers to the questions of where, how much, and what kind of malnutrition may exist in a region
or a nation. An action program based upon further knowledge of the etiologic correlates of malnutrition is likely to have the greatest effectiveness. Therefore, a more detailed ecological survey as a followup to the simplified assessment should be considered in areas where intervention is planned.

SUMMARY

A simple, inexpensive approach to the field assessment of nutritional status is proposed to determine the location and extent of protein-energy malnutrition and anemia in a defined geographic area. The approach is characterized by two principal features, a simple statistical method for randomly selecting the population samples to be studied, and a suggested core of objective nutritional indicators, uniformly measured, in young children.

The basic measurements, length or height, weight, and hemoglobin are recommended to be made on 30 randomly selected children between 6 months and 6 years of age, in each of 30 randomly selected sites in each region for which valid nutritional inferences are desired. Children in this age range are assumed to be at maximum risk of malnutrition, and their categorization by degree of physical growth impairment and anemia will in most cases reflect a community's nutritional status. Additional measurements may be performed, if indicated clinically or epidemiologically, and if feasible economically and technically.
The body measurements and collection of specimens for laboratory determinations are to be performed by especially trained para-professional personnel indigenous to the country. Their training in simple anthropometry and subsequent quality control of their measurement accuracy and precision are standardized by rigorous but simple field procedures. Inter-observer measurement bias can thus be minimized, and valid comparability of results can be assured.

Data should be gathered on forms amenable to automatic data processing. Observed anthropometric values should be compared with those of accepted reference populations. The method of cross-classifying children by the indices height-for-age and weight-for-height helps provide an estimate of past and more recent influences upon physical growth.

In addition to providing baseline indications of where and to what extent common nutritional problems may exist in various regions of a nation, the assessment method, repeated periodically, will indicate changes with time, and thus may be used to evaluate effectiveness of remedial intervention. Because of the limitations of this type of assessment, a supplemental ecologic analysis of possible causal factors may be indicated, if the assessment demonstrates protein-energy malnutrition to be a public health problem, in order for appropriate remedial programs to be instituted.
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