Appropriate Uses of Anthropometric Indices in Children – Nutrition policy discussion paper No. 7

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A Report based on an ACC/SCN Workshop

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UNITED NATIONS ADMINISTRATIVE COMMITTEE ON COORDINATION − SUBCOMMITTEE ON NUTRITION (ACC/SCN)

The ACC/SCN is the focal point for harmonizing the policies and activities in nutrition of the United Nations system. The Administrative Committee on Coordination (ACC), which is comprised of the heads of the UN Agencies, recommended the establishment of the Subcommittee on Nutrition in 1977, following the World Food Conference (with particular reference to Resolution V on food and nutrition). This was approved by the Economic and Social Council of the UN (ECOSOC). The role of the SCN is to serve as a coordinating mechanism, for exchange of information and technical guidance, and to act dynamically to help the UN respond to nutritional problems.

The UN members of the SCN are FAO, IAEA, World Bank, IFAD, ILO, UN, UNDP, UNEP, UNESCO, UNFPA, UNHCR, UNICEF, UNRISD, UNU, WFC, WFP and WHO. From the outset, representatives of bilateral donor agencies have participated actively in SCN activities. The SCN is assisted by the Advisory Group on Nutrition (AGN), with six to eight experienced individuals drawn from relevant disciplines and with wide geographical representation. The Secretariat is hosted by WHO in Geneva.

The SCN undertakes a range of activities to meet its mandate. Annual meetings have representation from the concerned UN agencies, from 10 to 20 donor agencies, the AGN, as well as invitees on specific topics; these meetings begin with symposia on topics of current importance for policy. The SCN brings certain such matters to the attention of the ACC. The SCN sponsors working groups on inter–sectoral and sector–specific topics. Ten–year programmes to address two major deficiencies, vitamin A and iodine, have been launched.

The SCN compiles and disseminates information on nutrition, reflecting the shared views of the agencies concerned. Regular reports on the world nutrition situation are issued, and flows of external resources to address nutrition problems are assessed. State–of–the–Art papers are produced to summarize current knowledge on selected topics. As decided by the Subcommittee, initiatives are taken to promote coordinated activities – inter–agency programmes, meetings, publications – aimed at reducing malnutrition, primarily in developing countries.

ACKNOWLEDGEMENTS

Preparation of this report involved much careful work. The ACC/SCN is most grateful to all those who contributed.

The first design for the workshop was put forward by Professor George Beaton – who played a leading role throughout – and finalized by the Advisory Group on Nutrition (AGN). Preparation of material for the workshop was assisted by Drs A. Kelly and M. Lotfi, SCN staff. The workshop participants (affiliations given in Annex B), were G. H. Beaton, W. Bertrand, F. Falkner, P. Greaves, J.–P. Habicht, A. Kelly, J. Kevany, M. Lotfi, R. Martorell, J. B. Mason, A. Pradilla, F. Trowbridge, J. C. Waterlow and R. Weisell. The workshop was chaired by Professor J. Kevany, the Chairman of the AGN at the time. Rapporteurs were Drs W. Bertrand and A. Kelly.

Funding for preparation and holding the workshop, and producing the report, was provided by SCN core funds, and from the Swiss and Dutch governments through the Interagency Food and Nutrition Surveillance Programme, which we gratefully acknowledge.

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Technical Secretary
ACC Sub–Committee on Nutrition
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FOREWORD

The use of anthropometry has increased rapidly in recent years. With this wider use, it has become even more important that the interpretation of results, for the individual and for populations, should be correct and well understood. I requested the Advisory Group on Nutrition at its first meeting in 1988 to help to define the issues. This led to the AGN proposing a workshop, for which they developed and approved terms of reference in early 1989. A number of the most experienced scientists in the field participated in the workshop convened by the SCN at WHO Headquarters in Geneva in June 1989. The workshop resolved most of the outstanding issues and provided much detail on specific uses of anthropometry.

The workshop report, reviewed first by the participants, was examined carefully by the AGN, and discussed by the Sub–Committee at its meeting at UNESCO, in Paris in early 1990. A group was appointed to finalize the document, which now includes explanatory material so that the conclusions are set in context for a wider audience. It should now truly provide a view of the current "State–of–the–Art" of appropriate uses of child anthropometry. I am particularly grateful for the painstaking work of Drs Beaton and Martorell in ensuring that the issues, sometimes complex, are correctly addressed.

We hope this document will find extensive use among all those concerned with improving the nutrition of children.

A Horwitz
Chairman
ACC Sub-Committee on Nutrition

CHAPTER 1 – INTRODUCTION

The use and interpretation of anthropometry in various operational settings has been a matter of much debate in recent years. In part, this has been conceptual, arising from a need to distinguish growth failure – measured by weight and/or length – and nutritional status. There has been a tendency to equate smallness with malnutrition. As Beaton (1989) remarks by way of illustrating the development of this misconception "Small size has changed from being a predictor of an undesirable health outcome (severe malnutrition and clinical complications) to being the undesirable outcome ... Small size and 'malnutrition' became synonyms." The SCN statement at its 15th. Session on "the significance of small body size in populations" (ACC/SCN, 1989a), provided the basis for clarifying this issue – the statement is attached as Annex A.

A second concern has been uncertainty in the choice of anthropometric indices, and their meaning, in different operational settings. Two considerations arise here. First, the selection of the index must fit the decision to be made, that is, ensuring that we are measuring the right thing. Second, the interpretation of the index will depend heavily on whether we are describing a population or diagnosing individuals for direct intervention. Both concerns have serious implications for policy and programme planning.

The SCN decided at its 15th. Session to convene a workshop to address the use of anthropometric measures from first principles, and following from these, to consider the reasons for the collection and interpretation of anthropometry in different programmatic settings. A previous review of a number of the issues central to this topic had been undertaken by a WHO Working Group in 1983 and the report of that meeting (see WHO, 1986a) provided a basis for the present discussions. The intended goal of the workshop was a publication that addressed underlying biological concepts and using these as a framework, addressed the interpretational issues that have arisen. The goal was a re-affirmation of the utility of anthropometric measures if appropriately interpreted and a conciliation of the debates that have arisen. In that sense the workshop was not intended to break new ground. Rather it was designed to recall and restate well founded understandings. Further, it was felt that an ACC/SCN publication, by providing a basis for the selection of indices, criteria and interpretation appropriate to each identified application area, could afford practical advise and guidance to users such as programme managers and policy planners.

The workshop was held in Geneva on 12 – 14 June, 1989. Participants are given in Annex B. This report, while based largely on discussions held during the workshop, has not been confined to these. Further consultations by the SCN Secretariat with Advisory Group on Nutrition and with the participants of the workshop, have resulted in the incorporation of additional material felt to be relevant.

Preamble

[1] The meeting agreed a statement on the significance of anthropometric measurements in children which, with minor editing, is given in this section.

The most extensive public health problem among children in many developing countries is developmental impairment. It arises from the complex of nutritional, biological and social deprivation and is manifest as ill health, wasting, and growth retardation resulting in stunting, functional disadvantages, and high mortality rates. Rates of physical growth and achieved body size mark the process of failing to grow and the state of having failed to grow respectively, and have been accepted as nonspecific *markers* of this syndrome of deprivation. Anthropometry is useful because it provides:

- a practical way of describing the problem;

- the best general proxy for constraints to human welfare of the poorest, including dietary inadequacies, infectious diseases and other environmental health risks;

- strong and feasible predictors, at individual and population levels, of subsequent ill health, functional impairment and/or mortality;

• under some circumstances, an appropriate indicator of the success or failure of interventions directed toward the many economic and environmental factors underlying the deprivation syndrome.

Anthropometric information *per se* is non−specific and does not identify the causes of growth failure. Anthropometry's usefulness stems from its close correlation with the multiple dimensions of individual health and development and their socio−economic and environmental determinants. In poor communities dietary inadequacies and infection are often major environmental determinants of growth failure. From these considerations it follows that interventions intended to avoid growth failure or to promote health may have to be directed at a number of points on the causal chain. While anthropometry may index the problem[2], it does not, by itself, identify the specific cause or indicate the specific solution. As will be discussed in the report, it is also true that while anthropometry may index the existence of a problem, it is not always a satisfactory index of response.

[2] Growth failure, and indeed the deprivation syndrome, have commonly been equated with "malnutrition". This has caused some misunderstanding since it has implied dietary inadequacy as necessarily a primary cause. Results of anthropometry are commonly and appropriately used as indicative of "nutritional status". It would be more accurate in this context (though perhaps less compelling) to refer to anthropometric status. The following terms are considered accurate and appropriate: underweight or overweight, for deviations of body weight from expected weight−for−age; wasted or obese, for deviations of body weight from expected weight−for−height; and stunted, for deviations of height below expected height−for−age.

Outline and Scope

This report summarizes the discussions at a workshop and subsequent considerations by the Advisory Group on Nutrition of the SCN and the SCN Secretariat. It aims to offer guidance on the appropriate use and interpretation of anthropometric indices in relation to:

1. The scientific justification for collection and use of anthropometric measures.

2. The basis for the selection of particular indices and the subsequent implications for interpretation of the indices.

3. Considerations pertaining to data collection and to analysis of these anthropometric measures for specific applications.

The report is not directly concerned with the epidemiology of growth failure or of the need to assign etiologic interpretation to past growth failure. The use of anthropometric indices as *markers* of risk of future morbidity, disability or mortality is noted in specific contexts without direct inference as to the aetiology of the deviant anthropometry. As appropriate, the report does comment on issues of specificity and sensitivity of the indices as measures of particular conditions, often with a note of caution.

In societies, or segments of societies, in which the burden of infectious disease has decreased significantly, dietary and other health−risk behaviour patterns remain associated with premature disability and death (WHO, 1990). Anthropometry − by providing a measure of *fatness* − is useful also in those settings. This application is not discussed in the present report (see discussion by Ferro−Luzzi and D'Amicis, 1987). The present report is addressed to circumstances prevailing in countries or population groups where inadequate diet and/or infectious disease remain important constraints to early human development.

The report focuses upon the use of length and weight measures since these are currently the most widely used indices for the purposes discussed in this report. The areas of potential application discussed in this report are:

SCREENING: INDIVIDUAL LEVEL − ONE TIME ASSESSMENT

a. to immediately decrease case fatality (emergency situations)
b. in non−emergency situations

GROWTH MONITORING: INDIVIDUAL LEVEL − ASSESSMENT OF TRENDS
ONE TIME ASSESSMENT AT POPULATION LEVEL

a. under circumstances of food crisis
b. for long term planning

NUTRITIONAL SURVEILLANCE: POPULATION LEVEL − TREND ASSESSMENT

a. for long term planning
b. for timely warning
c. for programme management

The report first reviews the biological basis and general considerations for the use of anthropometry (Chapters 2 and 3). It then proceeds to address the particular areas of application (Chapters 4 to 7). In discussing these a common approach has been adopted in the report. This begins with identification of decisions to be made within the area of application. From this the information requirements are specified, taking into account the nature, specificity and sensitivity of the measures potentially available: who to measure, especially by age group, with comment on sampling methods; and the particular index or indices to be used. Where, as is usually the case, the most useful form of reporting is as a *prevalence* figure then considerations relevant to the selection of cut−off points and usage of internal or external reference standards are presented.

CHAPTER 2 – BIOLOGICAL BASIS FOR INTERPRETATION

To provide a frame of reference for subsequent discussions, Figures 1 and 2 summarize the essential features of human growth and development relevant to the present report. These Figures provide the basis for definitions used in the report and for establishing areas of agreement and areas where further clarification is needed.

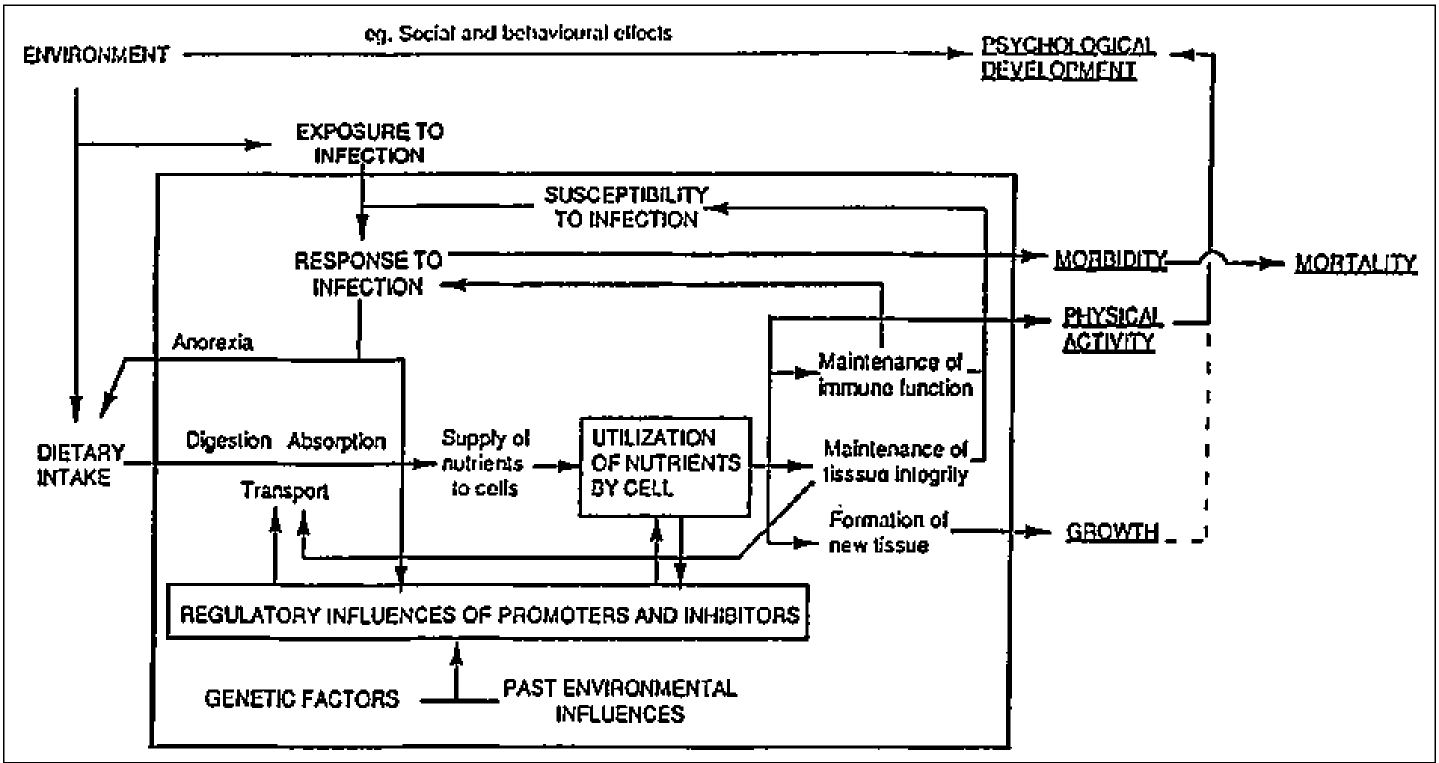

Figure 1. Influence of diet and other environmental factors (outside box) on physiological processes in children (inside box) and outcomes (on right, outside box, underlined).

Figure 1 shows certain physiological processes during growth and development, and ways in which a constraining environment affects these. First, inadequacy of dietary supply can reduce nutrient availability to cells, and impair cellular function, thus affecting susceptibility and response to infection, and reducing growth. However, cell function is also regulated internally, under the influence of both genetic factors and previous environmental influences – the latter for example through altered patterns of tissue development. Further, while susceptibility to infection and response to it are influenced by the competence of the body's immune system (a function of tissue activities) one of the responses to infection is itself an effect on the regulation of cellular activity. Thus, for example, the formation of new tissue (hence growth) might be reduced by: (a) an inadequacy of dietary intake, or (b) by an inhibition of cellular processes responsible for growth, secondary to an infectious process, or (c) by other regulatory influence, or (d) a combination of these.

The Figures suggest also that the observed variation in growth rates of young children, or of achieved size in older children, will be derived from the interaction of genetic and environmental factors. Importantly, current environmental effects become a part of the regulatory memory of the body. Consequently, failure to grow at normal stages of development may represent a missed opportunity with a lasting effect observed as stunting at older ages.

Figure 1 portrays a postulated effect of an unfavorable environment upon psychological development While it is not intended to imply a complete absence of effects mediated through tissue growth mechanisms (e.g. brain development), the figure emphasizes the fact that development of brain function involves interactions with the social environment of the child. These interactions may be influenced by the adequacy of energy intake and utilization for physical activity, such as for play, as well as household effects on child care and other family functions. While both growth failure and impaired psychological development may originate from the same constrained environment, they may have *unrelated* causal pathways. Thus achieved size would be seen as a *marker* of the environment that produced *both* growth failure *and* impaired psychological development. But small size itself would not be seen as a *cause* of impaired psychological development; and the two would not necessarily move together as the child matured (McGuire and Austin, 1987).

In considering 'underweight' and 'overweight' (as indexed by measures such as weight–for–length or arm circumference), the considerations differ somewhat from those of achieved body size (indexed by achieved length). Body weight is subject to genetic influences and in that sense fits the schema of Figure 1. However, it is also influenced by past and current energy balance – the balance between energy intake and energy expenditure, as displayed in Figure 2. Fatness and thinness (e.g. as indexed by weight–for–length in Fig. 2) reflect the magnitude of body energy stores or reserves. These may increase or decrease as a result of unbalanced changes in either energy intake or energy expenditure. Both intake and expenditure may be seen as influenced by both internal factors (e.g. regulation of intake, regulation of tissue metabolism) and environmental factors (e.g. food available for consumption by the individual, mandatory physical activity, socially desired physical activity, infection as a cause of anorexia, and infection (fever) as a cause of increased energy expenditure). Weight–for–length is generally seen as a measure of *current* influences on the state of the body, as contrasted to achieved size which is seen as a measure of past influences, or in the young actively growing child, of the combination of past and current influences.

Both Figures 1 & 2 emphasize the fact that neither achieved size nor weight–for–length is specific in relation to causation. While anthropometry is extremely useful, it must be interpreted with care.

One point regarding interpretation and use of anthropometry is now being re–emphasized: the importance of taking account of age (Martorell, 1989; Martorell and Habicht, 1986; Lutter *et al.,* 1990). This is because causes of growth failure are generally age–specific; and the required interventions often depend on age. Different factors affecting infant and child growth need to be borne in mind. At birth, infant weight and length are determined by maternal factors – including nutrition – and gestational age, i.e. whether the infant is full term. Interpretation of birth weight must take these into account. During the first 4 to 6 months, infant feeding practices and maternal health (and ability to take care of the baby) are the main influences on growth; growth failure at this early stage, less common than later, must be interpreted in this light. From about 4–6 months through two years of age, weaning practices and exposure to infectious disease have a major effect. As the age of the child increases, household access to food may have more importance.

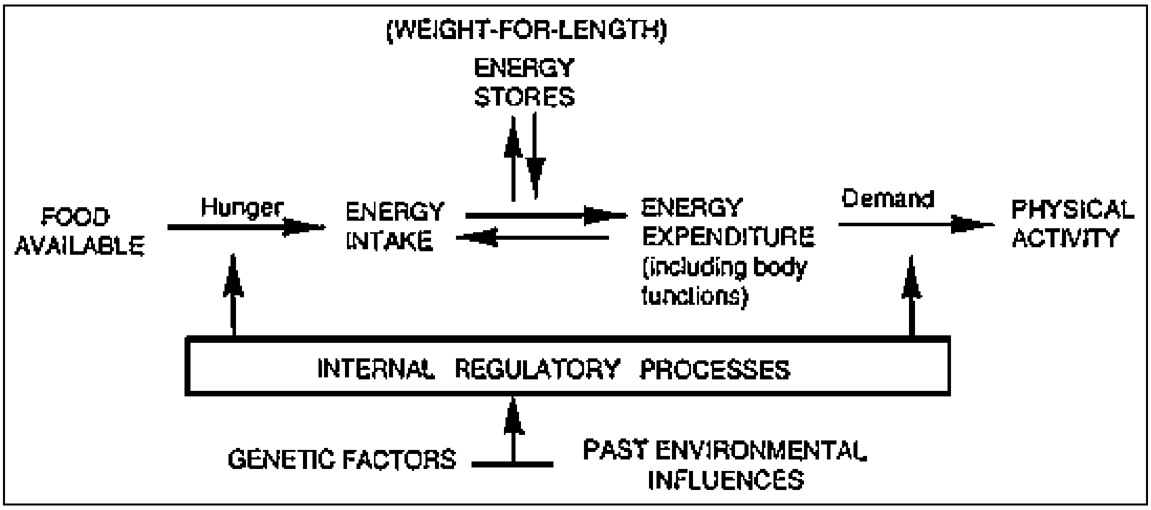

Figure 2. A portrayal of the association between weight−for−length and the processes underlying energy balance.

Almost all of the growth retardation documented in studies carried out in poor societies has its origins in the first 2 or 3 years of life. Studies in Guatemala (Martorell, Rivera and Kaplowitz, 1990) indicate that growth failure in early childhood is not recuperated through catch−up growth in later childhood and adolescence in males or females. In a similar prospective study from India, catch−up growth was not observed in males (Satyanarayana *et al.,* 1980) but partial catch−up growth was observed in females (Satyanarayana *et al.,* 1981). In both Guatemala and India, growth in length achieved between 5 years of age and adulthood was similar or greater than observed in developed societies. Cross−sectional studies from other areas of the developing world also suggest that growth retardation primarily occurs in early childhood and that catch−up growth does not occurr (Hussain *et al.,* 1985; Billewicz and McGregor, 1982; Hauspie *et al.,* 1980).

Across populations of different socio−economic status the differences in growth velocity and size are above all caused by environmental circumstances and not by ethnic differences in growth potential, at least up to five years of age (Martorell, 1985). This is not incompatible with the fact that within a well−nourished population the sizeable variability in growth and size is indeed genetic. One consequence is that where there are few detrimental influences on growth, small children will be small for genetic reasons and this smallness may have had no deleterious causes or future consequences. In contrast, in the deprived populations of concern to this report, environmental factors are a prime determinant of growth failure. While dietary inadequacy *alone* is not usually the prime determinant of growth failure, it is often an associated contributing factor along with repeated episodes of infectious disease (Martorell, 1989; Chen, 1983). Where stunting[3] is prevalent, the causes are likely to be found in environmental factors characterized by generalized conditions of dietary inadequacies, infectious disease and social deprivation. Where stunting prevalence is low, the causes of smallness may lie in normal genetic variation <u>or</u> in factors operating to the detriment of the individual child (including the effects of malnutrition and infection). It follows that the implications and interpretations of stunting observed in the individual child differ depending upon the circumstances in which it is observed.

[3]*Stunting* is used to denote reduced body length in relation to a reference standard. Usually reduced body weight will also be seen.

The theoretical model represented in Figure 1 is intended to clarify thinking on a number of general issues related to the uses of anthropometry in varied contexts. Essentially, the whole report is concerned with how measures of one outcome − growth − can be used to draw useful conclusions on complex biological processes and their determinants; and how to relate these to decisions on interventions to improve the determinants and outcomes. Moreover, of the various outcomes, growth is not necessarily the most important − it is still an indicator.

In this report, *relative risk* of an undesirable outcome (e.g. those shown in Figure 1) is regarded as *marked* by one or more of the anthropometric indices. As the index changes, the risk of undesirable outcome changes. It is not a necessary assumption that the actual index recorded (achieved size, current growth rate or weight−for−length) is on the direct causal pathway of the outcome. Different risks (for instance risk of morbidity, risk of cognitive impairment, risk of mortality or risk of other functional impairment) may be marked by the same index (for example length for age). Two important implications arise: (a) seldom is there a sharp break in the risk curve denoting a change from a 'no risk' to a 'risk' situation (rather the change is likely to be progressive although the slope of the curve may change with the level of the index), and (b) the level of risk associated with a given level of the index will depend upon which risk is being assessed and the circumstances in which it is assessed. As a generalization, the more deviant is the anthropometric measure for an individual, the more likely it is that significant risk (of many outcomes) is present. In some applications discussed in Chapters 4–7, the goal is to assess or monitor population risk. In its simplest form this is done by estimation of the proportion (prevalence) of individuals with index measurements falling below cut-off points accepted as marking a selected level of risk.[4]

[4] Given that risk is a continuous variable, this is a conceptually limited but practically feasible approach. Preferred approaches include examination of total distributions and their displacement from reference distributions coupled with estimations of risk probability functions (Mora, 1989).

In summary, three biological considerations have major impact upon the use and interpretation of anthropometric indices. The *first* principle is that interpretation of length *varies with age* of the subject. In very young children (particularly in the first year but perhaps through the first two years of life) achieved size (length) may reflect a *process of failing to grow.* After about two years it is likely to reflect a state of *having failed to grow.* (See Annex A). The state of having failed to grow continues to mark risk of detrimental outcomes (morbidity, mortality, psychological development, etc.) but no longer suggests that interventions will improve growth status. The *second* principle is that indices of weight in relation to length reflect current under– or over–nutrition (relative thinness or fatness) *regardless of age.* Major deficits in weight–for–length are suggestive of short–term risk of morbidity or mortality; in this case, the anthropometric index is likely to respond to immediate intervention. The *third* principle is that achieved size may be seen as a marker of the environment in which growth failure occurred and, as such, a marker of other risks associated with that environment. In this sense, achieved size in an older child might be seen, for example, as a marker of risk for a younger sibling.

CHAPTER 3 – GENERAL CONSIDERATIONS

The choice of anthropometric measures, methods of application, cut–off points, and interpretation of indices, differ among the many situations in which anthropometric measures are applied. The present chapter addresses general considerations relevant to application. In essence, the chapter develops the implications of the biological principles reviewed in Chapter 2 in relation to the types of application discussed in Chapters 4–7. (Table 1, in Chapter 4, gives a summary of applications and recommendations). Comment upon a few less typical applications is also included in this chapter.

Measures, Indices and Indicators

[5] See Report of the WHO Working Group on 'Use and Interpretation of Anthropometric Indicators of Nutritional Status' (WHO, 1986a) for additional discussion of terminology, use of data transformations and design of sampling. See Annex C.

The basic *measurements* addressed in this report are length[6] and weight recorded with age and sex. Measurements are used to derive an *index,* e.g. length–for–age, weight–for–age[7], weight–for–length. These have biological interpretations which may change with age. Indices are continuous variables. *Indicators* represent further derivations of use in social/medical decision making at population level (Culyer, 1983; WHO 1976a, 1976b, 1986a). These usually involve imposition of a cut–off point to estimate population prevalence, e.g. the proportion of children (of defined age and sex) with weight less than 2 standard deviations (SD's) below the median or mean of a reference distribution for that age and sex (see later discussion of cut–off points). The term 'indicator' is used only for population assessments and has no meaning for the individual.

[6] Under the age of 2–3 years it is customary to measure recumbent length, using a measuring board. In older children standing height is the usual measure. There is a systematic difference between these two measures and this must be taken into account when interpreting data (the systematic effect is likely to be present in reference data and there is advantage to standardizing the measurement method between the field operation and the reference data collection). In this report 'length' is used to mean the age–appropriate measure; in older children it substitues for the common usage of 'height'. While not discussed here, a number of guides are available which explain how to weigh and measure children, see for example, UN

(1986), WHO (1983), and Lohman, Roche and Martorell (1988).

[7] In most situations, weight–for–age is basically a proxy for length–for–age although it incorporates also deviations in the weight–for–length index and, when changing rapidly, may be a proxy for that index.

In some situations, indicators may provide a *direct* estimator of the underlying condition of interest (e.g. in famine the condition of interest is wasting and this may be assessed directly as weight–for–length). Conversely, in many applications the indicator serves as a *proxy* for some constraining factor in the environment (e.g. as illustrated in Fig 1, achieved size or current growth rate may reflect the effects of dietary inadequacies, infectious disease, and/or other variables).

Risk is seen as a continuous variable relating to the likelihood that a defined undesirable outcome will occur[8]. Risk in an individual may be marked by an index directly associated with the condition that gives rise to the risk. However, in some situations the anthropometric index (or indicator, at population level) is a *proxy* for the condition of interest. A specific example might be when achieved size is used as an index of household conditions that give rise to impairment of cognitive development (see Figure 1). The distinction is important since, when the index functions as a proxy variable, there is an explicit assumption that the relationship between growth/achieved size and the condition of interest is similar across populations. Clearly, this is unlikely to be the case. When anthropometry is a direct measure of the condition (as in the assessment of wasting) that gives rise to the risk of interest, the interpretation in clearer but even in this case, predictive power is likely to differ across populations because the causes of wasting may differ. If an infection such as measles is involved, for example, immunodepression will be more severe than if it is not (Tomkins and Watson, 1989). This would affect the degree to which wasting would predict response to infections.

[8] Throughout this text, "risk" is shorthand for "risk of undesirable outcome", such as morbidity or impaired psychological development – i.e. the outcomes on the right of Figure 1. It does not mean "risk factor" such as unsanitary environment.

The predictive power of an index is likely to vary with age. Consider achieved length–for–age as a marker of past constraints to growth. In very young children failing to grow may still be an active process whereas in older children, the process marked by reduced length–for–age is likely to have ended its active phase. Clearly, reduced achieved length predicts further growth failure and associated future risks in a very young child while in an older child it reflects a past occurrence. This may explain why length–for–age is a stronger predictor of mortality in children less than 3 years of age (Katz *et al.,* 1989; Smedman *et al.,* 1987)

In older children, achieved size may remain a useful predictor for other, continuing, risks arising from conditions that existed during the period of earlier growth failure (see Figure 1) – whether these risks directly cause growth failure or are simply correlates of the same household environment (i.e. proxies of the adverse outcomes). The important implication is that in the older child, interventions directed toward increased growth may no longer be effective while interventions directed at other risks might be effective. For example, achieved size often remains predictive of mortality among older children (more than 2 yrs). Results from India indicate that vitamin A supplementation reduced mortality among children 6–60 months of age, with impact declining as a function of age. Also, among *all* children studied, the benefits were greater among those who were stunted (Rahmanathullah *et al.,* 1990). Though findings about growth have not yet been published, it is unlikely that the intervention led to improved growth among older children. Until otherwise shown, one should not expect linear growth to be an indicator of response or nonresponse of the other risks in the older child. In contrast, in infants and toddlers, linear size could serve as a marker of change in the environment that leads to multiple risks and, as such, might also serve as a marker of change in a spectrum of risks.

The foregoing provides a basis for considering the *predictive* properties of an index or indicator. The *sensitivity, specificity and predictive capacity* depend on the particular indicator selected, the specific risk under consideration ('risk of what'), the age of the individuals being assessed, and also on the prevalence of the condition in the population (Habicht, 1980; Habicht *et al.,* 1979, 1982; Brownie and Habicht, 1984; Brownie *et al,* 1986). In the case of the proxy variable, they also depend on the stability of relationships among conditions giving rise to different risks in the population (as interventions proceed or as community development progresses, these associations may change and hence the sensitivity, specificity and predictive capacity of an index would change). The same index may perform well or poorly depending upon these factors. The user must consider these matters very carefully in selecting and interpreting indicators.

A special situation in which both risk and index take on a difference in meaning is in the identification of *households at risk* (see Chapter 4b, section 2). Here the anthropometric status of an index child may be used as a marker (proxy variable) of a household environment/situation likely to be associated with risk to another child, perhaps a sibling yet to be born. It follows that that risk (or that spectrum of risks) is what must be addressed in any consideration of sensitivity, specificity and general utility of anthropometric indices. While the choice of anthropometric measures may be the same as in the assessment of individual risk, different cut−offs may be applied to the derived index. In identification of households at risk, anthropometric measures usually are not the only indices used.

The foregoing discussion relates primarily to the use of anthropometric measures and indices in a cross sectional mode (i.e. a particular individual measured only once). A special situation is found in growth monitoring (see Chapter 5) − the tracking of anthropometric measures across time (age) in individuals (see Lotfi, 1988, and Yee and Zerfas, 1987, for recent reviews of issues in growth monitoring; see WHO, 1978, 1986c, Falkner, 1987, Nabarro, 1987, and Tremlett *et al.,* 1987 for discussions of growth charts). Here interest lies in the examination of the pattern of change in anthropometric measures in relation to the pattern expected in unconstrained growth, rather than the departure of a single measure from a reference median. In this application, the achieved weight or length relative to the reference standard carries limited interest and the derived indices (except perhaps weight−for−length) are also of limited interest except in special applications. Risk assessment (and cut−off points) here refer to changes over time and relate to the separation of pathological deviations from the normal vacillations of growth rate. Expected increments in size for the age range and sex (expected growth rates or growth channels) remain based on reference data drawn from populations in which environmentally conditioned growth failure is minimal (and where secular trends are minimal).

A variant on the concept of longitudinal monitoring of individuals is the use of cross sectional data, categorized by relatively narrow groupings of age (and sex) to derive a picture of the pattern of growth failure by age in a population − when it occurs and how extensive it may be. Here examination of length−for−age or weight−for−age indices may be the preferred approach − as descriptors rather than as indices of risk. Secular changes in growth need to be taken into account in interpreting cross−sectional data.

Identification of responders and estimation of response. Selection of indices and cut−off points

In some programmatic applications, an objective is to identify individuals who are likely *responders* to a particular type of intervention or group of interventions; or in population assessments, to estimate the prevalence of *potential responders.* In such programs, there is need to also monitor *response* to the intervention. Use of anthropometric measures and indices in these situations involves special considerations. Detailed discussion is beyond the scope of the report; a brief overview is presented below.

Consider first the *selection of the individual as a likely responder.* One would wish to select an index and a cut−off point that would differentiate between an individual who has deviant anthropometry due to an underlying condition (past or present) that associates with the specific risk, and an individual who deviates because of normal (genetic) variation in the population. This is a probability assessment. The specific considerations are those usually discussed under specificity and sensitivity. In simplest terms, if it is established that the index does mark a specified risk and that the available intervention is effective, then the more stringent the cut−off point, the more likely it is that the individual will be a responder. At the same time, as the cut−off point is made more stringent, fewer of the potential responders will be identified. As discussed in Chapter 4, if program resources are limited, the cut−off point may be adjusted to admit only as many children as can be handled. In a famine or emergency situation the concern may be prevention of serious morbidity and mortality in the immediate future and this may dictate that measures reflecting wasting (e.g. weight−for−height) constitute the primary index. In non−emergency situations detection of current or past growth failure (indexed by length or weight−for−age) may be more appropriate to medium and long term program goals. In either situation there is a trade−off among the total cost of an intervention program, the coverage of potential responders by the program, and the apparent efficiency (proportion of selected individuals who actually respond) (Beaton, 1989; Beaton and Ghassemi, 1982). Both the selection of the indicator and the choice of the cut−off point affect these parameters.

Even more problematic may be the *estimation of actual response.* In the situation where the index is a direct measure of the condition of interest (e.g. wasting in a famine situation), then response of the index is an expected outcome. Here the situation is simplest. The same index can be applied for identification of responders and for assessment of response.

This is not the case for all risks and all indices. For example, it is established that length−for−age is a good predictor of risk of infectious disease and of mortality in children, whether as a direct or proxy measure of the conditions giving rise to that risk (Tompkins and Watson, 1989). However, in older children, interventions that address the specific risk (nutritional intervention and/or control of infectious disease) may no longer influence linear growth (because age is beyond the period in which growth response is expected or because the presence of other conditions that impair responsiveness − see Rothe *et al.,* 1989). Clearly here the preferred measure of effect would be one that related directly to the outcome of interest (morbidity or mortality rates). A similar example that currently attracts much interest lies in concern about long term impairment of human functions consequent to compromised physical activity in the face of constrained energy intake (see FAO/WHO/UNU, 1985; James *et al.,* 1988). Anthropometric indices effectively mark major shortfalls of energy intake but may not mark the shortfalls that compromise nonobligatory activities (see Figure 2). Such anthropometric indices will not mark the activity response of children to supplementary feeding (Beaton and Ghassemi, 1982). Here then anthropometric measures serve to detect both likelihood of response and magnitude of response to one aspect of energy insufficiency − body size and composition − but have very limited predictive power for another dimension − activity − and are of no value in assessing response in that domain.

In the evaluation of program response, it is essential that the index selected be one that is sensitive to, and if possible specific to, the intended goal of the program. The response index used need not be the same index used to select individuals for admission to the program; in fact, the response index may not be anthropometry at all. Programatically, it is quite valid to use a measure (e.g. thinness or stunting) for selection of targeting, but *not* for evaluation.

Parallel considerations hold for population assessments and for population monitoring of intervention responses. However, there is one additional consideration that takes on particular importance here. It was argued in Chapter 2 that the process of failing to grow (in very young children) often marks an environment of multiple deprivations and is associated with multiple risks − risks that continue into older ages. It was argued above that because the period of active growth failure occurred in the first two years of life, older children should not be expected to be responsive in linear growth. Hence, it was argued, linear growth might be an inappropriate index of response. In population assessments conducted over time, achieved size may be a very appropriate index of response to a continuing population intervention − as long as the age−specific nature of responsiveness of this index is recognized. Thus, for example, monitoring the achieved size of two year olds may serve to monitor and assess the impact of an intervention directed toward the period of early growth − during the previous one or two years. Monitoring the achieved size of entering school children (e.g. 7 years of age) might do the same thing but it would be expected to reflect changes in the environment of early growth that occurred 5−7 years earlier. That is, there is an expected lag in the response of the population indicator that must be taken into account in interpretation of population data. This, of course varies with the indicator and with the age of the children being measured. *Weight−for−length should be responsive in the short term and at any age. Weight−for−age reflects both achieved linear size (responsiveness age−specific) and thinness/fatness (currently responsive); it should be responsive in the short term and at any age but it may be less sensitive, and less specific, to change in wasting than would be weight−for−length.* Since, in this example, anthropometry is being used, at least in part, as a proxy for a general syndrome of deprivation, it must be recognized that as conditions improve, the index may be less satisfactory − the association of the different dimensions of deprivation may change. The same reservation would hold if narrow interventions directed toward a specific aspect of the environment of early growth were mounted. Thus, for example, it is conceivable that effective control of infectious disease might result in increased growth without necessarily being accompanied by improvement in those aspects of the environment that compromise psychological development. Our current information about these associations is based largely on "natural" improvement of conditions where the cluster of environmental conditions tend to move together.

Choice of reference population data

In the foregoing discussion of indices, indicators and cut−off points, it is implicit that anthropometric measurements are being compared to a reference population. Such an anthropometric reference may be 'internal', a suitably prepared description of distribution of anthropometric measurements in the national or regional population. It may also be 'external', such as the WHO−adopted reference population based on anthropometric measurements in US population surveys. For some types of application, the choice of reference standards may be arbitrary; for others a particular choice may be strongly preferred or may be mandatory for interpretational purposes.

There is a debate about whether internal or external anthropometric references should be used in assessment of risk. In reality there are at least three components to the debate. *One* relates to the previous discussion of proxy variables – with general improvement in household conditions, the associations among conditions predisposing to particular risks may shift and hence the predictive power, sensitivity and specificity of a given index for a given risk may change with the stage of population development. This, of course, has no meaning when anthropometry is a direct measure of the condition of interest (e.g. assessment of growth or assessment of wasting *per se*). A *second* component is the simple fact that sensitivity changes with prevalence – the same indicator (index with cut–off point applied) could carry different meanings at different stages of development when true prevalence has changed. The *third* issue is purely artefactual. If one changes the reference standard but does not change the relative cut–off (e.g. declares the cut–off to remain at – 2 SD) then there has been an effective change in cut–off and, of course, the risk associated with the cut–off point changes. Seen in this perspective, the real debate is not about which reference standard should be used. In reality, the issues rest upon the choice of cut–off points used in the assessment of relative risk and more particularly the cut–off points used for selection into intervention programs. Such cut–off points could be stated with reference to either an internal or external standard.

Here this report is explicit in its recommendations. It advocates the development of criteria based on local experience (systematic collection and analysis of information about admission criteria and response rates) and taking into account local resources. The report is not concerned about whether such criteria should be referred to internal or external reference population standards; it is the selection of the cut–off points that is seen as demanding local experience.

Assessments of growth failure in the population pose a different situation. Questions of interest may be: when (at what age) does failure to grow typically occur? and, what is its apparent magnitude? Here the report is explicit in advocating the use of external reference standards.[9] To use local standards might imply acceptance of the *status quo* growth pattern.

[9] The desired characteristics of a reference population standard have been discussed elsewhere. In essence the data should be drawn from, and be representative of, a population in which constraints to early growth and development are minimal and in which secular trends in achieved size are no longer present (or are minimal) if artefactual deviations attributable to cohort effects are to be avoided (Dibley et al, 1987a, 1987b). While it may be possible to develop % wch a reference data set from the more privileged groups in many populations, these may offer limited advantage in comparison to widely available anthropometric reference data sets (e.g. the reference data published by WHO) since available evidence suggests that the unconstrained growth potential in early childhood is similar among most populations that have been examined (e.g. see Martorell, 1985).

A simple utilitarian argument is invoked when data from multiple countries are being compared. If the data are expressed as indices of the type discussed in this report, it is essential that a common reference standard be used in all cases. There is now wide usage of the WHO reference for that purpose and there is strong argument to continue that usage to maintain comparability. For purposes of presentation, the choice of cut–off points is relatively arbitrary since these do not carry a connotation of specific risk assessment. Conventions of convenience for such presentations have been widely adopted and, for consistency, might be continued (e.g. proportion falling below –2 SD of the reference population). Only their interpretation needs be considered with care.

Two previous recommendations by Waterlow *et al* (1977) on choice of reference data and scales for summarizing descriptive data have been widely accepted in principle and continue to be endorsed:

a) Anthropometric measurements should be *reported* in relation to international reference values (even if estimates are also made with internal standards). For this purpose it was recommended that the US National Center for Health Statistics (NCHS) data set should be used (WHO, 1983)

b) It is recommended that the measurements made in a study population should be related to the reference population by standard deviation scores (Z–scores) rather than as a percentage of median as has been the general practice in the past[10].

[10] The relevant section of the WHO report is reproduced in Annex C.

In examination of time trends within populations, or in the comparison of subgroups within a population, the choice of reference is much less important than the maintenance of consistency of the reference from one time to the next or from one group to the next.

While local standards are seldom essential (as contrasted to the use of local experience in setting cut−off points), this does not argue against the collection and use of local anthropometric survey data. Only with such data is it possible to monitor the overall condition of the population and trends within the population.

It is noted that at the time of preparation of the present report, the NCHS reference data are under revision. The above recommendations are seen as applicable to any revised data set. One potential impact of the revision now underway may be some alteration of reference values for length and weight during the first 2−3 years of life. In turn this may influence the apparent age of onset, and the perceived degree, of early growth failure. The magnitude of the changes, and the potential import for public health interpretations and applications, should be considered before a decision is taken to adopt a revised reference for international reporting or for uses other than research applications.

Sampling in anthropometric surveys

The design and approach to collection and analysis of data has a direct bearing on interpretation. Although this has been discussed in detail in many other reports[11], certain features are emphasized here.

> [11] Some standard references for sampling are Cochran (1977), Lilienfeld and Lilienfeld (1980), and Casley and Lury (1987a); WHO (1988) is a training manual on household surveys; WHO (1986b) looks at the issue of sample size determination in various contexts.

Age

The importance of age of the individual in the interpretation and use of anthropometric measures has been emphasized in this report (see Chapter 2). It follows that the individuals to be included in a survey and the method of reporting results should take into account the purpose of the survey and be sensitive to the impact of age on interpretation. For example, if programmatic concern focuses upon breast feeding, weaning practices and early growth, it would be desirable to report data by relatively narrow age intervals (e.g. 1−3 month intervals during the first two years). A similar strategy would be in order if one wished to compare the timing of growth failure between populations or between population sectors. Conversely, if interest were in the state of the population reflected by achieved size (as a measure of past growth failure), it might be better to examine children after the second year and to pool indices across wider spans of age. This may be particularly relevant if anthropometric measures are being used as a proxy for generalized deprivation and poverty. Nevertheless initial examinations should be on an age− (as well as sex−) specific basis, before pooling, to obtain maximum information from the data.

Practical considerations suggest that the final choice of age intervals will be conditioned by cost and logistical considerations. The narrower is the age interval chosen for reporting, the larger is the total sample size required and the greater is the number of households that must be visited to collect the data. The decision on age ranges must reflect both the intended uses of the data and the resources available to collect and analyze the data.

In comparing the status of young children across population groups, serious bias can develop if the distributions of ages are not reasonably matched between the groups being compared. That is, because of the age−specific effects of growth constraints, a major mismatching of very young and older children could yield seriously misleading comparisons of achieved size whether this be done with absolute lengths (or weights) or indices expressed as Z scores or centiles. Similar problems can arise in "before − after" evaluations of interventions (age will have increased) when no control group has been included.

Sampling procedures

A one–time sample survey provides a portrayal of the state of the population at a particular point in time. While it can provide the policy analyst or manager with an estimate of the prevalence of a condition (and of potential contributing factors), it cannot assign causation and it cannot document incidence (rate of appearance of new cases). The sample may be obtained in several ways – *probability–based sampling, judgement sampling,* or *convenience sampling.* The first of these imposes strict procedural rules for sample selection – an important feature being that each individual in the population has a known probability of being selected into the sample. Probability–based samples permit valid generalizations to the population as a whole (provided sample size is adequate). However, unless the population has been enumerated recently, it is very difficult to implement such a design directly[12].

[12] A solution commonly employed in epidemiological surveys is based on the "30 clusters of 7" which entails randomly selecting 30 individual villages (each village representing a cluster of households) and then, within each village 7 households or individuals are selected randomly. This technique is widely used in cross sectional prevalence surveys in which the condition of interest is relatively common. The method is discussed at length (along with other forms of health information gathering, e.g. surveillance systems) in a recently published manual (Vaughan and Morrow, 1989).

An alternative approach frequently used under emergency conditions – expert judgement – involves choice of a subgroup of people or places, based upon judgements about a range of criteria, with the intent of generating a quasi–representative sample (i.e. where the bias due to sampling uncertainties is considered relatively unimportant). This differs from the sample survey in that there is no guarantee that the sample selected is truly representative of the population. With careful judgements, this approach may not present serious drawbacks but inferences to the larger population must be made with due caution.

Convenience samples (e.g. individuals or families attending hospitals or clinics) may exhibit major biases in relation to the general population. That is, there is no way to control the makeup of the sample (the reasons why they chose to attend the hospital or clinic) and hence their characteristics could differ in important ways from those of the general population – and could change over time. Extrapolating from a convenience sample to the general population is risky although generalization to a larger population of similar 'volunteers' (e.g. to hospitals or clinics not specifically studied) may be safer. Every attempt should be made to use some kind of sampling frame such as a list of villages, towns or districts with corresponding population estimates. Use of even rough population data to select sample sites is better than haphazard sample selection. If, for practical reasons, a convenience sample must be used then the characteristics of that sample must be documented. For example, it might be noted that the sample measured consisted of children attending health care clinics in certain regions (any additional information on attendance numbers and characteristics would be helpful in interpretation), or that the sample consisted of children in recently established refugee camps, etc.

In certain applications, two other sampling strategies may be encountered: *purposive sampling* and *sentinel site sampling.* Both are used primarily in the connotation of population surveillance (monitoring trends in the population). A purposive sample will deliberately target the most vulnerable age group and repeatedly sample it over time, perhaps to obtain an early warning of a deteriorating condition. Sentinel site sampling involves the selection of specific (sentinel) sites which are either judged to be 'typical' (although not necessarily representative in the rigorous statistical sense) or to represent a high risk segment of the population. The populations in these sites are then sampled and studied repeatedly to document change with time. The sites could be markets (for price data), health posts or schools, etc (for anthropometric data). The use of sentinel sites can reduce both reporting lags and basic costs[13]. Because the sites are used on a continuing basis, the quality of data collected may be controlled more effectively than in surveys.

[13] For further discussion of the use of sentinel site sampling see WHO (1987) Chapters 7.6 and 11.10, and Kirsch (1988).

In collecting and reporting anthropometric data, it remains desirable to include also information on household characteristics, socio–demographic data and district service facilities, levels of infection and possible causal factors (for long term planning; less relevant in a famine context). Which additional data to collect will depend upon the purpose of the data collection.

The chapters which follow deal with selected application areas: at the individual and population levels, and further divided by whether the assessment is based on a once–only measurement or by means of an on–going process. Each section addresses a number of issues in order – the decision to be made, what is to be assessed, who to measure and what age group, the relevant index, and, where applicable, the population−level indicator. This follows the sequence of headings in Table 1, which provides a summary of the key points of the discussions which follow.

CHAPTER 4 – SCREENING: INDIVIDUAL LEVEL – ONE−TIME ASSESSMENT

A. Screening to immediately decrease case fatality (emergency situations)

A typical emergency situation considered was when there had been a severe disruption in the food supply, for example as the result of drought. Some of the existing guidelines are given in: de Ville de Goyet, *et al.,* (1978); UN (1977); UNICEF, (1986). Food distribution was the intervention in mind, either distributed as take−home rations, or as camp feeding. This form of screening does not usually apply to i) long−term or chronic malnutrition (see Chapter 4b), ii) recurrent stress due to seasonal food shortages, or iii) sudden environmental disasters (earthquake, flood) where there has not been a previous deterioration in the nutritional status of the population.

Table I – Summary of recommendations

Type	*Use*	*What is being Assessed*	*Who to Measure*	*Index*	*Cut−offs*
Individual – one time assessment, emergencies. (Chapter 4A)	Screening to identify individuals requiring immediate intervention.	Immediate needs of individuals in at−risk population.	Priority is children under 5 years in at−risk population.	Weight−for−length preferred. If length not feasible, arm circumference.	Depends on resources, ofte set to select th number of chil who can be managed. Conventional cutoffs in table
Individual – one time assessment, non−emergency. (Chapter 4B)	i) Screening for nutrition and/or other health intervention;	i) Need/priority for entry into programme.	i) All children under 5 years in at−risk population.	*See table III.* i) Under 2 years: select those with low weight−for−length *and* those with low length−for−age. If length not feasible, use weight−for−age or arm circumference. Over 2 years: select those with low weight−for−length. If length not feasible, use arm circumference.	Depends on resources, ofte set to select numbers that c be handled. In absence of oth criteria, conventional cut−offs are −2SD's, or arm circumference 13.5 cm.
	ii) selecting groups/households at long−term high risk.	ii) Need/priority for targeted longer−term intervention.	ii) All children under 5 years (older age groups also if feasible) in at−risk households.	ii) Select using low length−for−age. If length not feasible, use arm circumference.	
Individual – trend assessment:	Early intervention to prevent growth	Growth failure; often requires	All children under 5 years	Deviations from target (weight)	Assess mainly trend, especia

Growth Monitoring. (Chapter 5)	failure and associated problems in individual children.	further information to assess cause and intervention.	registering, including healthy children.	growth rates.	relative to "road to health" (above −2SD's or 80% reference). For example see footnote 15.	
Population – one time assessment in emergency. (Chapter 6A)	Whether emergency relief required, how much, for whom, etc.	Identification of population affected. Priorities for assistance by area and population group.	Children under 5 years in vulnerable population. Data on older children and adults also informative. Convenience sample may do.	Weight−for−length. If length not feasible, arm circumference.	Cut−off can be determined locally, must be consistent between areas and previous surveys. Conventional cut−off for weight−for−length of −2SD's of reference, or 13.5 cm for arm circumference, often adequate. If sample size permits, multiple cut−offs – e.g. see Table II, may be useful.	Pr be po as di ag (e yr et
Population – one time assessment, for long−term planning. (Chapter 6B)	Inputs to planning, e.g. resource allocations, targeting, programme design, etc.	Growth failure in relation to: targeting criteria (e.g. area); possible causes, for intervention design; and as a proxy for inadequate diet, infectious disease, more generally for detrimental environmental & socio−economic factors.	Children under 5 years. Data on older children and adults also informative. Probability−based samples best.	Length−for−age. If length not feasible, weight−for−age. Birthweight (if representative). Arm circumference also a possibility. For adults thinness may be assessed by Wt/Ht^2 (body mass index)	Cut−off points and references must be same across all survey areas. Conventional cutoffs are −2SD's (13.5 cm for AC)	Pr be po va fo
Population – trend assessment; Nutritional surveillance for long−term planning. (Chapter 7A)	Inputs to planning, e.g. resource allocations, targeting, programme design, etc. Monitoring & evaluation.	Trends in anthropometric indicators and determinants: reasons for trends; required interventions.	Children under 5 years. Data on older children and adults also informative.	Length−for−age for assessing long−term changes, descriptively and in relation to determinants. Weight−forage or weight−for−length for short run changes in dietary intake and/or infectious diseases. For adults, trends in thinness (as body mass index) may	Consistency essential. Conventional (e.g. −2SD's or locally derived cut−offs may be used).	C pr be po va fo

				be used.	
Nutritional surveillance for timely warning. (Chapter 7B)	i) Concurrent indicator of nutritional stress; for safety net, to modify targeting & relief, in food shortages, ii) Retrospectively for predictive indicator identification.	Current nutritional situation in food crisis; predictive capacity of early indicators.	Children under 5 years in vulnerable groups. Data on older children and adults also informative.	Weight–for–length, if not use weight–for–age. Note rapid changes in underweight prevalences usually mean wasting.	Consistent wit previous. Conventional c locally derived cutoffs may be used.
Nutritional surveillance for programme management. (Chapter 7C)	Management of programmes (eg. targeting, logistics, etc.)	Factors relevant to programme management, such as targeting, general status of participating population.	Programme participants.	Depends on programme type. Short run effects, use weight–for–length or weight–for–age. Long–term effects, use length–for–age.	Consistent wit prior usage. Conventional c locally–derivec cutoffs may be used.

The prime objective of screening in this context is to identify those individuals requiring immediate intervention to prevent deterioration of nutrition and risk of death, and to ensure survival until longer–term help is available. The individuals at immediate and gravest risk need to be identified. Distinction between those at–risk and those likely to respond to food (alone) is often relevant – the malnourished will often be sick – so that need for medical attention should also be assessed.

If assessment is taking place in an emergency feeding camp, all individuals need to be examined and all children under 5 years of age should be measured. In such circumstances, wasting is more highly predictive of risk than is stature, thus, the preferred index is weight–for–length. Weight–for–age may also estimate wasting moderately well under conditions of acute food shortage, but often in this situation determining age may be difficult and/or time–consuming.

Arm circumference is often used in emergency screening because it is quicker to apply and requires simpler equipment. Arm circumference (AC) has been shown to predict mortality in some studies, particularly from Bangladesh (Chen *et al.,* 1980). Further studies are needed to be able to compare the relative value of weight–for–length and arm circumference, particularly over the short–term (e.g. < 3 months after assessment). On the basis of limited information and theoretical considerations, arm circumference was considered to be an adequate substitute for weight–for–length as an indicator of short–term risk where measuring weight and length is not feasible.

As discussed earlier, cut–off points cannot be recommended for all circumstances, as they will depend on the resources available for the intervention. Examples of cut–offs for weight–for–length and arm circumference that have been in use for some time are given in Table 2 (de Ville de Goyet, *et al.,* 1978).

Table II – Examples of interim classifications and cut–off points used in emergency situations

A: three categories	Arm circumference (cms)	Weight–for–length (%) *(note)*
Mild or no risk	> 13.5	> 80%
Moderate risk	12.5 – 13.5	70 – 80%
Severe risk	< 12.5	< 70%
B: two categories		
Mild or no risk	> 13.5	> 80%
Clear risk	< 13.5	< 80%

Note: Equivalent SD (Z−score) values are: 80%, minus 2 SD's; 70%, minus 3 SD's.

A two−stage procedure using arm circumference as an initial screen, followed by weight−for−length for those identified as at−risk, has been recommended previously (UNICEF, 1986). This could be particularly appropriate when large numbers of young children require to be screened quickly, and manpower and equipment are somewhat limited. All children under 5 years are measured by AC. Those falling below the chosen cut−off point are referred for a further screen based on weight−for−length. This determines (in this example) whether a child is discharged, receives general rations, supplementary feeding or therapeutic feeding (see Fig. 3).

The meeting endorsed in principle the cut−off points (see Table 2 & Figure 3) for application in emergency situations, at least until past experiences have been analysed and more appropriate cut−off points are developed. It considered that since such choices must be specific to situations where resources were usually constrained, the main recommendation should be to ensure that cut−off points were tailored to select the worst−off − that is lowered to the point where the intervention was not overwhelmed by numbers (see discussion on choosing a cut−off point in Chapter 3).

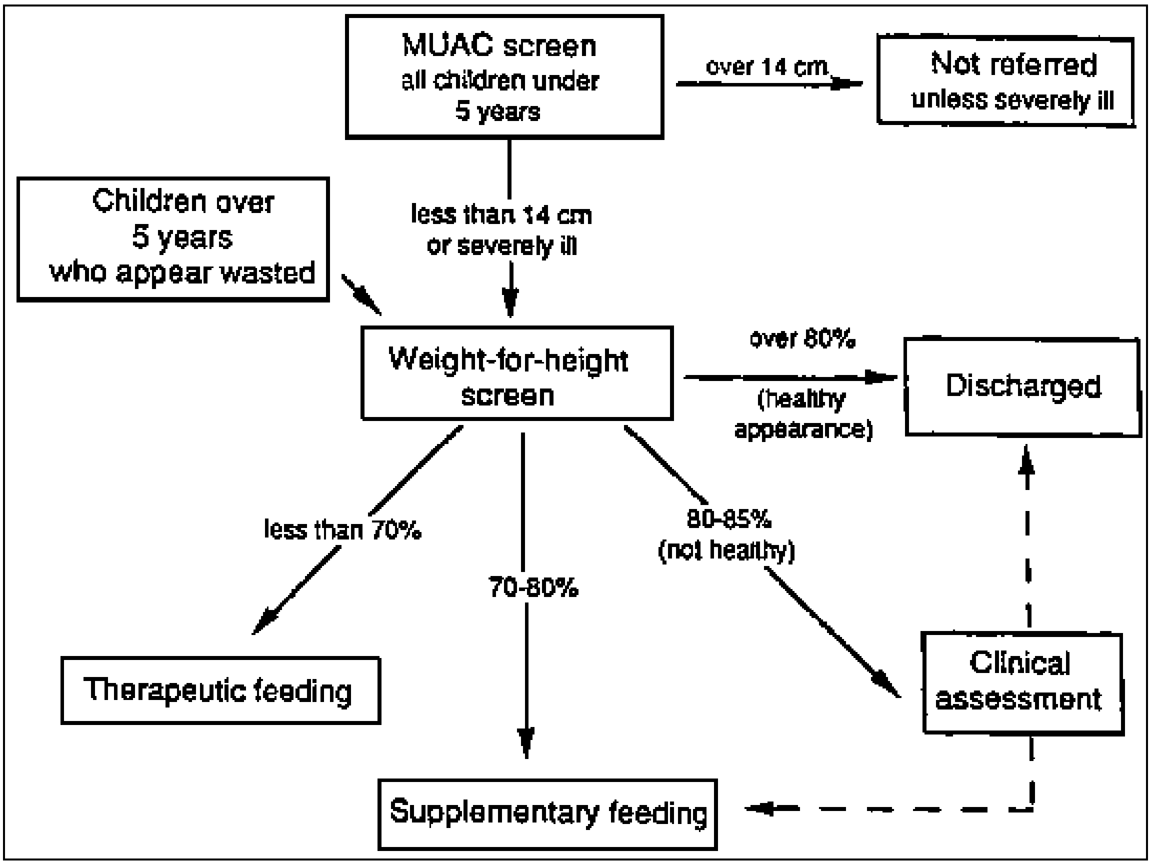

Figure 3. Example of a possible emergency screening procedure where time, manpower and equipment are not constraining (adopted from UNICEF, 1986).

For purposes of reporting and determining required resources, an estimate of prevalence below the cutoff point being employed for purposes of intervention is needed. International reference data are appropriate for identifying children who are in the lower tail of the distribution and require intervention, however, in this setting the choice of reference is not critical. The cut−off will vary with a change in references. Additional information on prevalence of clinical signs, rates of infectious disease, state of sanitation, mortality, etc. may be very useful.

Summary Recommendations

A. In emergency situation affecting food supplies, wasting (weight−for−length) is more highly predictive of risk than is stature (length−for−age) and the preferred marker is weight−for−length. If measuring length is not feasible then weight−for−age (if age can be determined) or arm circumference (AC) may be used. If assessment is taking place in an emergency feeding camp, then all children under 5 years should be measured.

B. If resources for intervention are adequate then conventional cut−off points (such as those indicated in Fig. 3 or Table 2) may be used. However, where resources are more limited then the cut−off point should be modified (e.g. lowered from minus 2 SD's of reference median to minus 2.5 SD's or minus 3 SD's) to select the number of children for which resources exist.

C. Multiple screening methods, such as that proposed by UNICEF shown in Figure 3, may be appropriate when very large numbers of children must be screened and resources are scarce.

B. Screening for programmatic interventions (non−emergency situations)

Two situations for non−emergency screening are considered:

1. Screening for immediate nutrition and/or other health intervention, in order to prevent growth failure and associated problems.

2. Identifying children in high−risk households for either of two related purposes:

   i) to prevent severe protein−calorie malnutrition, and

   ii) to reduce mortality risk or functional impairment − possibly associated with early growth failure − over the long run. The objective is to select children who will respond to the programme intervention.

Screening for immediate nutrition and/or other health intervention

Outside of an emergency situation, anthropometry may be used to screen individuals for intervention (often a programme in which feeding is a component).

In principle, all children under 5 years old in the population should be screened. Previous examination results, if available, can also be used to determine the age group which is presently experiencing growth failure or wasting. Very young children (below 2 years) can respond to feeding if they are either thin or small, or both. Children who show evidence of having being affected in the past (i.e. children over 2 years whose growth in length was impaired at younger ages and who are now stunted) may not respond (in terms of anthropometry) to supplementation unless they are also thin. This does not mean that they do not manage any catch−up growth at all, but perhaps not sufficient to be counted as 'responders'.

If length can be measured then it is preferable to screen on the basis of two indicators. For children *under two years of age,* use weight−for−length to pick up thin children, and use also length−for−age to add those that are stunted. The latter group can benefit from intervention while they still have a chance of catching up. For children *over two years of age,* use weight−for−length to detect wasting. The meeting recommended that length−for−age not be used for screening for immediate intervention in this age group, as the child will not respond in terms of catch−up growth.

The aim is to pick−up under 2−year−olds who need attention (e.g. feeding) by wasting or stunting in order to benefit several of the factors associated with growth failure shown in Figure 1 (immunity, activity, etc.), and success can be determined by improved growth. For the over 2−year−olds the position is slightly more complicated. Those wasted should be selected in for immediate intervention, and response will be measured by weight gain; this is straightforward. Those stunted but not wasted would not be selected if resources are limited. But these might still benefit from (say) extra food, as their stunting marks a deprived environment, in terms of increased energy for activity, and perhaps better immunity. But their obtaining this benefit will not be measured by improved growth, since by this age they have less capacity for catch−up in terms of length (and they are not thin). One conclusion is perhaps that if, for example, long−term feeding were feasible − intermediate between the categories of 'immediate nutrition intervention' and 'long−term risk' in Table 3 − then selecting in *both* stunted *and* wasted children of over 2 years of age may be worthwhile.

Table III − Recommended criteria for non−emergency screening

Selecting for:	Children under 2 years	Children over 2 years
Immediate nutrition and/or health intervention	Select those with low weight−for−length *and* those with low length−for−age. If length cannot be measured, use weight−for−age or arm circumference.	Select those with low weight−for−length. If length cannot be measured, use arm circumference. (If resources unconstrained, stunted children may also be selected and benefit in terms of e.g. activity, but length may not respond)
Selecting households at risk (e.g. to protect future children)	Select on basis of length−forage (or if necessary arm circumference)	Select on basis of length−forage (or if necessary arm circumference)

Choice of cut−off points depends on whether resources are constrained or not (see discussion in Chapter 3). In general, choose a screening level with a high cut−off point − this will ensure that more individuals are included in the programme, so that almost everybody will be selected who could potentially benefit. If resources are limited then lower the cut−off point to deliver the number of children for which adequate resources exist.

Selecting groups/households at long−term high risk

In this context we are considering an intervention which may have some food supplementation as an integral part but which will mainly consist of non−nutritional components, e.g. family−related health and education programmes. The emphasis is on targeted assistance to reduce risk of death − possibly associated with early growth failure − in the longer run (rather than within the next month or two). Anthropometry is convenient to pick−up a situation of high−risk, even if risk may or may not be primarily nutritional, and may or may not be reversible by nutritional intervention. In selecting households at−risk, the risk to be prevented also applies to future children as well as individuals who are examined − the goal is to change the environment of the household and not solely to treat/modify the risk for a particular individual.

All households within the targeted area will need to be screened and all children, or at least those under 5 years, will need to be examined.

Small size − indicating a failure to grow adequately − is a better predictor of long−run risk than wasting (as the latter may simply reflect very recent events, such as a bout of illness). As such, where length can be measured, then length−for−age in both younger and older children is the indicator of choice (see Table 3). If length can not be measured, then weight−for−age is an acceptable substitute, but this indicator will identify more lower−risk children or households.

Presentation will be as prevalence below the chosen cut−off point by age/sex and the attributes of the target population, e.g. household characteristics.

Summary Recommendations

Screening for immediate nutrition and/or other intervention:

> A. If length *can* be measured, then for children under 2 years of age select by either − weight−for−length to pick up the thin children, and length−for−age to add those who are failing to grow (i.e. becoming stunted). Both will benefit from better nutrition. For children over 2 years of age use weight−for−length to detect wasting. However, if resources are not scarce, stunted children over 2 years may well benefit from long−term feeding in terms of e.g. improved activity and immunity.
>
> B. If length *cannot* be measured, then use weight−for−age in children below 2 years and arm circumference for older children. If resources are limited then lower the cut−off point to select the number of children for which adequate resources exist. If resources are not unduly limited then choose a screening level with the cut−off point raised to include more children so that almost everybody will be selected who could potentially benefit.

Selecting for high risk groups/households:

C. It is recommended that length–for–age be used for all age groups.

D. When measuring length is not feasible, weight–for–age in both younger and older children is an acceptable substitute.

CHAPTER 5 – GROWTH MONITORING: INDIVIDUAL LEVEL – ASSESSMENT OF TRENDS

Growth monitoring involves following changes in a child's physical development, by regular measurement of weight, and sometimes of length. It is an important tool in individual care, for early detection of health and nutrition problems in growing children (Healy *et al.,* 1988). Deceleration in linear growth at an early age has been shown to be associated with increased risk of subsequent mortality (Van Lerberghe, 1988). Indications of growth failure alone are not readily related to specific causes, and often more information is needed to decide on the response. Growth monitoring also has the advantage of recording responses to intervention. In general, growth monitoring may provide for earlier detection of the need for intervention than one–time screening measurements (see previous section). Moreover, the trend measurement can distinguish children of adequate achieved size who are running into problems. Descriptions of growth monitoring methods are widely available – see for example the detailed reviews by Lotfi (1988), Yee & Zerfas (1987) and a special edition of the Indian Journal of Pediatrics (Vol. 55, No. 1, 1988).

Well–documented comparisons between decisions taken on the basis of growth charts and those taken on the basis of one–time measurements from screening are not readily available. The group recommended that a compilation of existing data and an assessment of the relative performance, under field conditions, of growth monitoring and one–time screening should be undertaken. An additional examination of the use of growth charts as a tool for the mobilization and application of community resources and the focusing of community decision making would be very useful.

The use of growth monitoring extends beyond problem detection. It has been used to provide a basis for communicating with mothers and with health workers, concerning child health and nutrition, and to stimulate thinking about the causes of poor growth and malnutrition. This in turn has led to action at the level of the household and of the community itself. Experience of this is, as yet, limited, but it appears very promising. Notable pioneering work has been done various settings including Colombia in the 1960's and Thailand in the 1970's and recently in the Joint WHO/UNICEF Nutrition Support Programme in Iringa, Tanzania. In the latter programme, children under 5 are weighed every 3 months, by village, and the results discussed in the village health committee. This often led, for example, to the establishment of day–care facilities. The children are classified according to weight–for–age. Those identified as malnourished are then followed up by monthly growth monitoring, often done during household visits by a village health worker.

Who to measure? Growth charts in particular have been used for healthy children, under the normal circumstances of growing up, in both developed and developing countries. It is this early and continued use which gives them a particular advantage for prevention. Thus, ideally all children should be regularly weighed and the results kept on growth charts. In practice, certainly all children enrolling in health and nutrition programmes should be issued growth charts, and mothers motivated to ensure regular weighing – preferably every month but at least every three months.

By far the commonest measurements are those of weight. Target growth rates (often called 'road to health') are generally based on the WHO/NCHS reference values – these are very similar to local references when the latter are derived from non–poor, healthy children. The point (as noted in Chapter 3) is that the chosen reference growth curves should be based on a population whose growth patterns are unconstrained by environmental factors. Concern is not with whether a child is on a given centile at one point in time, but whether its pattern of growth falls along the same centile band as age increases. This pattern provides more important information than the actual weight at any particular time. In effect, the child's longitudinal record represents its own control; the reference curves serve only to illustrate expected patterns of change.

As weight–for–age is a composite index, growth failure can be due to either a loss of weight or a failure to gain in length, or both; differentiating between these causes may be problematic. Thus, in addition to weight, measuring length would give more direct information on linear growth. If length measurements can be taken, then it would be advisable to also monitor weight–for–length.

The main difficulty in basing decisions on signals from growth charts – aside from the non–specificity to cause – is to define what growth faltering is, at different ages. Growth faltering is identified by emphasizing the direction of growth obtained in serial recordings, rather than the actual weight–for–age itself. No change or an actual decrease between successive measurements is taken as a sign of growth faltering, whereas adequate growth is reflected in a measurements tracking in parallel to the expected weight gain in the reference curve. Moreover, interpretation and action varies by the child's age. Specific interpretation of changes in weight gain varies considerably among different practitioners.[14]

[14] One definition of growth faltering that has been used (Steveny, 1982) is as follows:

age 0–4 months: gains of < 0.5 kg per month; 6 – 15 months: three horizontal or falling monthly weights, even within the 'road to health' area (usually from –2 SD's to median); 16–60 months: three horizontal or falling monthly values, below the 'road to health' area; any loss of > 1 kg in a month; any value > 2 kg below 'road to health' area.

A practical difficulty in assessing growth rates concerns normal fluctuations in body weight over short time periods. This may be due to minor and normal changes in hydration status (including insensible loss), before/after a meal, etc. The variation thus introduced can be significant, up to several hundred grams or perhaps 50% of expected normal monthly weight change. This natural variation complicates interpretation.

In general, current practices of growth monitoring were endorsed by the meeting. Attention for future development of growth monitoring was directed towards:

– improving the definition of growth faltering and response at different ages;
– understanding and use of growth charts by health workers, and for communicating with mothers.

Summary Recommendations

A. The current practices of recording weight for growth monitoring should continue.

B. Measuring length may also be useful especially when:

– resources are not constrained, so that length growth velocities can be used for additional information;

– in contrast, when coverage and regularity of weighing is poor – i.e. true monitoring is not done – weight–for–length may be assessed as a substitute.

C. Target growth rates should be based on reference values derived from populations where environmentally conditioned growth failure is minimal – the WHO/NCHS reference data meet this criterion. The child's longitudinal record serves as its own control and interest lies in the growth pattern, and whether this tracks along the same centile band as age increases.

D. A compilation and analysis of existing data should be undertaken to address the question of the advantages of growth monitoring in practice over cross–sectional screening in detection of growth faltering. This study should also determine the degree and level of significant weight loss (as distinct from normal variability) or failure to gain weight, that is of longitudinal signals with respect to diagnosis and response.

CHAPTER 6 – POPULATION LEVEL – ONE–TIME ASSESSMENT

The indicator chosen for population assessment must function either as a direct measure of the problem and risk involved (e.g. wasting, in the case of a food crisis); or as a proxy for causal factors (e.g. stunting, for long–term planning). For ranking purposes, whether by region or otherwise, different indicators may give very different results. For example, empirical evidence shows that indicators based on length–for–age and weight–for–length have either zero or negative correlation; thus even opposite rankings can be found.

A. Population Assessment under Circumstances of Food Crisis

The crisis is already underway by the time anthropometry shows a measurable response. A common policy−related problem is: at what point does a crisis become an emergency (at least in certain groups of the affected population)? Are there 'trigger' levels of wasting that could define an emergency? The meeting concluded that there are no accepted criteria of the level of wasting that could be used in all areas of the world to define 'emergencies', partly because levels of wasting under non−emergency conditions vary greatly across populations.

Nonetheless, guidance on these points was often sought, and review of past experience could be relevant. The meeting therefore recommended that experiences in famines should be analysed retrospectively to explore: i) which groups within the population (age, sex, ethnic group, etc.) are most likely to be affected, and ii) the relationship between rises in levels of wasting and changes in mortality patterns. In addition, knowledge of non−emergency levels of wasting will be helpful in deciding when a situation is becoming critical. For example, in Latin America the usual prevalence of wasting (below minus 2 SD's weight−for−length) in children is around 2.5%. There, any assessment that finds higher levels − say 10% − should be regarded as indicative of a seriously deteriorated situation, even though the level found may be lower than that usually measured in parts of Asia or Africa. One compilation of observed wasting levels is given in Annex D.

Given indications that a food crisis is underway (for example, recorded food shortages in the market place, rising grain prices, population migration, sale of basic possessions, etc.), decisions must be taken regarding the provision of emergency relief. Anthropometric data can provide urgently required information on the current and changing scale of the problem − how many are affected or at immediate risk ? Which regions ? Which groups ? Such data will assist decisions on resources necessary to deal with the problem.

The most vulnerable groups should be sampled. If these are not known, it is appropriate to measure all children between six months and five years. In an emergency situation, assessing older children and adults may also be important to clarify who is affected and to what degree.

A sample focussed on the most affected group will aim to detect higher than expected prevalences. Sampling methods were discussed in Chapter 3.

Wasting is the condition of immediate concern because of risk of death. Weight−for−length is the required indicator. Arm circumference may also serve as a practical alternative to weight−for−length, however its predictive ability in relation to short−term population mortality risk has yet to be fully established.

Concern is not only with the immediate level of wasting, but how that level is changing with respect to historically expected levels (taking seasonality into account, if necessary). An issue is whether the problem is static or becoming worse, and if the latter, how rapidly? Consequently, what should trigger action is not necessarily only the absolute level of wasting but the change in that level. Comparison of results of one−time assessments with data from previous surveys is particularly important, taking account of seasonal effects and of comparability of samples (e.g. by age, population group, etc). Repeated surveys are also discussed under 'surveillance'.

Results should be displayed as prevalences below the chosen cut−off point − often below minus 2 SD's of the reference for age/sex groups (WHO/NCHS external references are often suitable, see discussion in Chapter 3). Should comparisons with historical prevalence information be intended, the cut−off point and standards must be the same as that used previously (or the previous results must be recalculated). Clearly, it is important that concurrent studies in different regions use the same indicator and cut−off point for comparability and to assist ranking. As with all population−directed studies, if feasible an examination of the whole distribution − not simple prevalence below a cut−off point − should be undertaken; sample size permitting, distributions by narrow age bands may be informative.

Determination of wasting prevalence would usually not be the only information required to make decisions about food assistance (or other forms of assistance). Additional useful information for assisting the planner and for subsequent targeting should be provided, e.g. ethnic status, administrative area, socio−economic status in relation to access to food, etc.

Summary Recommendations

A. Prevalence of wasting, measured by weight−for−length, or if this is impractical by arm circumference, provides the best anthropometric indicator for assessing current effects of food shortages.

B. No universal trigger level based on wasting prevalences can be recommended. *Changes* in wasting prevalences may be particularly informative.

C. A sample based on the most vulnerable group – usually children under 5 years or age – will suffice to detect higher than expected prevalences. Information on older children and on adults may also be informative.

D. Presentation of prevalence findings in terms of appropriate targeting characteristics – e.g. age/sex, ethnic status, administrative area, socio–economic status in relation to access to food, etc. – will assist the planner. Examination of frequency distributions (by age, if sample size large enough) is recommended.

E. Research should be encouraged along the lines of reviewing data sets and studies where it is possible to relate mortality rates to different levels of anthropometrically measured nutritional status.

B. Population Assessment for Long–Term Planning

Anthropometry is relevant to defining problems to be addressed in planning, their extent and localisation, perhaps suggesting suitable interventions. Contributing to a range of indicators, anthropometry can be used to rank areas or population groups by need. Should the intervention decided upon involve a direct or indirect nutrition component, then anthropometry will clearly have a further part to play in evaluating both the progress and outcome of the intervention. There are clear similarities between the role of anthropometry here and in nutritional surveillance for long–term planning (Chapter 7a): choice of indicators, sample and presentational considerations, have much in common.

Sampling should be on a representative basis to enable proper comparisons by region or other policy variable. In certain circumstances a sample of convenience may prove adequate. One possibility where school attendance is high is to measure the length of all school entrants.

Who to measure depends on the type of information required for planning different types of interventions. Causes and correlates of deviant anthropometry are age–dependent; therefore selection and interpretation of indicators also depends on age. For example, where the concern is mortality risk of young children, the age group of priority would be from birth to two years, and the interventions would be aimed at mothers, infants and young children. In looking at the relationship between weaning practices and early growth faltering the key period is from 6–24 months. On the other hand, where the concern is contributions to more general planning for socio–economic development, a wider age range may be selected. Attention is also being directed increasingly to measurements on adults. In this case, vulnerable groups of particular concern may often include pregnant and lactating women, non–pregnant women, the elderly, and adolescents.

The need is usually for a marker of growth failure, as this correlates best with causal factors that have been constraints to past development and may be influenced by appropriate actions in the future (e.g. food availability, food prices, income, etc.). The recommended measurement for this purpose is length–for–age. Should length–for–age prove not feasible to collect, weight–for–age may serve as a substitute, although usually weight–for–age is less closely associated with environmental constraints than length–for–age, hence is a poorer proxy measure.

While length–for–age is the proxy variable of choice for causal factors to be tackled by long–term development, other indicators may have greater positive predictive value for specific purposes. As an indicator of potential problems for the individual, particularly in the first year of life, birth weight is clearly important Birth length may indeed be better than birth weight as a measure of perinatal and neonatal risk; this is a subject for further investigation. However, for planning purposes at the population level, the usual constraint with regard to using birth weight (or length) is its availability and representativeness (Rasmussen *et al.,* 1985). Should coverage be less than say 60%, then its reliability must be suspect. Arm circumference has been cited as relating well to long–term risk of mortality (Trowbridge and Sommer, 1981; Alam *et al.,* 1989) and to morbidity (Trowbridge *et al.,* 1981), and may become increasingly useful in this context as a substitute for length–for–age.

Analysis is best done using derived values as percentage of reference, or Z−scores. For purposes of establishing rankings according to need, similar inferences will result if data are expressed as Z−scores (the preferred format), as percentage of reference median, or percentile. (This is further discussed in Annex C.)

In addition to providing a breakdown of prevalence by age/sex, other classifications will be relevant to the planner: administrative unit, ethnic group, social group, plus other variables felt to be related to causality − extent of diarrhoea, infectious diseases, access to water, sanitation, and so on.

Adult anthropometric assessment was beyond the scope of the workshop, but the following was noted. Usual measurements are weight and length, generally calculated as a body mass index (BMI: (weight in kg) divided by (length in metres squared)). Recently suggested cut−off points that are considered useful for BMI are 18.5 and 16 (James *et al.,* 1988). Generally, it is believed that a BMI over 18.5 indicates adequate nutrition, and a BMI under 16 is clear evidence for chronic energy deficiency. For BMI between 16 and 18.5, additional information on food consumption may be necessary. There is increasing evidence that the mean and distribution of BMI may be useful in distinguishing between the nutritional state of different groups, monitoring the evolution of food adequacy and in specifying the proportion of malnourished in the population (see James *et al.,* 1988). The interpretation of adult BMI data will often involve comparisons among groups rather than assessment of absolute prevalence.

Summary Recommendations

A. Anthropometry can be used as one criterion to identify high−risk, vulnerable areas for planned interventions. Its role is in terms of assisting with problem definition; this may involve ranking areas and/or groups by prevalence rates, for example for targeting purposes.

B. Sampling should be on a representative basis to enable proper comparisons by region or other policy variables. In certain circumstances a sample of convenience may prove adequate (e.g. school entrants).

C. Who to measure depends on the information required for planning a given intervention. Where concern is with the mortality risk for young children, then the age range will be from birth to 2 years. If a more general intervention is intended in order to target economic assistance, or development of health services, etc., then the choice may well include a wider age band.

D. The choice of indicator is dictated by the intended use of the information. It must be decided if the selected indicator is intended to function as a direct measure of the condition to be addressed or as a proxy for causal factors. Indicators are not equally sensitive or predictive of a given condition or outcome at different ages.

E. The recommended measurement for long−term planning purposes is length−for−age. Should length−for age prove not feasible to collect, weight−for−age may serve as a substitute, although the latter is less well related to presumed causal factors.

F. Other indicators such as birth weight or birth length, and arm circumference may be useful under specific circumstances − for example to assess perinatal problems and longer−term risk of morbidity/mortality, respectively.

G. For *presentation,* measurements are converted to prevalences using external (e.g. WHO/NCHS) references. For *analysis,* for example of differences between groups, associations with possible causal factors, etc., would use indices as continuous variables, such as Z−score (recommended), percent of median, or percentile.

CHAPTER 7 – NUTRITIONAL SURVEILLANCE: POPULATION LEVEL – TREND ASSESSMENT

In this report the term surveillance is reserved to refer to a system of data collection and application (WHO, 1976b; Mason *et al.,* 1984). Such systems are based upon routinely compiled data and monitor changes in relevant variables over time, give warning of impending crises or monitor the effectiveness/ineffectiveness of existing programmes and policies. Surveillance may draw upon several types of data but the essential features are that the data are collected across time, as in repeated cross−sectional surveys or repeated reporting of the prevalence of underweight children from growth monitoring, and that the data collection and analysis are linked to decision−making.

Operationally, this may be visualized in terms of the flow of information to planners, its assessment in policy terms, decisions on appropriate activities, implementation, population impact, followed by a further cycle of data collection and analysis (see Figure 4). The process is clearly iterative. The purpose is to provide on an continuing basis timely, accurate and relevant information to facilitate detection, control and prevention of nutrition problems. The focus is entirely pragmatic − data requirements being determined by planning and decision−making needs; in effect, surveillance measures what is necessary for policy guidance, programme design and management (ACC/SCN, 1982; Mason *et al.,* 1984; IFNS, 1988; for addition sources on data collection and analysis see Lwanga, 1978; Tabatabai, 1983; Test, 1986; Valverde *et al.,* 1981)

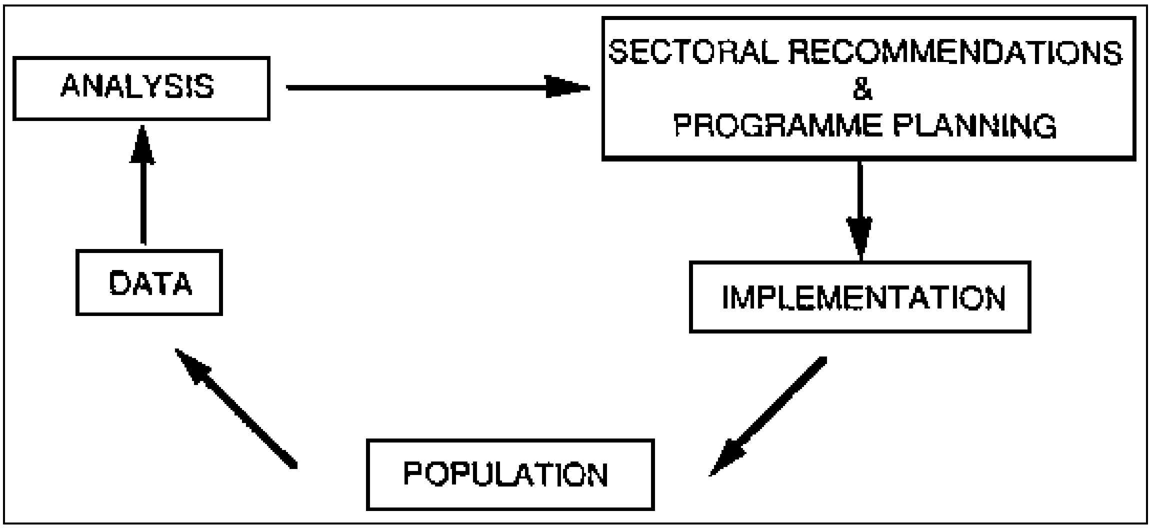

Figure 4. Information cycle in a nutritional surveillance system (Adapted from ACC/SCN, 1986b)

Since the initial specification of a general strategy for nutritional surveillance in the mid−seventies, a number of specialized systems have evolved to address particular application areas (Mason *et al.,* 1984; Rothe & Habicht, in press). These are:

i) policy and planning in the medium−to−long term;
ii) timely warning and intervention for famine prevention;
iii) programme management and evaluation.

The role of anthropometry is considered in these areas respectively. The importance of specifying the purpose of the system must be stressed, since data characteristics and interpretation may be quite different for different applications.

A. Nutritional Surveillance for Long−Term Planning

By providing information on nutrition conditions and associated factors in different population groups and how such conditions are changing with time, nutritional surveillance can facilitate decision−making in relation to current and future policies, and direct targeting for health/nutrition and general development programmes. Surveillance information can be utilized to promote actions that will alleviate or prevent malnutrition in the population at the individual, family, community and regional levels. Anthropometric data play an important role in this process.

The purpose of anthropometry in this setting is clearly similar to that for Chapter 6b (Population Assessment for Long−Term Planning), the key difference being that monitoring over time permits better problem identification and intervention targeting. As noted in Chapter 6b, anthropometry will address only one dimension of the planning requirement and additional information (social, economic, agricultural, health) is normally required for intervention design and implementation.

The population to be measured again depends upon the decisions to be made – for example, for specific interventions or more general inputs to planning. Broadly based, representative samples, covering such groups as preschool children, school entrants, and adults, are usually appropriate. It is vital that samples are comparable over time in order to assess trends.

Determining the age group to measure relates to the causes and/or interventions of interest – is it intended to target a particular age group? For example, birth weight relates to maternal nutrition (and maternal size) and is predictive of the child's perinatal development; growth in the age range six months to two years reflects weaning practices and health environment, etc. Although there is little experience, monitoring weight, or BMI (body mass index, weight over length squared), in adults may require raised priority. Considerations relating to selecting indices are similar to those for one–time population assessment. Since time–series data are used, indicators may in principle be refined with experience. Further, *changes* in indicators may be related to causes. Seasonal effects can be assessed.

Generally, trends in weight–for–length or weight–for–age in children (especially between 6 months and two years) will be more sensitive to stress resulting from inadequate food consumption and/or infection in the short run, while trends in length–for–age (2–5 year olds) provide information on long–term changes in the environment and their nutritional consequences, as linear growth is a better proxy for general development constraints.

Analysis of anthropometric data may be in terms of *mean* weight–for–length and length–for–age values for population groups, classified by such factors as age/sex, socio–demographic variables of relevance to the planning context, etc. *Presentation* of information for decision–making purposes may be by trends in prevalence below the chosen cut–off point classified by such socio–demographic and administrative variables as are required for planning. Cut–off points are not critical and may be those commonly used (i.e. minus 2 SD's); these should be chosen so as to be comparable over time. Similarly, external or internal references are equally valid if employed consistently over time. (The same cut–off point will obviously yield different results depending on the reference values used, and thus must be determined having regard to which reference data are used.) Where sample sizes are large enough, it would be useful to examine the changes over time in the frequency distributions for different age groups.

Summary Recommendations:

A. As linear growth is a good proxy for general development constraints, trends in *length–for–age* provide information on *long–term changes* in the environment and their nutritional consequences. *Weight–for–length* or *weight–for–age* patterns in children will reflect stress resulting from inadequate food consumption and/or changes in infectious disease incidences in the *short run.* For adults, measures of thinness, such as the body mass index, are the most relevant in this setting.

B. The sample frame – age, sex, area, and socio–economic status, etc. – should be chosen to reflect planning needs. Initially broadly based samples to identify and monitor current and potentially vulnerable groups – preschool and school children, and probably adults in some settings, will be valuable. An important consideration is that samples should be comparable over time to allow for trend assessment.

C. Presentation is in terms of trends in prevalence below the chosen cut–off point, classified by such socio–demographic and administrative variables as are required for planning. External or internal references are equally valid if employed consistently over time; choice of cut–off point is not critical but should also be comparable over time, and will need to be considered in relation to which reference data are to be used.

B. Nutritional Surveillance for Timely Warning

Timely warning systems are intended to prevent acute food shortages, often resulting from drought. 'Timely' is used to imply that the decision to intervene with a predetermined response (e.g. release and distribution of stocks) is triggered early and in time to prevent deterioration in nutritional status. This is dependent on the collection and rapid analysis of a selected few predictive indicators.

Anthropometry is not used primarily for predictive purposes; agricultural, meteorological, and similar data can serve for this. There are two distinct principal uses of anthropometric indicators in this context:

(a) as a concurrent indicator of nutritional stress, they are used under some circumstances where there is a rapid system for reporting information; this allows monitoring of nutritional conditions over time, modifications to targeting, and verification of adequacy and effectiveness of intervention;

(b) retrospectively, anthropometric information can be used for identification, characterization, and validation of other predictive indicators (e.g. agricultural and meteorological) for future use.

The population to be measured is the historically vulnerable population, as this is the most likely to show early response to food shortages. The issue of national representativeness is less important and so a purposive sample, monitored over time, will serve. Children under 5 years of age will generally be most at−risk, but older children and adults should not be ignored.

For monitoring within a timely warning system, wasting is usually the condition of concern, and weight−for−length is the appropriate index. Weight−for−age is a serviceable substitute and is more widely used at present. Reporting will be in terms of trends in weight−for−length (preferably), or weight−for−age. It should be noted that rapid changes in weight−for−age will be due to changes in wasting. Arm circumference changes may be an adequate substitute for weight−for−length in assessing wasting trends.

In relation to the second use of anthropometry (i.e. for validation of predictive indicators), since the analysis is historical, results do not need to be available in real−time, relating to current events. The same anthropometric indicator as that being used for current warning is appropriate − weight−for−length, or weight−forage. Historical analyses should assess sensitivity and specificity of predictive indicators in relation to anthropometric measures of the outcome to be prevented. The retrospective analyses have been shown to be useful for identifying predictive indicators in this way.[15]

[15] In Botswana, the analysis showed that certain agro−meteorological indicators were good predictors of subsequent malnutrition; more important, it allowed an estimate of relevant cut−off points in the predictive indicators and their timing (Mason et al., 1987). In Indonesia, the analysis allowed a choice between an array of potential predictive indicators: it showed for example, that the percentage of rice area that was harvested was a good predictor, whereas early indicators of yield were not (Brooks et al., 1985; Brooks et al., in press).

The question of rates of response of an anthropometric indicator over time is probably fairly straightforward, although not much data is yet available to confirm this. A frequently asked question is: "how rapidly do we expect prevalence to change?" The answer is rapidly − if capable of eating and digesting food, an underweight child will start gaining weight almost immediately on re−feeding (often even if there is concurrent infection, provided the food is actually eaten). Equally, the seasonal changes shown in the SCN's 'Update' Report (ACC/SCN, 1989c) show rapid changes of prevalence, at the expected times of the year. So the question of sensitivity to change over time in that sense seems clear in principle[16]. On the other hand, when the anthropometric indicator is being used as a measure of response − for example to a feeding programme − there is less information on the actual lags experienced (although there is no biological reason for long lags).

[16] Prevalence data which are not collected by probability−based survey methods (e.g. clinic or health post administrative records) must be carefully examined to determine if large swings in proportion of cases under the selected cut−off point might be due to changing bias in the data. For example, a large influx of malnourished refugees could distort the underlying pattern; some means of assessing this confounding are discussed in ACC/SCN, 1989c, pp 182−3.

Data are usually presented as trends in prevalences below the cut−off point In this case, trigger levels for intervention may be related to changes in prevalence, not to absolute levels of prevalence itself, and therefore the choice of cut−off point is not critical but must be used consistently, and will be a function of whether external or internal references are used, and to what degree these distributions differ.

Summary Recommendations

A. Anthropometry is used for assessment of effects of an impending or actual emergency, for targeting of relief supplies, and for tracking such concerns as whether certain areas are showing continued deterioration when food is being distributed.

B. Anthropometry may serve to identify and validate, retrospectively, agricultural and meteorological predictive indicators for future application.

C. Sampling methods depend on the population of concern – usually the most vulnerable, based on historical evidence. Random sampling is encouraged, although clinic based data often provide a convenient source. Preschool children are likely to show the first signs of stress due to food shortages, but older children and adults should not be ignored.

D. Changes in weight–for–length or weight–for–age are the most useful current indicators. Reporting is in terms of trends in prevalence below the cut–off point (typically, minus 2 SD's below reference median, depending on local experience).

C. Nutritional Surveillance for Programme Management

Effective programme management calls for monitoring in order, for example, to ensure that services are being delivered to the planned target group and having the desired outcome (see e.g. Casley and Kumar, 1987 & 1988). Anthropometry may be useful in the first instance to identify target groups. Secondly, if the programme have a nutrition–related component, it has a role in checking progress. Finally, anthropometry may be relevant to assessing overall programme performance and impact.

The population to be measured is that targeted for the programme, or the participants in the programme (these will very likely differ). Since growth retardation occurs primarily in children of less than two years of age, assessments that focus on this age group are more likely to show anthropometric responses to interventions. A key issue, discussed in some detail in Chapter 3, is that for evaluation purposes little if any anthropometric response to intervention may be found in children of greater than two years of age. Thus careful interpretation of results of monitoring such children is required.

For management purposes the question might be "Is enough of the right food getting to the right people at the right time ?" In this case, the 'right' people needs to be defined by the anthropometric indicator, which is again dependent on those who can benefit from supplementary feeding (in this example). This argues for several things. First, that a weight–based indicator be used, i.e. weight–for–length or weight–or–age. Second, that a cut–off point is set sufficiently low that it defines adequately those who are deficient in food (and who will respond to that intervention). Third, that the problem for those of low weight is indeed lack of food and not primarily infection. In any event, the choice of indicator must reflect the objectives of the programme and the nature of the intervention. If the programme is designed to alter the micro–environment of the recipients (e.g. a household food security programme) over the long–run, then length–for–age will target those individuals/households requiring intervention. Changes in the prevalence of stunting (by age) will provide information on effectiveness of targeting and help evaluate both process and outcome.

Actual experience with regard to the responsiveness of programmes is mixed (Beaton and Ghassemi, 1982). A number of programmes do not appear to have altered child growth whereas others have produced marked effects within a few years after their initiation. A variety of factors may explain the disparate results including the nature of the programme, the characteristics of the population served, and the adequacy of the evaluation design. Expectations of impact on growth are often unrealistic. Total elimination of growth retardation should never be anticipated, certainly where programme effects on nutrition are indirect, for example through income: it took decades for growth retardation in industrialized societies to disappear as a result of continuous economic development. Programmes in developing countries that affect only a small array of causal factors of growth retardation should not be expected to produce dramatic effects. Depending upon their nature, it may not be practical to expect effects on growth from all programme types. Consequently, interpretation of findings should take careful account of whether the programme participants are likely to respond to the intervention.

Another example of a nutrition–related programme might involve a geared response (possibly income support or food subsidies) to a structural adjustment programme which has a direct or indirect effect on food prices (see Stewart, 1987; and ACC/SCN, 1989b, on suggested approaches for nutritional surveillance in the context of structural adjustment). Here the issue which arises is to ensure that the vulnerable population are protected by timely application of appropriate compensatory measures. This situation also shares elements of the

Timely Warning System and differs from the latter only is so far as the action required will be in terms of some modification to an on–going economic adjustment programme. Here again, the need is for rapid data turnaround from a limited number of sentinel sites defined with regard to recognized vulnerable groups. The interpretation proposed would both quickly show changing trends, and also interpret these with respect to indicators of access to food, and possibly of health services.

Summary Recommendations

A. Anthropometry is relevant to programme management for three reasons: i) to identify target groups, ii) in monitoring progress, and ii) in assessing overall programme effects.

B. Indicators used must relate to the objectives of the programme. The choice of indicator depends on factors such as the nature of the intervention and the age of the target group. Pooling of age groups (e.g. all under 5's) can be misleading due to a potential differential response to the programme by children of various ages. Specifically, little *anthropometric* response to intervention may often be found in children of more than two years of age, although there may be other benefits in terms of activity and immunity, for example.

C. The sample to be measured must be well defined and allow estimates for the programme's target population in order to provide assessments of efficiency and effectiveness.

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ANNEX A – The significance of small body size in populations

Extract from: ACC/1989/PG/2
English
page 7

There is a debate about the concept of "small but healthy" concerning whether small body size is in itself significant for a lasting normal life. The implications of this for policies could be far–reaching, because of the widespread failure of populations of developing countries to reach genetic potential.

The Sub–Committee examined the issue and approved the following statement to ACC:

> "The human response to adverse conditions during early life is a slowing of normal physical growth and development. When this failure of growth occurs in early childhood, it can persist throughout life, as smaller stature and weight in comparison to values seen in unconstrained populations.
>
> "It is the factors associated with the process of becoming small, not the state of being small, that are the real concern, albeit both are marked by achieved size. Although the small individual may be healthy at a particular time, the conditions that have caused this smallness are basic deprivations, including poor diet and ill–health, frequently due to poverty. The reason that economic disadvantages and poor social performance are observed to be associated with smallness is that these frequently occur in conditions where health and diet are poor. But the resultant smallness itself – with two exceptions noted below – is not a primary factor perpetuating these conditions. Small achieved body size is often an indicator that conditions have detrimentally affected human development and may be continuing to do so in the population.
>
> "With two exceptions it is not considered that 'being small' – as opposed to becoming small – is in itself harmful to the individual. One exception lies in the relationship between body size (lean body mass) and maximal physical working capacity as well as perhaps the capacity for sustained work (endurance). The other exception lies in the linkage between maternal size and infant birthweight – the inter–generational linkage of smallness and risk.
>
> "Failure of growth in the individual may be a symptom of an underlying diet or health problem warranting intervention. It can also be seen as a marker of a high–risk environment.
>
> "Smallness seen at the population level is explicit evidence for a generalized public health problem calling for policies and programmes designed to alleviate social and economic deprivations, in addition to direct public health interventions."

The Sub–Committee proposes that this position be drawn to the attention of United Nations member agencies and other interested parties, to contribute to the correct interpretation of conditions in developing countries.

Source: Report of 15th Session of the ACC/SCN, UNICEF, New York, February 1989, para 19–21.

ANNEX B – List of participants

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ANNEX C – Extract from: Use and Interpretation of Anthropometric Indicators of Nutritional Status. Report of a WHO Working Group (1986a)

Bulletin of the World Health Organization, **64**, No. 6, pp929–941.

USE OF THE NCHS POPULATION AS A STANDARD

Discussion has continued in recent years on whether or not it is necessary and appropriate to utilize an international reference (5–7). In analysing this question, it is important to distinguish between a *reference* and a *standard.*

A *reference* is a device for grouping and analysing data. Thus the average weight of a group of children has no meaning unless they happen to be exactly the same age, whereas the average value of the index "weight–for–age" does have meaning. For the construction of such an index a reference population is necessary. In principle, it does not matter what set of reference data is used, provided that it is large enough to contain adequate statistical information and the population is reasonably healthy and well–nourished to avoid major distortions. It is also clearly desirable, for comparative purposes, that there should be a common reference. These principles underlay the recommendation, which was made in 1977 *(2)* and subsequently endorsed by WHO *(8)*, to adopt the NCHS population as a reference for international use.

A *standard* embodies the concept of a norm or target – that is, a value judgement. It is this concept that has led to difficulty, since the international reference is widely used also as a standard. The justification for this usage is the evidence collected by Habicht and others *(5, 7)* that in populations the effect of ethnic differences on the growth of young children is small compared with the effects of the environment. It is accepted that there may be some ethnic differences between groups, just as there are genetic differences between individuals, but for practical purposes they are not considered large enough to invalidate the general use of the NCHS population both as reference and as a standard. This judgement has been endorsed in the report of a recent FAO/WHO/UNU Expert Consultation *(9).*

There are, however, circumstances in which this usage is felt to be inappropriate and in which local standards are preferred. As a matter of principle, those who are concerned with planning in a particular country may find it unacceptable to base their targets on the characteristics of an alien population. In countries where growth failure in children is widespread and severe, such targets would be unrealistic and unattainable and therefore serve as a hindrance to practical planning.

A realistic target or local "norm" could be set by shifting the international reference downwards. This approach is acceptable if it means simply altering the target, so that, for example, the stated aim would be for the mean height of children to be within 95% rather than 100% of the international reference. It is not acceptable if it means that in the calculation of height−for−age the expected height is taken as 95% of the reference median rather than 100%. When that is done, it is not possible to use the centiles and standard deviations of the reference population, so that the statistical value of the reference is lost.

It is necessary to distinguish between two types of local standards: that derived from an elite, presumably well−nourished group and that which represents the average of the population. A disadvantage of the former is that often an elite group may not be ethnically representative of the population as a whole. Where elite standards have been established in some cases (e.g., Colombia, Mexico, Brazil), they differ little from the NCHS reference. Local standards which represent an average of the population rather than an elite are only useful for identifying groups or individuals who differ from the rest of the population and who may therefore constitute priority targets for intervention. However, many developing countries are experiencing secular trends of increasing weight and height *(10)*, making it necessary to update local population−average references after several years. The development of statistically valid national reference values is costly and often beset with logistic problems, particularly in a very large country such as India. There appear to be no major advantages to offset these drawbacks, and therefore the establishment of local or national reference values is not an urgent priority.

ANALYSIS AND PRESENTATION OF DATA

There are two approaches to the analysis and presentation of data. The first describes the whole distribution; the second provides an estimate of the number or proportion outside the reference distribution. The approaches are complementary and the purpose will determine which is preferred, as discussed in more detail below (pp. 936−937). This type of choice exists in many fields of public health nutrition, and is succinctly described as the choice between shifting the distribution and truncating it.

Whichever approach is to be used, there is then, as discussed in the 1977 report *(2)*, a choice of three ways in which each observed measurement can be related to the reference: by its position within the centile distribution of the reference; as a standard deviation score (Z−score); or as a percentage of the reference median.

Descriptions of the whole distribution

Fig. 1 is an example of how the distribution of the total population may be represented in *centiles.* The figure is drawn from an actual study and illustrates how a change in the distribution, as the result of an intervention, can be visualized very easily. Statistical methods, such as the chi−square test, can be used for comparing these distributions. However, problems in using centiles for cut−off points are discussed later.

The presentation and statistical treatment of the numbers is the same, whether they represent *Z−scores* or *percentages of the reference median.* The simplest descriptor of the whole distribution is the mean Z−score with the SD, or the mean percentage of the reference median with the SD. Standard statistical tests can be applied to these numbers.[a]

[a] Concern has been expressed about the application of statistical tests when the distribution is skewed. In most populations the distribution of height−for−age is approximately normal (Gaussian), whereas the distributions of weight−for−age and weight−for−height are skewed. In most groups from developing countries the distribution is less skewed than that of the reference population, because the latter contains more overweight children. Therefore, in constructing the NCHS reference tables *(3)* the population was divided into two halves at the

median, and standard deviations calculated separately for each half. Since both observed and reference populations are skewed, relating one to the other will reduce the effect of skewness. Standard statistical tests based on the assumption of a normal distribution can then be applied to the values so derived.

A method of representing the whole distribution, which has been useful in population studies, is to construct a cumulative distribution curve and calculate its slope (Fig. 2). The slopes found for different populations and the position of the curve can then be compared, along with the median Z−scores. However, it is unclear just how much of the cumulative distribution slope can be explained by measurement variability.

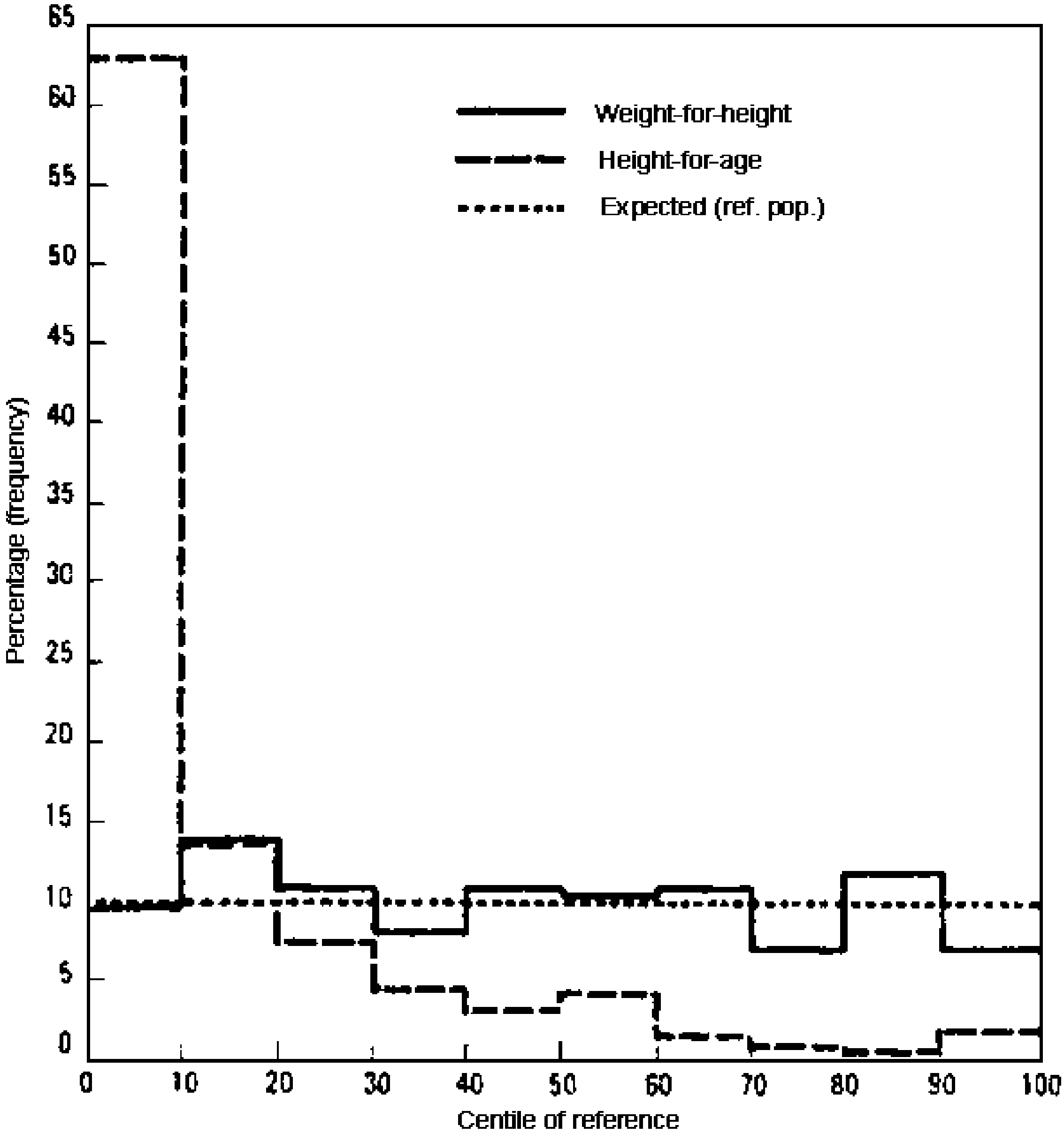

Fig. 1. Centile distribution of weight−for−height and height−for−age. (WHO 861466)

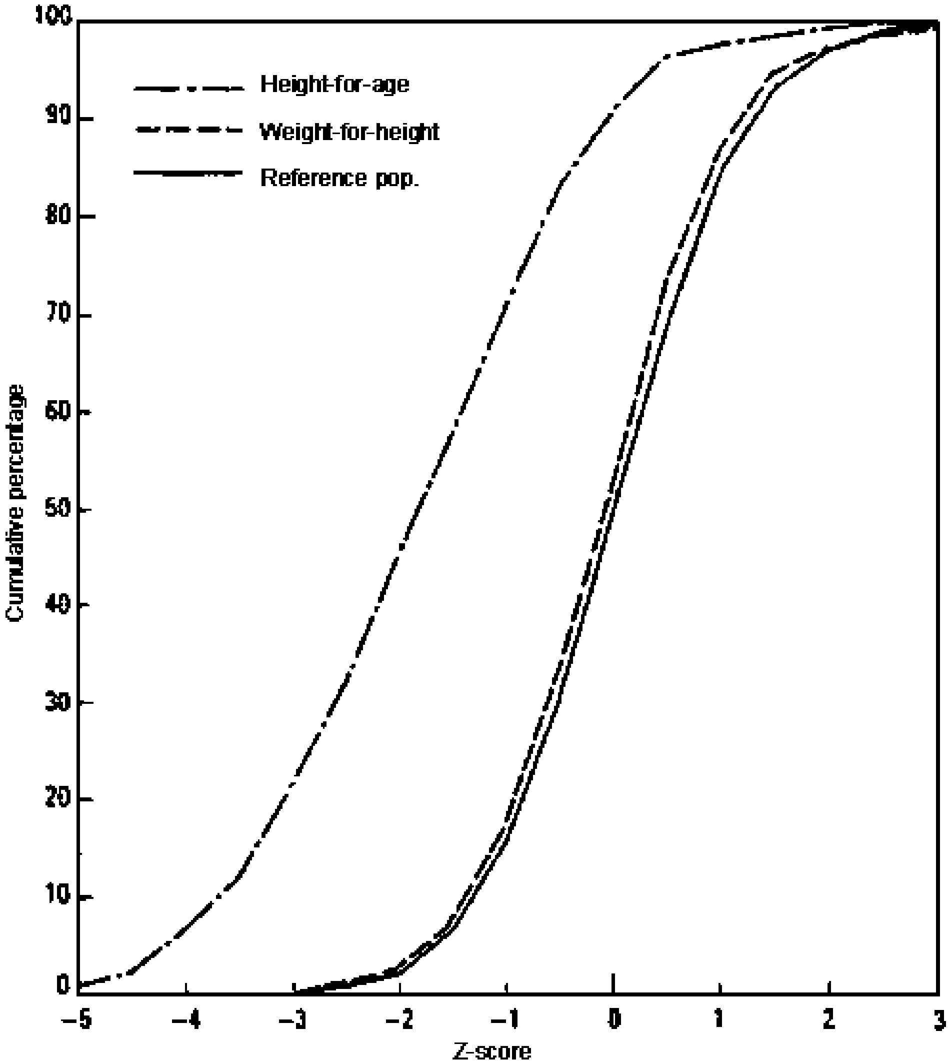

Fig. 2. Cumulative distribution curves of Z−scores, the weight−for−height and height−for−age values are for a population that is stunted but not wasted. (WHO 861468)

It appears that the best way of giving a complete picture of the whole distribution which can be compared with that of the reference population is a frequency curve or histogram of Z−scores (Fig. 3). The first step in constructing such a distribution curve would be tabulation of the data in the form shown in Table 1, which can be done for any age group, with any index. The size of the interval used for grouping the data, e.g., 0.5 or 1.0 Z−score unit, will depend on the number of measurements available, the facilities for analysing them, and the extent to which fine grouping is likely to be of practical value. For percentage of the median, the distribution curve is not practical because the data for the reference population are age−dependent when expressed in these terms and are not readily available.

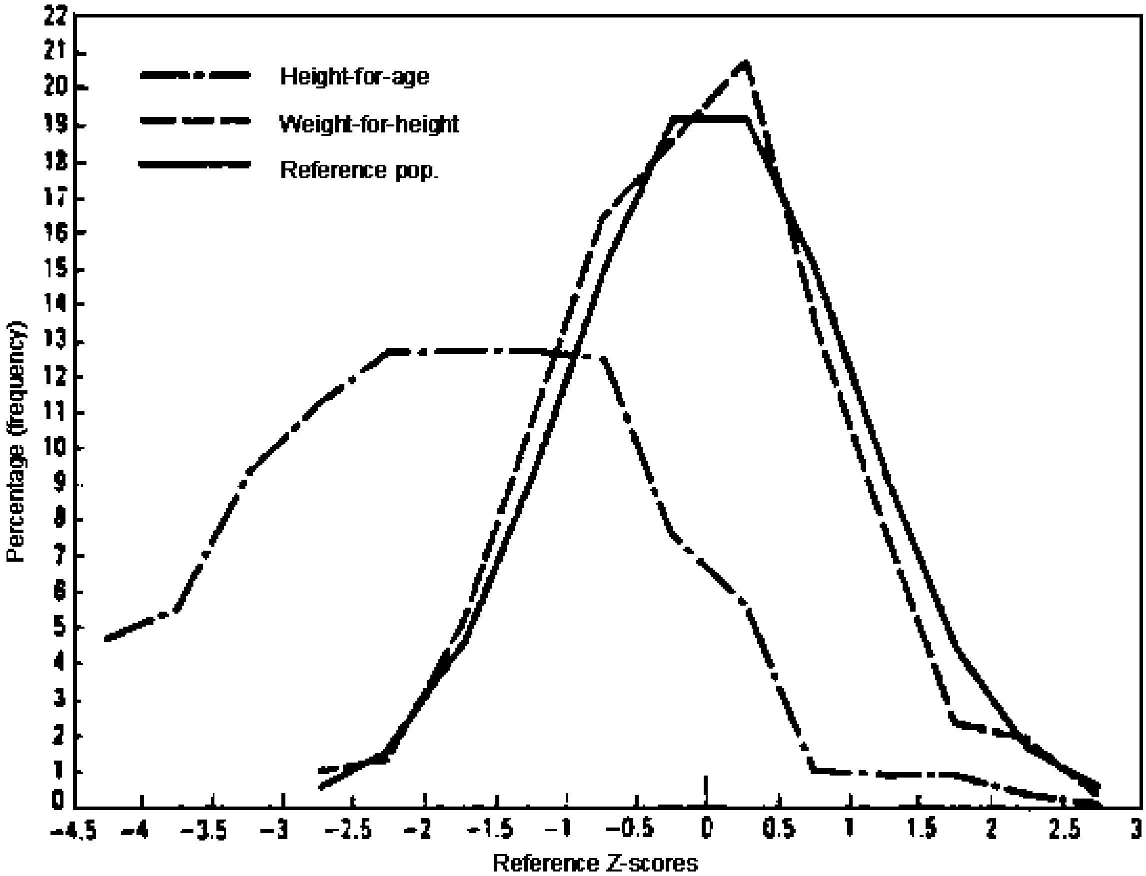

Fig. 3. Distribution curves of weight−for−height and height−for−age in relation to reference Z−scores. (WHO 861467)

Definition of the number at risk and choice of cut−off points

For many purposes the most useful way of describing the nutritional situation is to present an estimate of the number or proportion who might be considered at risk. In principle such an estimate is given by the number outside the reference population. In practice it is conventional to use cut−off points, which are *indicators,* in the sense defined above; for example, the number below the 3rd centile; the number with Z−scores less than − 2SD; or the number with weight−for−height less than 80% of the median. With centiles and Z−scores it is an advantage that the same cut−off can be used for both weight and height, whereas with percentage of the median the cut−offs are necessarily different.

The disadvantage of using centiles for cut−offs is that the number at extreme degrees of risk cannot be quantified, since centiles below the 3rd or above the 97th cannot be defined from the reference population except by back−calculation from the standard deviations.

It is in the choice of cut−offs that the difference between Z−scores and percentage of the median becomes particularly important. For example, in one survey of weight−for−height of children between 1 and 2 years old, 27% had Z−scores of −2 or below, whereas only 15% were below 80% of the reference median *(17).* This discrepancy cannot be eliminated simply by adjusting one or the other cut−off, because the coefficient of measurement variation varies with age. By definition, Z−score cut−offs take this into account, percentage of the median cut−offs do not.

Two objections have been made to the use of fixed cut−off points such as those cited above. The first is that at best they represent a purely statistical separation of "malnourished" from "normal". Ideally, cut−off points should be based on biological considerations, such as increased risk of mortality or of functional impairment. The cut−off should distinguish a deficit that matters from one that is of no real significance. This is a valid objection, but the practical problems of establishing a relation to risk are very great. Prospective studies of mortality, such as those of Chen and co−workers in Bangladesh *(29)*, make it possible to determine the predictive value of different indices and to define the cut−off points which produce the optimum combination of sensitivity and specificity *(30−32).* However, death is not the only outcome which needs to be considered, and even for this particular outcome the results almost certainly cannot be generalized from one region to another. The quantitative relation between mortality risk and anthropometric deficit will vary, among other things, with infectious load. It also varies with age, a given deficit carrying greater risk in younger children *(33).*

Table 1. Anthropometric data on the distribution of Z–scores in a sample population, used for constructing the distributions in Fig. 1 and 3; the reference distribution in column 4 is a normal distribution, by definition

	Sample population distribution		
Z–score range	**Weight–for–height of 2–year–olds (%)**	**Height–for–age of 2–year–olds (%)**	**Reference distribution (all indices and age groups) (%)**
–5.49 to –5.0		0.8	
–4.99 to –4.5		1.3	
–4.49 to –4.0		4.7	
–3.99 to –3.5		5.5	
–3.49 to –3.0	0.0	9.4	0.1
–2.99 to –2.5	1.0	11.2	0.5
–2.49 to –2.0	1.3	12.8	1.7
–1.99 to –1.5	5.0	12.8	4.4
–1.49 to –1.0	10.7	12.8	9.2
–0.99 to –0.5	16.4	12.5	15.0
–0.49 to 0	18.6	7.6	19.1
0.01 to 0.5	20.8	5.7	19.1
0.51 to 1.0	13.5	1.0	15.0
1.01 to 1.5	7.6	0.8	9.2
1.51 to 2.0	2.3	0.8	4.4
2.01 to 2.5	1.8	0.3	1.7
2.51 to 3.0	0.3	0.0	0.5
3.01 to 3.5	0.0	0.0	0.1

The second objection is that the conventional cutoff of – 2SD or its equivalent may be unrealistic and of limited use in practice. Thus, in an emergency situation where resources are restricted a lower cut–off point might have to be used to identify the children most in need, i.e., an increase in specificity at the expense of sensitivity *(20, 30, 31).* Again, if 60% of children in a particular country are described as significantly stunted, because they are below –2SD in height–for–age, this cut–off would defeat one of the aims of concentrating on the tails of the distribution, which is to identify those particularly and exceptionally at risk. In this case, if one wants to determine which children are most severely stunted, a lower cutoff point could be used.

Cut–offs should be chosen at the point most appropriate for the particular purpose in view, the reasons for choice being clearly stated. For most group or population comparisons, where uniformity is important, the standard statistical cut–off points of ±2SD from the mean should be maintained *(17).* In order to utilize a single method of relating measurements to the reference, it would also be necessary to use Z–scores in the presentation of whole distributions (Fig. 3). This is in accordance with the 1977 report *(2)*, which recommended the use of Z–scores to express both distributions and cut–off points because they have a statistical meaning. Since then, WHO has also recommended to Member countries *(8)* the use of Z–scores for monitoring nutrition and health progress.

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ANNEX D – Illustration of wasting prevalences

(% <–2 SDs weight–for–height)

Country	*Prev. %*	*Country*	*Prev. %*	*Country*	*Prev. %*
Botswana	6	Burkina Faso	12	Bangladesh	16
Burundi	6	Mali	11	Burma	11
Ethiopia	12	Niger (Drought)	23	India (Tamil Nadu)	21
Kenya	5			Thailand	6
Lesotho	5	Cameroon	2		
Malawi	3	Congo	5	Ecuador	2
Somalia (Drought)	40	Cote d'Ivoire	9	Peru	1
Sudan (Drought)	36	Ghana	7		
Tanzania	5	Nigeria (Drought)	21		
Uganda	4	Senegal	6		
		Zaire	5		

Source: taken from WHO (1989), "Global Nutritional Status, Update 1989"; results are to illustrate common prevalences of wasting, generally in 6 to 60 month old children in 1980's.

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