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ABSTRACT

The assessment of individual or community nutritional status involves the use of indicators; when properly analyzed and interpreted, these may be used to decide what strategies to implement, or how to orient activities aimed at improving nutritional status. In primary health care programs, one approach which remains underused involves obtaining knowledge of the nutritional status of families, so as to better adjust treatment to each individual, to guide preventive action at the family and community level, to evaluate nutrition programs, and to provide the information needed for planning in the field of food policy. This approach involves the use of judiciously selected indicators or indices, each measuring a specific phenomenon and yielding a well-defined piece of knowledge. In the interpretation of the findings, certain rules must be applied if the exact signification of each tool or measurement is to be respected. Periodical longitudinal monitoring of the nutritional status of families, extended to the in-depth interpretation of qualitative and quantitative findings, is needed for the early detection of malnutrition, the regular observation of the evolution of the nutritional situation in each region over the years, and the gradual development of interventions aimed at improving living conditions through action in the many sectors involved, including food and agriculture, health, economics, and education. This report provides a rationale for evaluating nutritional status and describes anthropometric indicators of nutritional status. Further discussion concerns neonates, pregnant women, presentation of data, and biological assays in the assessment of nutritional status. A brief glossary of terms is given, followed by an appendix of anthropometric reference tables. (RH)

CHILDREN IN THE TROPICS

NUTRITIONAL STATUS : THE INTERPRETATION OF INDICATORS

1989 N 181 182

The International Children's Centre was created by the French government in 1949, on the initiative of Professor Robert Debré in particular, following negociations between France and the United Nations. Its purpose was to furnish those international and national agencies dealing specifically with child care with training facilities and educational and informational tools in the field of child health and development, viewing children within their family and surroundings.

ICC soon turned essentially toward Third World children and devoted its activities to the training and education of personnel with social, educational and administrative responsabilities as well as medical and paramedical workers. The desire for greater efficiency has led it to work increasingly with trainers and to concentrate its efforts on the methodological and educational aspects of mother and child care programmes.

ICC is also engaged in an attempt to further study — and — action on some aspects of the life and health of children and their family, so as to contribute to practical improvement, particularly in the fields of growth, nutrition, planned parenthood, the control of transmissible and nutritional diseases, preschool and school education, the needs of disabled and underprivileged children, etc.

Over this period of more than 30 years, a large amount of documents on children and adolescents, mostly from the developing countries, has been accumulated. This international documentation has been classified and sorted out, and has been computerized since 1983 : a bibliographic data base (BIRD : « Base d'Informations Robert Debré ») may be consulted anywhere in the world, through international communications networks. ICC also publishes periodicals, educational documents and specialized bibliographic bulletins.

As for its legal status, the International Children's Centre is a foundation under french law of recognized public utility, administered by an executive board with broad international membership.

CHILDREN
IN THE TROPICS

REVIEW OF THE INTERNATIONAL CHILDREN'S CENTRE

NUTRITIONAL STATUS : THE INTERPRETATION OF INDICATORS

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1989 - N° 181/182

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Worked in health centres in Latin America for several years, and has accomplished a great many missions in the training of health personnel as well as in field research and action in Africa, Asia and Latin America over the last 19 years.

Her writings have appeared in a number of books, including :

- La santé de la mère et de l'enfant en Amérique latine. Paris, CNRS, 1974.
- Les troubles nutritionnels chez la mère et l'enfant. Epidémiologie et prévention. DUPIN H. Paris, Editions Saint-Paul. 1978.
- Santé publique, santé de la communauté. MONNIER J. et col. Villeurbanne, SIMEP. 1980.
- Manuel d'alimentation humaine. TREMOLIERES J., SERVILLE Y. Paris, Editions ESF. 1980.

She is editor in chief of "Children in the Tropics".

SECRETARIAL WORK — SYLVIANE LE BIHAN

ENGLISH TRANSLATION — HELEN ARNOLD

NUTRITIONAL STATUS : THE INTERPRETATION OF INDICATORS

Analysis taken from the Bibliographic Bulletin « Public Health Nutrition », N° 31, 1989.

BENAVIDES M. ; RHOADES R.E.

Socioeconomic conditions, food habits and formulated food programs in the pueblo jovenes of Lima Peru.

Arch. Latinoam. de Nutr., 1987, 37, 2, June ; pp. 259-281.

While many studies have been devoted to the composition of formulated foods, few have dealt with the economic and social factors that determine whether a population group accepts or rejects such foods. This study was conducted in the shanty towns (« pueblo jovenes ») that surround Lima, Peru. Documents were researched, and mothers, other women in local « cantinas » as well as nutrition specialists working in these neighbourhoods were interviewed. A questionnaire was also given to a sample group of mothers.

The origins of people living in these neighbourhoods are most varied: they come from the coastal areas, the Andes and the forested regions. Insufficient work and unemployment prevail, and family incomes are extremely low. 55 to 78 % of this income is spent on food. Breast-feeding is the rule. It is generally continued for one year, and completed by cow's milk in various forms. Solid foods are introduced toward the age of 3-6 months. They are taken from the family dish, since the notion of special foods for children is nonexistent. Mothers avoid giving their children fish, legumes or even bananas, however, since they are considered too heavy.

Food staples include legumes and rice, as well as eggs laid by the family's hens, and fish and shellfish, which are less expensive than meat. Men, who often eat dishes purchased from street vendors, claim to prefer home-cooked meals. Food is purchased by women on a day-to-day basis. They spend 4 hours a day preparing meals, and 4.45 hours when there is a small child in the home. Several food distribution programmes are active, but apparently not all of the foods supplied are accepted by families.

The authors recount the history of two attempts to commercialize inexpensive products for the needy, one of which was a food protein and cottonmeal concentrate. The failure of these projects is essentially due to laxity in analysing the taste and palatability of the food components, the ways in which the product could be used, and the economic feasibility of the project. Various preliminary studies have been conducted within the population in order to determine the acceptability of a new potato-based product, to avoid the repetition of these errors in forthcoming projects. Consumers' nutritional needs, their financial possibilities and the available alternatives should be known, if past errors are to be avoided.

INTRODUCTION

WHY EVALUATE NUTRITIONAL STATUS ?

The assessment of individual or community nutritional status involves the use of indicators ; when properly analysed and interpreted, these may be used to decide what strategies to implement, or how to orient activities aimed at improving nutritional status.

The importance of decision-making consecutive to the collection of data on health cannot be overemphasized. Too often health workers — nurses, midwives or doctors — make the effort to weigh children regularly, and to record their weight on a curve, but do not react when the curve falters, or even when it is seen to have stagnated for several months. Too often prenatal consultation registers, rich with systematically recorded information on each pregnant woman, are never examined and analysed in order to determine the overall situation of pregnant women attending such consultations. If this was done, advice and activities could be more specifically targetted, and dialogues on health matters with representatives of the different development sectors could be based on concrete figures and local facts.

How can individuals and communities participate in improving their health and endorse a primary health care policy if the basic acts required for the assessment of nutritional status are not followed by any concrete action adjusted to each case and to each population group ?

On the individual level

The physical symptom of pathology (fever, cough, diarrhoea, etc) produces suffering that is easily perceivable by the individual, or by the child's mother. Health workers respond to these by using their competence to calm the pain or even better, to eliminate the cause. On the other hand, the early symptoms of malnutrition, be it a protein-energy deficiency or an iron or vitamin A deficiency, go practically unnoticed. It would seem, then, that the role of health personnel, be it on an individual or a community level, should be to create an awareness of such deficiencies, so as to motivate action.

On the community level

The underlying causes of malnutrition are of course multiple, inter-related and presently well known. They range from family poverty to a poorly educated mother, insufficient availability of food and poor hygiene. Does that mean that one should wait until these living conditions are improved before taking any action on a village or neighbourhood level ? There are many instances of improvement of health and nutritional status of poor families, using the meagre resources available within a given context. In addition to technical competence, this requires an observative attitude and an ongoing reflexion on family and community life, as well as an open ear, an ability to dialogue both with mothers and with representatives of the community so as to develop their confidence in their respective capacity to act. In attempts to avoid malnutrition, it is usually up to the mother or the family to have healthful day-to-day behaviour. The role of basic health personnel is to initiate changes in behaviour and to support them when they are positive. This is an individual as well as a collective task, since each family has its own difficulties and needs a specific type of support.

Decisions on action should be the result of an analysis of the individual, familial and community situation, which in turn is based on relevant information on the specific life context, health and nutritional status. When these findings are analysed in terms of the different agents who will be involved in the action, then appropriate, efficient measures may be set up, along with means of evaluating them.

The health personnel should fully comprehend the significance of the data recorded and the way in which they may be interpreted.

In the assessment of nutritional status, many indicators are utilised by health personnel, be they research scientists or people working directly within a community. This issue of Children in the Tropics is devoted to the indicators of nutritional status ; that is, to the means of obtaining a more or less dynamic evaluation of the outcome of dietary energy and nutrient intake on the one hand, as balanced against the physiological nutritional requirements, the extra expenditures of energy linked with physical activity and diseases on the other hand (figure 1), on an individual level or in population groups.

Physiological requirements for energy and for each nutrient vary with the phase of the individual's physical development. Research unanimously shows that these are proportionately (that is, when expressed in relation to the the person's weight) much higher in children, and this is even more true of infants, pregnant women and lactating women (and for some nutrients such as iron, even for women of childbearing age). These groups are what is known as at-risk groups for the different types of nutritional deficiency. The indicators designed for the assessment of the nutritional status of these groups are analysed below.

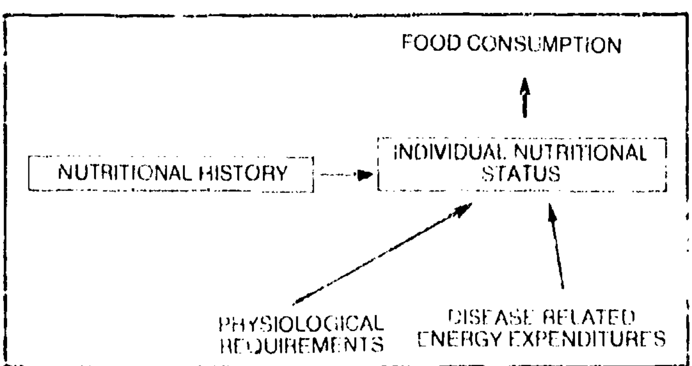

Figure 1 Factors influencing an individual's nutritional status at all times

Although an increasing number of pathologies linked with overnutrition are observed in developing countries (1), deficiencies remain and will probably continue for a long time to be the major nutritional risk for people in those regions. This discussion will therefore concentrate essentially on those indicators that are useful for the detection and identification of deficiency-related malnutrition problems. Globally speaking, the highest prevalences involve

(1) SOUSTRE Y., CHAULIAC M., HERCBERG S. - *The epidemiology of obesity. In : Children in the Tropics. Paris, International Children's Centre, 1984, n 151, 40 p.*

protein-energy malnutrition, iron, vitamin A (1) and iodine deficiencies (2). Protein-energy malnutrition represents a major public health problem in most developing countries. Its evolution is not a cause for optimism : 126 million children under 5 years old suffered from protein-energy malnutrition during the 1963-73 decade, and 145 million between 1973 and 1983, according to WHO (3) (malnutrition being defined as a weight-for-age below the median for the NCHS reference population minus two standard deviations).

Several more recent investigations seem to indicate the further deterioration of the situation as a result of anti-social measures taken in conjunction with the structural adjustment policies imposed on many countries. Despite this, however, diet and nutrition. viewed from a public health standpoint, are still the poor relative of health and agricultural production policies, as well as of health personnel training programmes. Too often, protein-energy nutritional status is not taken into account by health workers, and the morbidity reports collected at all levels, up to the central, ministerial echelon conceal this problem, by omission.

INVESTIGATIONS

The choice of one or several indicators for assessing the nutritional status of an individual or a community should result from an analysis of the objective assigned to such assessment, of the human and material resources available and of the concrete context.

If properly chosen. they provide information on the type and extent of malnutrition within a population group. Regular monitoring or repeated cross-sectional surveys make it possible to follow the evolution of the situation in the course of time, to compare groups of individuals and to evaluate programmes.

While the aim should always be the regular monitoring of the nutritional status of the most vulnerable groups, in practice such surveillance will never be able to cover all mothers and children in a given region. Specific investigations, which have their advantages and their drawbacks, may sometimes be quite useful.

When well designed and properly conducted, these epidemiological surveys, be they descriptive or even analytic (that is, attempting to determine the various factors within the overall, familial or individual environment that have a major influence on nutritional status) provide an accurate picture of the prevalence of malnutrition as defined by the indicators chosen. Such surveys are usually

(1) DEMAEYER E.M. - Xerophthalmia and blindness of nutritional origin in the third world. In : Children in the Tropics. Paris. International Children's Centre, 1986, n 165, 36 p.

(2) THILLY C.H., BOURDOUX P., CONTEMPRE B., SWENNEN B. - Strategies for combating endemic goitre. In : Children in the Tropics. Paris. International Children's Centre 1988, n 175/176, 72 p.

(3) WHO, Geneva - Nutritional Surveillance. Global Trends in Protein-energy Malnutrition Prevalence. In : Weekly Epidemiological Record, 1984, 59, n 25, pp. 189-192.

cross-sectional ; they are done on a cross-section of the population at a given point in time. The analysis of the data collected should provide a basis for decision-making with respect to the implementation, discontinuation or reorientation of health or development programmes involving the agricultural, educational, economic, hydraulic and sanitation sectors.

Their limits

The limits of such studies are also well known, however. If they cover the population of a large region, not to speak of a national territory, the results tend to mask many specific local elements. They are then only of limited value for personnel working at the grass roots level. Such surveys are relatively costly : they require the collaboration of epidemiologists and nutritionists, much time and relatively sophisticated computerized analyses. They are out of the hands of field workers, who are most often not consulted at the decisive phases, when the study is designed and the results analysed. There is only an illusory participation of the population, which is then an object of analysis rather than an active participant in the investigation. The findings are usually only communicated to grass roots personnel and to the population at a very late date, sometimes never at all. Such studies (except in the case of pilot projects) may rarely be repeated at regular intervals in order to analyse the evolution of the situation either in the course of a year or from one year to another. Further, case analysis is generally absent.

8 MONITORING

Monitoring of nutritional status involves the direct, everyday participation of health workers. It enables every individual to take into consideration the nutritional component of his or her health status. Thus, within each family there is a growing awareness of this aspect of health and of the active role that the family may play. The analysis of all of the data collected provides an accurate picture of the main local at-risk groups or areas, and of the evolution of the nutrition situation in the course of the year or from one year to the next. The impact of projects conducted in the fields of health and development may be measured. This type of activity is difficult to run, however : the health personnel is often unprepared to view as important the taking of measurements and the interpretation of the individual and collective data gathered. The collective analysis is usually biased, since the individuals on which measurements are made are not "representative" of the overall population ; there tends to be a "self-selecting" effect among consultants, and it is quite difficult to determine the ways in which they differ from the average population. Do they attend consultations because they are better educated, more aware of the importance of this type of follow-up, because they are ill, or poor, or are anxious to receive the food supplements occasionally provided by health centres ?

In every situation it is important that the difficulties inherent in taking various measurements, in establishing indices and indicators and interpreting them be understood.

At the national level, it seems most important that the same indicators be used in different regions so that an overall analysis of the nutritional situation will be feasible. Thanks to the latter, resource allocation may be optimized through the definition of the highest risk groups and areas. Nonetheless, the need for national standardization should not lead research workers to overlook the fact that local situations may require the use of additional indicators.

ANTHROPOMETRIC INDICATORS OF NUTRITIONAL STATUS

Protein-energy nutritional status may be evaluated using clinical, biological or anthropometric methods. The analysis of the reliability, cost, value and feasibility of these different types of indicators shows anthropometric indicators to be globally preferable, for the time being, in the context of everyday practice. These are in fact most practical and most valuable even for cross-sectional epidemiological surveys aimed at describing the nutritional status of a population group.

WHO (1) distinguishes :

— measurements, which are raw figures obtained on individuals : age, weight, height and arm circumference, but also concentration of haemoglobin, plasma retinol, serum albumin, presence of oedema or of a Bitot's spot, for instance ;

— indices, which are combinations of measurements : the weight of an individual or the average weight of a population group are meaningless figures in themselves. They must be interpreted with respect to age, sex or height. Examples of anthropometric indices include weight-for-age for a boy, height-for-age of a group of girls, the ratio of arm circumference to head circumference of 6 to 12 month-old infants ;

— indicators, which are constructed using certain figures called cut-off points (or thresholds) for an index. Their use provides information on a community or an individual's nutritional status : for example, the percentage of individuals of a given sex in a given age group and a specific region with a weight-for-height located below the cut-off point defined. Does any individual run a greater risk of mortality or morbidity because he or she is located above or below this cut-off figure ?

Prevalence

Various indicators may measure the same phenomenon, but show extremely different facts : there is little sense in asserting that 500 million children around the world suffer from malnutrition if the indicator used is not mentioned. Is this figure based on food consumption figures ? Or on clinical or anthropometric data ? What are these, and what references and cut-off points are used ? Are the children incriminated under age 1, under age 5 years, or under age 14 years ? Every clarification should be sought with respect to the indicators used and the meaning of any figures cited. Similarly, when health workers present their findings, these should always be concise and provide all information required for their complete interpretation.

(1) *WHO Working Group. Use and interpretation of anthropometric indicators of nutritional status. In : Bulletin of the World Health Organization, 1986, 64, n 6, pp. 929-941.*

MEASUREMENTS

Measurements are the base on which indices and indicators are built. Any error committed at this point results in an erroneous interpretation of the health status of the individual and of the community.

Measurements for the assessment of nutritional status may be the fruit of simple observation (muscle wasting, conjunctival pallor, Bitot's spot, visible goitre), of clinical palpation (enlarged liver, non visible goitre, oedema), of the use of tools (scales, tape measure, coloured strips, measuring rod) or of laboratory tests (analysis of blood or urine, assay of albumin, haemoglobin, etc).

For each measurement, the question of its reliability and reproducibility should be examined : will a same observer find the same result if he or she takes the same measurement on the same individual at two consecutive moments ? This is known as the intra-observer difference. If two or more observers take the same measurement on the same individual, will the result be the same (this is the inter-observer difference) ?

Reliability

Some measurements may be viewed as objective, while others are more subjective. Aside from some obvious clinical cases, muscle wasting is an element for which assessment is extremely varied. The same is true of conjunctival pallor : several studies have showed intra and inter-observer differences. For example, many prenatal consultation registers contain a column for "anaemia" or "conjunctival pallor". The analysis of this column often shows a very low frequency of anaemia, whereas a study of the concentration of haemoglobin within the same population shows a prevalence of anaemia ranging from 40 to 60 %. Similarly, there is a great variability in the findings yielded by biological assays, for various reasons linked with individual parameters or the techniques used. Results may be influenced by the person's position when the specimen was taken, the tightness of the garrot, the precision of the laboratory instruments, age, sex, time of day, consumption of medications or food, smoking, etc, depending on the variable studied.

At first glance, anthropometry seems to be the simplest, most reproducible, most reliable and least costly method for evaluating protein-energy nutritional status. This is certainly true, provided a number of precautions are taken and the procedures utilized are standardized or normalized, and regularly controlled.

Errors

These may be caused by the observer, the tools used and the person measured. Examples of the many possible errors include :

– regardless of the type of measurement, the observer's fatigue or the repetitive nature of this work plays a role. Is it possible to measure 200 children reliably in the same morning ? To copy the findings on a register or on any appropriate material without committing any error ?

– a child may be weighed naked once, and the next time with clothing and shoes. The scale may be systematically wrong - that is, constantly show 220, 540 g or 1 kg more or less ; or on some one day, the scale may be off balance, and show an error of 110, 270 or 500 g. The tired observer may make a mistaken reading, not wait until the pointer or the beam of the scale comes to a halt, round out the weight to the nearest kilogramme or 500 g. The cursor of the scale may be rusted and blocked. The technician may also make mistakes in recording findings, for a number of reasons ;

— when measured lying down a child moves about and cries, the head does not touch the headboard of the measuring rod, the knees are bent, the cursor touches the toes, when the feet are in extension. Occasionally locally made measuring rods with a tape measure pasted to them may be encountered : if the latter is not placed properly the children will systematically have 0.5 or 1 cm added to their height ;

— when measured standing up, the individual's position is not checked if the measurement is taken too rapidly, or the measuring rod is not properly calibrated, or again - and this is frequent - the top of the head is marked using a hand or a soft notebook. There is then a tendency to under or over-estimate height, since the line from the rod to the top of the head is oblique, rather than horizontal ;

— to determine a child's age, there are still some countries in which no reliable system exists for recording births and furnishing an official document validating civil status. It is then necessary to question the parents or refer to a calendar of important local events based on the cycle of farming seasons, the main traditional festivities, the death of prominent persons or any other event that may have left a permanent impression. The date of birth becomes increasingly imprecise as children grow older. The validity of a document should always be checked. Gross approximations based on the number of teeth, for instance, should be eliminated, given the tremendous interindividual variability in the age at which teeth come out. An effort should be made to check the mother's assertions, since mothers definitely tend to "round out" their child's age to the nearest year or half year. Errors in transcription are also frequent ;

— errors in arm circumference are due to measurement of a bent arm or a tensed muscle faulty assessment of the halfway point between the acromion and the olecranon, and above all the varying tautness of the tape measure, string or coloured strip of paper. The latter error is particularly important in delicate contexts in which many children are only millimeters from the limit of "normalcy", since there may be a tendency for the observer to wish children to be located on one or the other side of the cut-off point ;

— measurement of head circumference is of little value for the assessment of individual nutritional status. Errors are due to the child's agitation and a poorly positioned tape measure ;

— measurement of triceps skinfold thickness requires the use of a thickness compass, a fragile and expensive instrument to be avoided in everyday practice. This measurement should be reserved for certain epidemiological investigations covering small samples ;

— in any case, regardless of the anthropometric measurement, many errors are introduced when the information is recorded on the final document that is to be kept : this is the case when a measurement is memorized by the examiner and only noted on the consultation register and/or the child's health card at the end of the clinical examination. Occasionally a health agent reads the measurement, transmits it orally to the mother who repeats it at another point in the consultation, when it is recorded.

Training of personnel

In the case of cross-sectional epidemiological surveys designed to describe the nutritional status of a population group, special attention is generally paid to the training of investigators. Exercises in the standardization of measurement-taking are done at the beginning of the survey. If this phase is properly conducted there will be few errors, since the investigation is limited in time, involves a small number of workers and is generally strictly supervised.

Conversely, during routine monitoring of nutritional status measurement-taking is an everyday matter and is done by health personnel working at different levels in the health care pyramid : doctors, nurses, midwives, nurses' aides and even community health agents. Harmonization is much more difficult to achieve, and **one of the responsibilities of supervisors is to make sure that measurement-taking and recording is done correctly and that the instruments used function properly.**

Standardization of measurements

Height

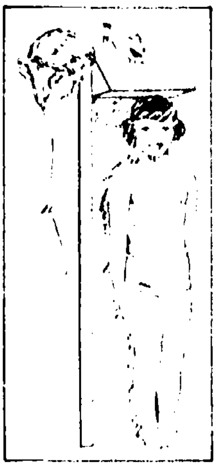

Figure 2 Measuring height standing up

Source : JELLIFFE D.B. - The Assessment of the Nutritional Status of the Community. Monograph Series WHO, Geneva, 1966, n 53, 271 p.

• Beyond age 2 years, a vertical measuring rod or a ruler hung on a perfectly vertical wall is used. The wall itself may also be graded, provided the zero is exactly located in the angle formed by the ground and the wall. The ground on which the feet are set must be perfectly horizontal.

• Below age 2, a horizontal measuring rod is used.

• Beyond 2 years of age : shoes must be removed. The person must stand with his or her back to the wall, heels joined, with the buttocks, shoulders and occiput touching the vertical wall, looking straight ahead, arms along the body. The observer reads the measurement directly after lowering the cursor, or a horizontally held flat, rigid object (wooden board, book, etc) until it touches the top of the head. The hair should be completely flattened (see figure 2). The figure should be given to at least the nearest 0.5 cm, and for epidemiological surveys to 0.1 cm.

• under 2 years : height measured lying down is called length. Its measurement requires 2 people. Shoes are removed and the child is placed on his or her back on a flat surface. One person (the mother, for instance) maintains the top of the child's head against the fixed vertical board, with the eyes directed upward. The other person firmly presses the knees together and down so that they touch the horizontal surface, then moves the mobile board with his or her free hand, so that it touches the child's heels when the feet are at a right angle (see figure 3). Accuracy must be to the nearest 0.5 cm. In epidemiological surveys, accuracy to the nearest 0.1 cm should be sought.

In any case, the legibility of the graduations should be checked at regular intervals.

Weight

- Above age 4-5 years, a high quality, sturdy ordinary household or bathroom scale is used. It is most important to check it regularly (daily, ideally) using a known tare.

- For children under age 4-5 years, a beam scale or Salter type scale with pants or a basket in which the child is placed is used. Here too, it is essential to check the scale's accuracy regularly, using a known tare. The beam should be properly balanced and move freely when at rest (make sure there is no rust, or blocked mechanism, etc), and the pointer should be on the zero.

The scale should be set on a flat, horizontal surface. Older children and adults should retain as little clothing as custom permits. Shoes should always be removed, along with any "foreign" weight (objects in pockets or hands, heavy bracelets, necklaces, hats, etc). The individual should not be in contact with any other object. Weight is either read directly or by balancing the beam, depending on the type of scale.

Small children are weighed naked, with no "foreign" object. The result should not be read before the beam reaches its balance point or the pointer becomes motionless (see figure 4).

Occasionally children are so fidgety that no balance point can be reached. In these cases double weighing is done, using the medical scale : first the mother is weighed alone (weight A), then the mother is weighed holding her child (weight B). The child's weight is W = B − A. This is only a last resort, since accuracy is usually less satisfactory (owing to the type of scale used for adults) and the great risk of erroneous calculation. It is always preferable to record both weights, A and B, before doing the substraction.

For older children and adults, weight should be accurate to the nearest 0.5 kg, whereas for small children an accuracy of 0.1 kg is sought.

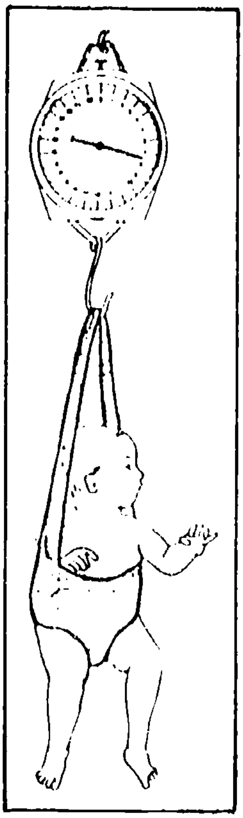

Figure 4 - Weighing using a "Salter" type scale

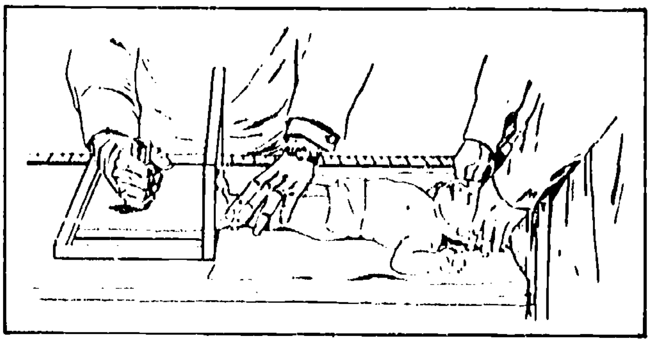

Figure 3 - Measurement of length
Source : JELLIFFE D.B. - Op. cit.

Arm circumference

A flexible, non-stretchable tape measure, unaffected by high temperatures and with 0.1 cm graduations is used. If the agents in charge of this work are unable to read, ribbons with 3 colours corresponding to the locally determined cut-off values (see figure 5) are used. Other types of instruments have been suggested so as to minimize the risk of errors (1).

Measurement is performed on the left arm, which should be hanging freely, and at a distance halfway between the acromion and the olecranon. The measuring tape is held gently but firmly taut so as not to press on the soft tissues (see figure 6). The measurement should be accurate to the nearest 0.1 cm.

Head circumference

A flexible, non-stretchable tape measure with 0.1 cm graduations is required. The greatest circumference is measured by placing the tape above the orbital crests, on the face, and on the most salient region of the occiput in the rear. Hold the tape firmly. The result is read directly at the junction point (see figure 7). The measurement should be accurate to the nearest 0.1 cm.

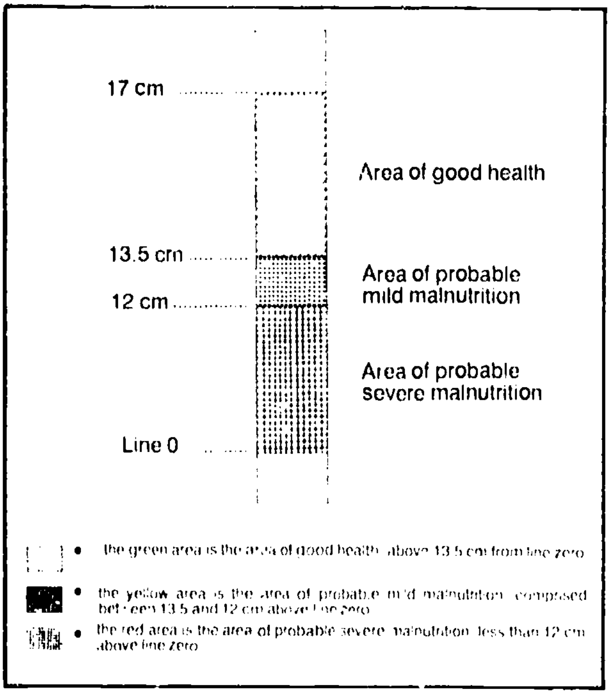

Figure 5 : Example of a coloured ribbon used to measure arm circumference
Source : AGBESSI DOS SANTOS H., DAMON M. - Manuel de nutrition. Paris, IPD-ACCT KARTHALA. 1987. tome I, 311 p.

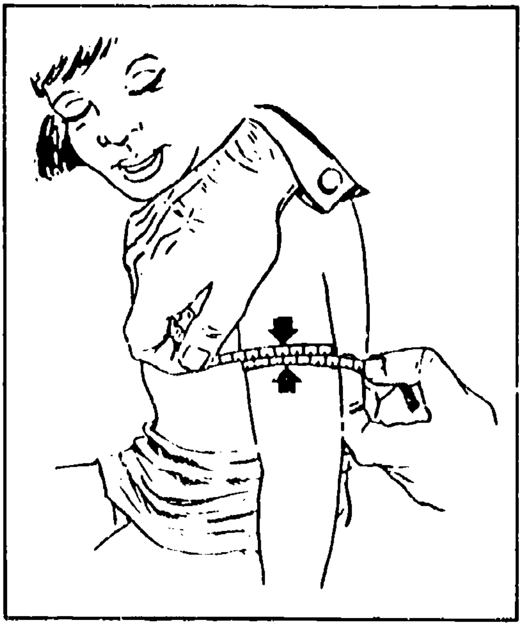

Figure 6 : Measurement of arm circumference
Source : JELLIFFE D.B. - Op. cit.

(1) ZERFAS A.J. - The insertion tape : a new circumference tape for use in nutritional assessment. In : American Journal of Clinical Nutrition, 1975, 28, pp. 782-787.

INDICES

However accurate and reliable they may be, measurements are of no use if they are not interpreted, at both an individual and a community level, in view of decision-making and the implementation and evaluation of actions. Is the nutritional status of this individual, child or pregnant woman satisfactory ? If malnutrition exists, is it incipient, mild, moderate or severe ?

What are the long-term risks for the individual ? What means are available for action at the family level or through the health structures ?

Is malnutrition more prevalent in certain groups within the community : children, boys, girls, infants under 6 months old, 6-12 month-olds, 12-36 month-olds, pregnant women ? Do these people live in a specific geographic area, in certain villages or parts of a city ? Is the prevalence of malnutrition linked to the farming cycle, seasons, socioeconomic category, when wages are paid, or other factors ?

Are specific investigations required for an in-depth analysis of the situation ? What attitude do mothers take toward their children, what is the quality of follow-up by health personnel ? What are the population's eating habits, how are infants fed ? Can any changes be seen, and what is the tendency ?

Should action be suspended on the results of these complementary investigations ? How can the impact of activities be assessed ? Once differences in the prevalence of malnutrition - even statistically significant ones - are found between 2 groups, do these justify a priority in the allocation of resources ? Is the priority set a real one ?

Their interpretation

These questions show the numerous implications of measurement-taking and of the interpretation of findings. They also emphasize the fact that analysis should not isolate the figures obtained from people's overall life context. At best, the responses should be individualized, but this is not always possible. Decisions on programmes involving considerable expenditures are made by the higher echelons and cannot take local specifics into account. Conversely, their adjustment to the local context should be in the hands of grass-root health teams specially trained for that task.

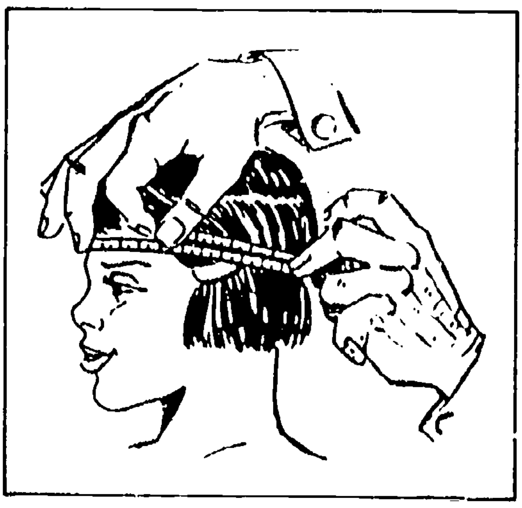

Figure 7 - Measurement of head circumference
Source : JELLIFFE D.B. - Op. cit.

Raw figures are non interpretable out of context : what is the meaning of the fact that a child weighs 4.4 kg, for instance ? His or her weight should be viewed with respect to another measurement ; it then becomes an index. Every health worker knows that a weight of 4.5 kg does not have the same meaning and the same prognosis at birth or at age 6 months, and does not call for the same decisions.

The above example is an extreme one, however. What interpretation should be given to a weight of 4.5 kg at age 2 months, and a fortiori, to the fact that a child weighs 4.5 kg and measures 55 cm ? An adequate comprehension of these measurements and indices (weight-for-age, weight-for-height, birth weight, height-for-age or arm circumference, etc) requires references : how is one child's index located with respect to the population of children of the same age or height ? Are the mean figure and distribution of an index within a population group satisfactory in comparison with what is currently viewed as the "ideal" ? What child population group should be used as a reference ?

References

A distinction should be made between a "norm", or "standard", and a "reference". A norm refers to the notion of a rule, of what should be, whereas a reference serves as a landmark with respect to an existing situation. Anthropometric studies consistently show a great variety in the weight and height of children and adults of the same age and same sex living in different countries with different living conditions and genetic origins.

Internationally accepted anthropometric references make it possible to compare the growth of children living in different environments, and to compare these groups with each other. There has been much discussion, in the past, around the establishment of references for children's height and weight (1). For more than a decade now, a degree of consensus among scientists has made it possible to set some rules as to what data are acceptable references for use in international comparisons (2) :

— measurements must be made on a well nourished population ;

— the sample group from which data is collected should be comprised of at least 200 individuals per age group and for each sex ;

— the sample must be cross-sectional, since the comparisons will be cross-sectional ;

— the sampling procedures must be well defined and reproducible ;

— measurements must be carefully made and recorded by observers trained in anthropometric techniques, using tested, regularly standardized material ;

— measurements made on the sample must include all of the anthropometric variables used to assess nutritional status ;

— the data on which reference tables and curves are based must be made readily available for consultation, and the procedures

(1) DIBLEY M.J. - Development of normalized curves for the international growth reference : historical and technical considerations. In : American Journal of Clinical Nutrition, 1987, 46, pp. 736-748.

(2) LAVOIPIERRE G.J., KELLER W., DIXON M.H. et al - Measuring Change in Nutritional Status. Guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. WHO, Geneva, 1983, 101 p.

used for the establishment of all curves and tables should be accurately described and discussed.

NCHS data

Although none of the series of data available anywhere meets all of these requirements, WHO and the immense majority of nutrition scientists recommend the use of National Center for Health Statistics (NCHS) data as references. These are obtained by studies done in the United States by the Fels Research Institute of Yellow Springs on children from birth to 36 months and on national samples for 2 to 18 year-olds. Data is structured and centiles and standard deviations calculated by the Center for Disease Control, in the USA, so as to provide a concrete picture of the distribution of values around the mean.

These references show weight-for-age, weight-for-height and height-for-age for reference boys and girls. The appendix shows the findings for children from birth to 36 months.

Other references frequently utilized in the past and occasionally still used are the Stuart and Stevenson references, or Harvard references. Jelliffe mentions them in one of his books (1). They have now been discarded since they are based on measurements performed before 1950 on middle class Caucasian (white) children living in the Boston and Iowa areas (USA). The NCHS references are more recent and comply more satisfactorily with WHO criteria. Despite this, the latter are still questioned, since the NCHS sample is composed of children living in an environment where childhood and adult obesity is frequent, and therefore also affects pregnant women and, by rebound, their children. Further, most infants are not breast fed or only for a very short lapse of time. Some people view these children as overnourished, with a life style and diet that is far from representing an ideal of health (2).

At present, the great majority of scientists and health officials consider the NCHS references as the best available, but these will probably be revised in the future.

Since the NCHS reference medians for the indices combining weight, height and age are based on a sample of healthy children, it would be absurd to interpret this median as the objective to be attained by each child individually.

Given the diversity of living conditions prevailing around the world, the reference figures cannot constitute a universal objective. Local reference figures may be established by health officials for each country, or even for each region, but this represents an enormous, costly venture. The sample taken as a reference in that case should include children suffering from malnutrition, if it is to be representative. Otherwise, the sample exclude children suffering

(1) JELLIFFE D.B. - The Assessment of the Nutritional Status of the Community. Monograph Series (WHO Geneva), 1966, n° 53, 271 p.

(2) MAC LAREN D.S. - A fresh look at some prenatal growth and nutritional standards. In : BOURNE G.H. - Nutrition and the quality of life. World Review of Nutrition and Dietetics. Basel, Karger, 1987, 49, pp. 87-116.

from malnutrition, and a standard must then be defined for eliminating these, or for including only children whose living conditions are satisfactory, and this is somewhat arbitrary.

Further, the evolution of the situation in different countries shows that such references should be revised at regular intervals.

Another possibility, broadly recommended at present, is that officials determine a level for each country or region, with respect to the international NCHS reference, on the basis of the initial situation, the resources available and the local policy decisions. Concretely, this means that the objective may be to attain the 40th centile of the NCHS references, or 95 % of the reference median, for example (1).

Genetics and environment

Do children everywhere around the world have the same genetic potential for growth ? Often clinicians and health officials in developing countries attribute retarded growth - which is sometimes so frequent that it becomes the "norm" in groups of children - to a lesser genetic potential. It is true that there is great interindividual variability in genetic potential. Like all biological variables, weight and height differ among people whose environment and living conditions are similar.

This interindividual variability is expressed through the statistical measurements that compose the mean (or the median, since these values have a normal distribution) and the standard deviation. Graphically, it may be pictured as a Gaussian or bell-shaped curve. This means that 95.4 % of all individuals are located within the interval defined by the mean plus and minus two standard deviations. "Normal" Gaussian distributions of height-for-age (for example) within the NCHS reference population and a population sample from a developing country are overlapping but do not entirely coincide (see figure 8). The distribution of height-for-age is then said to be shifted to the left in the sample. What are the reasons for this : living conditions or genetic constitution ?

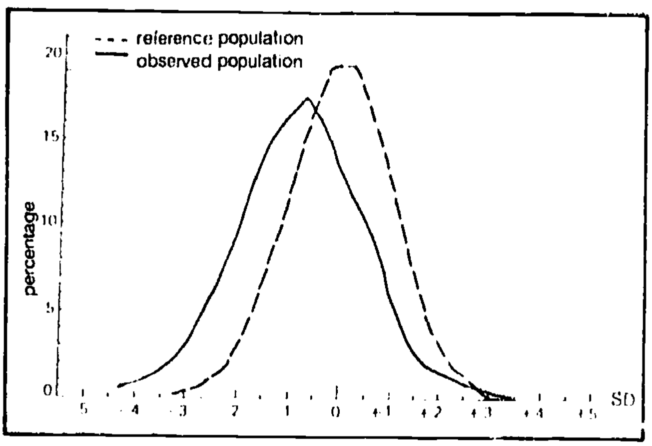

Figure 8 - Distribution of height-for-age in a reference population and an observed population
Source : LAVOIPIERRE G.J., KELLER W., DIXON M.H. et al. - Op. cit.

(1) C. WATERLOW, R. BUZINA, W. KELLER et al - The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. In : Bulletin of World Health Organization. 1977, 55, n° 4, pp. 489-498.

Many arguments, summarized by R. Martorell, suggest that the environment has a far greater influence on people's height than heredity (1).

The comparison of 19th century anthropometric data, or even of the height of children and adults some 30 to 50 years ago, with present-day data confirms the evolutionary acceleration of growth in industrialized countries. The average height of children living in industrialized countries during the 19th century is not very different from the height of present-day children living in most poor countries. And yet, their hereditary constitution has not changed : what has changed is that material living conditions have greatly improved in rich countries.

The height of both children and adults varies considerably within a given population group, in accordance with the family socioeconomic level. This indicates that for a same hereditary constitution, variations in standard of living and in the quality of the environment result in differences in height.

Comparisons of studies conducted in different countries and in different social groups within each country show that the growth of children in more advantaged groups within developing countries is very similar to that of the NCHS sample, whereas the less advantaged have a mean height located toward the 20th, or even the 10th centile of these reference figures.

At age 5-7, for instance, the greatest difference in height attributable to a genetic influence is 3.5 cm, whereas the level of affluence may produce differences of 12 cm or more.

Habicht (2) has compared weight-for-age and height-for-age of children with extremely varied ethnic origins and socioeconomic levels, from birth to age 60-84 months. He concludes that in advantaged children with differing hereditary constitutions, the difference between the shortest (or lightest) and the tallest (or heaviest) is about 3 % for height and 6 % for weight. By contrast, the difference between children from wealthy and poor backgrounds is about 12 % for height and 30 % for weight, after the age of 12 months. He also found that advantaged children from different ethnic groups have practically the same growth pattern as children in the USA. The same is true of children living at high altitudes (up to 2,500 m, in any case). Even in Pygmies, a famously short African ethnic group, some authors (3) have shown children's height to be similar to that of other African children until the age of 5 to 10 years. The difference found at adulthood seems to be connected with the lack of a growth spurt, caused by an endocrinological problem at puberty.

(1) MARTORELL R., MENDOZA F., CASTILLO R. - Poverty and stature in children. In : WATERLOW J.C. - Linear growth retardation in less developed countries. New York, Raven Press, Nestlé Nutrition Workshop Series, 1988, vol. 14, pp. 57-73.

(2) HABICHT J.P., MARTORELL R., YARBROUGH C.et al - Height and weight standards for preschool children. How relevant are ethnic differences in growth potential ? In : Lancet, 1974, 1, n° 7858, pp. 611-614.

(3) MERIMEE I.J., ZAPF J., HEWLETT B. et al - Insulin-like growth factors in pymgies. In : New England Journal of Medicine, 1987, 316, n° 15, pp. 906-911.

All of these arguments show that in the present state of knowledge, the growth potential of children everywhere is quite similar until the age of 6-7, provided their living conditions, diet and health are satisfactory. Some people unhesitatingly conclude that retarded height growth, or stunting, in children is one of the best indicators of social inequalities.

Practically speaking, these questions regarding growth references should be considered in the light of national recommendations issued by each ministry of health. Indeed, many countries use their own references, or regional ones. It is important, for the definition of a national policy aimed at improving nutritional status, that data collected in various parts of the country be compared so that priorities may be established for the allocation of resources, and the evolution of the situation may be monitored. At the national level, a common reference should be accepted and used by all health workers (scientists, clinicians, health and social workers). If local references are recommended, it is interesting to compare local findings with those of other countries, from time to time, using a shared international reference. The findings may also be presented along with NCHS figures.

Analysis and interpretation of indices

On the individual level

For the monitoring of nutritional status, anthropometric measurements are performed routinely during consultations for any specific pathology or examinations in the mother and child health framework : they should be interpreted immediately and individually, so as to guide decisions and the dialogue between the health personnel and the patient.

In the case of certain programmes, such as dietary supplementation. individuals will be included in or excluded from the group of beneficiaries on the basis of the interpretation of measurements and indices.

The procedure for this individual interpretation depends on the index used and on the tools available : growth chart showing a reference weight-for-age, and perhaps even a height-for-age growth curve, table containing reference data expressed in percentage of the mean, in centiles or standard deviations of weight-for-age, height-for-age, weight-for-height (see appendix), arm circumference-for-age or for-height.

In some other situations, the measurement or index is compared with a value known as the "cut-off point". The individual may then be directly classed as above or below this cut-off value : this is the case for arm circumference or weight-for-height defined on the basis of a weight-for-height chart or for birth weight. It is also the case if a child is seen for the first time, and no other anthropometric data are available.

All indices requiring some mathematics, such as the calculation of arm circumference/head circumference, should be eliminated from the monitoring of nutritional status.

On the community level

These findings are also used to interpret the situation of all children and/or pregnant women seen, in order to analyse the evolution of the community's nutritional status. This is helpful in deciding what activities to start, reinforce or discontinue.

In the framework of a descriptive epidemiological survey, measurements are collected for analysis on a community level, using the entire sample. This is valuable in determining those groups and areas at high risk of malnutrition, and deciding which programmes are most relevant. Only severe, clinically detectable cases should be immediately included in appropriate nutritional rehabilitation programmes (for ethical reasons, this should be included in the programme design).

Short-term malnutrition

Under satisfactory living conditions, children's height and weight increase with age. On the average, for a given age, the taller the child the heavier he or she is, and vice versa. Conversely, if the dietary situation is unsatisfactory and infections occur frequently, malnutrition may develop. During the first phase, this rapidly affects the child's weight : he or she "burns" his fatty reserves and muscle proteins to provide the energy needed for growth and daily activity. Within several days or one to two months, depending on the seriousness of the problem, his or her weight growth begins to slow down, to stagnate or to decline. This occurrence affects the weight-for-age and weight-for-height ratios. This situation is frequently encountered in Africa during pre-harvest periods, when the granaries are empty. If the episode is of short duration and is not repeated, the velocity of height growth will not be affected.

Long-term malnutrition

If undernourishment and infections continue, the velocity of height growth also slows down - height itself can never drop - and the child's height-for-age index will fall below the theoretically desirable value. At the same time, as a result of this effect on height, the weight-for-height index levels off, and may even increase provided the balance between energy intakes and expenditures becomes positive. This is particularly evident when the decreased velocity of height growth limits the related energy expenditures. Even if weight-for-age increases, it does not return to its "normal" path, since an individual's height considerably influences his or her weight, and the former is low for the age.

This general explanation is helpful in understanding the interpretation of each of these indices. When an individual's energy balance is negative, weight-for-height and weight-for-age are first to falter, and the same is true at the community level. Height-for-age leaves its theoretical path if the unsatisfactory conditions continue, whereas weight-for-height tends to increase, and weight-for-age remains low.

> A drop in weight-for-height therefore reflects an acute problem ; that is, one that occurred recently. A drop in height-for-age signals a chronic problem, one that has persisted for several months, but is not necessarily present when the measurement is taken. A decline in weight-for-age may be connected with one or the other of the above mentioned explanations, since it expresses an overall situation.

On the individual level, the interpretation of these indices, and of anthropometric measurements in general, should take clinical findings into account. Weight, for instance, is also affected by the presence of other pathological conditions such as oedema caused by a nephrotic syndrome or congestive heart failure, dehydration due to diarrhoea, etc.

Nutritional history

This type of interpretation implies that a series of measurements have been made at regular intervals. since the child's past history may be used to analyse the evolution of indices, and to detect any change at an early date : the family may then be rapidly alerted.

Personnel working at the grass-roots level often encounter a very different situation. For example :

— no reference figures are available for the calculation of the different indices ;

— children attend the consultation at irregular intervals, and the personnel does not travel outside the health centre ;

— the consultation is overcrowded and there is not enough time to record the different measurements and to interpret them :

— the equipment needed is not available.

Local constraints

Other solutions must be adopted, with the knowledge that the information collected will be less complete, the choice of actions more limited and often more specifically oriented toward the curative aspect. There is a risk that families will feel less involved in maintaining an adequate nutritional status, and only clinically evident protein-energy malnutrition will be detected.

Scales should be purchased and maintained at a local level, with the help of the community, the ministry of health, non-governmental or international organizations, religious authorities or rich and influential citizens. No health centre anywhere in the world should be deprived of a scale in 1989.

A tape measure and a vertical wall suffice for the measurement of children over 2 ; the tape measure may even be returned to other uses if the graduations are noted on the wall. For children under 2, two boards may be glued or nailed together, graduations noted on the side, and a small board or any other light, flat, rigid object used to press on the child's heels. The quality of such locally made measuring rods, and especially of the graduations, should always be carefully checked.

Reference figures (see appendix) should be available for consultation in the ministerial health services. Their use requires specific training, which should be a part of the curriculum for doctors and nurses.

If consultations are overcrowded and time for personal attention to each child is lacking, perhaps the health centre may be opened more often, or for longer hours, and its hours adjusted to families' working schedules. In any case, it is preferable to limit the number of measurements and to reserve more time for the interpretation of findings and for talking with mothers. Children are weighed, and the result recorded on the register or on a file card kept at the health centre, as well as on a growth card that belongs to the mother. The profile of the child's weight-for-age curve is most valuable for interpretation, provided weight is measured at regular intervals (1). When the curve stagnates or drops between two weighings, the personnel is generally aware of the danger, or of the warning signal. It is more difficult to make them understand that any inflexion of the curve, even if it continues to mount, should be given attention, and possibly be discussed with the mother. It is a fact that a weight curve may continue to rise somewhat but, after a number of months, still be indicative of protein-energy malnutrition (see figure 9).

INDICATORS

When children are seen quite irregularly, their past is not charted, and decisions for action must be made on the basis of a single measurement. There is no difficulty in making decisions in clinically evident cases of malnutrition with pretibial oedema (in the absence of nephrotic syndrome or cardiac insufficiency) or major muscle wasting. These children urgently require immediate attention (2). The interpretation is not as simple in other cases, since choices must be made.

Protein-energy malnutrition is a condition resulting from an imbalance between intakes and nutritional requirements ; its course varies considerably with its severity, duration, and the age at which it occurs : younger children have a more rapid growth velocity and are therefore more vulnerable.

When famine occures, intake is quite insufficient owing to the very limited supply of food available, and children are soon plunged into acute, severe malnutrition.

Workers are much more frequently faced with a chronic deficit. Malnutrition sets in gradually, with no visible signs, and makes the very identification - be it clinical, anthropometric or biological - of protein-energy malnutrition extremely difficult. At what point does malnutrition begin ? The decision is somewhat arbitrary, or rather, it involves the acceptation of the concept of probability (as opposed to certainty) in the establishment of anthropometric cut-off points for the diagnosis of malnutrition. This type of diagnostic approach is completely different from the one used in infectious pathology, where the detection of a plasmodium is a definite sign of malaria, for instance, or the isolation of a tubercle bacillus is a clear sign of tuberculosis, etc.

Cut-off point

The way in which the cut-off point is established may depend on the objective defined for anthropometric data-collection :

(1) M. CHAULIAC, A.M. MASSE-RAIMBAULT - From routine... to epidemiology...to health activities. In : Children in the Tropics. Paris, International Children's Centre, 1986, n 160 161. 72 p.

(2) WHO Geneva - The Treatment and Management of Severe Protein-Energy Malnutrition. WHO, Geneva, 1981. 47 p.

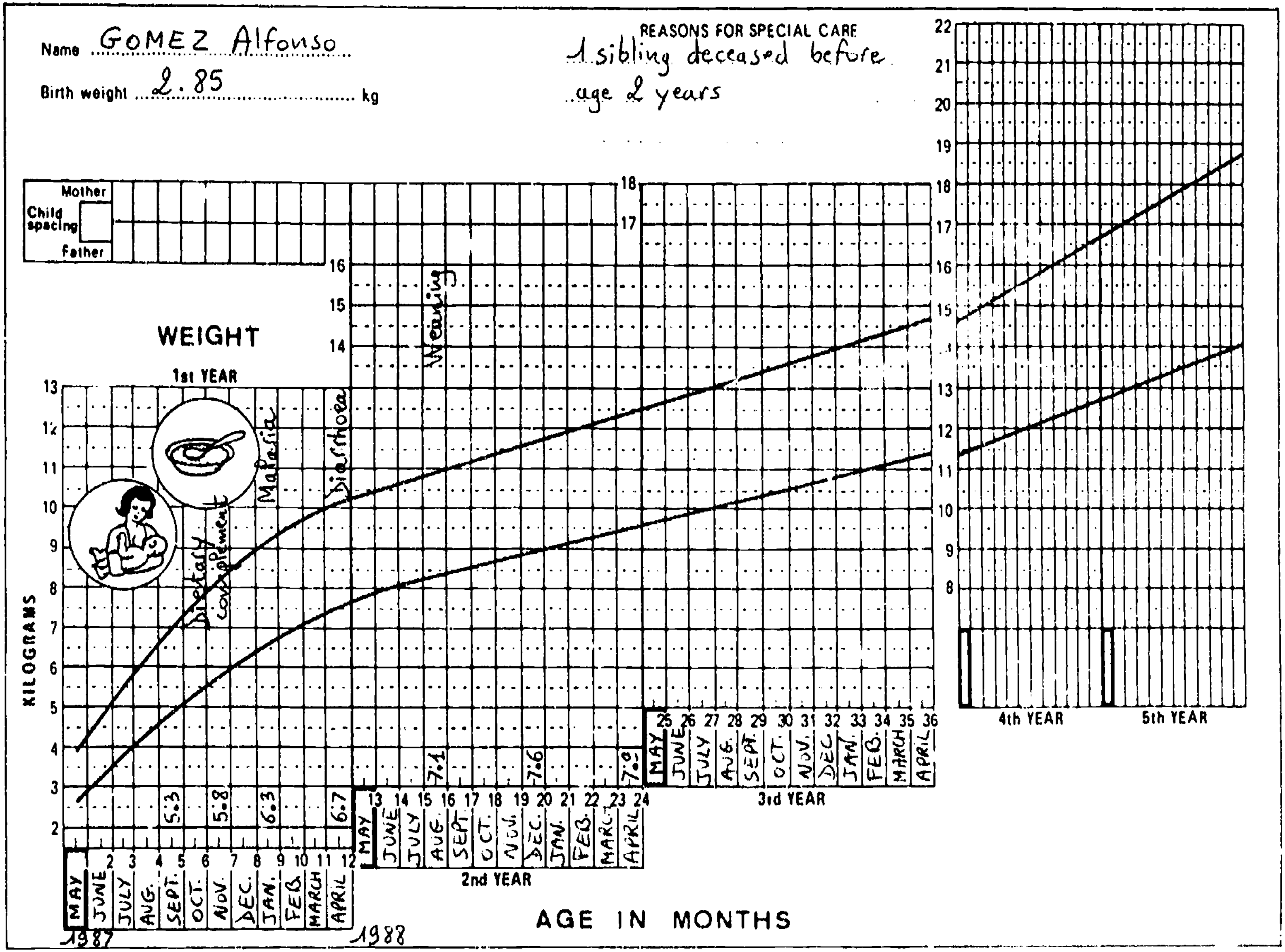

Figure 9 : Weight curve of a 23-months-old boy.
Note that his weight never stagnates or declines. Despite this, the visible deviation of the curve at age 6 months is already a warning sign. The child gradually fell into a state of malnutrition.

— is the objective the definition of the prevalence of protein-energy malnutrition within a population group, as is the case in descriptive, cross-sectional epidemiological surveys ?

— is it to determine the nutritional status of a community and its evolution in the course of time, as is the case in the analysis of data collected during the monitoring of nutritional status ?

— is it the detection of those children, within a given group, who require urgent attention because they run a particularly high risk, such as death ?

Statistical determination of cut-off points

It is recommended and generally accepted practice to use the lower limit of the reference figures for three indices - weight-for-height, height-for-age and weight-for-age - as cut-offs for determining the prevalence of PEM, comparing geographic areas or age groups, sexes or socioeconomic categories, studying the seasonal or general temporal evolution of the nutritional situation or evaluating certain actions. **However, weight-for-height and height-for-age may be used singly as indices.**

Standard deviation

The reference limits are the values that bound the reference interval for the given index. This is a statistical concept. As shown above, the distribution of values for an anthropometric measurement within a reference population practically takes the shape of a Gaussian curve. This is the graphic expression of what is known as a "normal" law of distribution. It may be described by its mean (which coincides, in this case, with the median or 50th centile) and its standard deviation, calculated mathematically. The latter provides information on the variability of the measurement within this population. The standard deviation is a figure such that the interval comprised between the mean minus two standard deviations and the mean plus two standard deviations includes 95.4 % of values for the measurement in the reference population. This is the reference interval. 4.6 % of values for the index within that population are located outside of it (see figure 10).

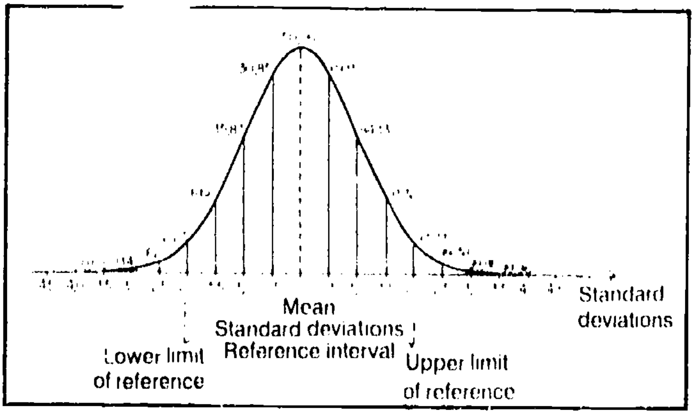

Figure 10 : "Normal" distribution of a variable : percentage of individuals with a value of the variable located below different standard deviations

The cut-off point recommended by WHO for protein-energy malnutrition is the mean minus two standard deviations. In the reference population, 2.3 % of values for the measurement are located below this point. The classification most commonly used at present to describe the protein-energy nutritional status of children under 5 years, the Waterlow classification, uses limits of this type. Its value resides in the fact that the **combined position of two indicators (weight-for-height**

and height-for-age) with respect to the mean minus two standard deviations distinguishes between wasting, caused by acute malnutrition, and **stunting,** caused by chronic malnutrition. There is no way of determining whether this chronic state is continuing or not, however.

The Waterlow classification

W/H H/A	> m − 2SD	< m − 2SD
> m − 2SD	Normal	Wasting
< m − 2SD	Stunting	Wasting and stunting

m = mean
SD = Standard deviation

Keller (1) has shown that these two indices are independent, and measure completely different things : "95-98 % of the variation from the median weight-for-age is due entirely to variations from the median in weight-for-height or height-for-age." This means that in population analysis, the information provided by weight-for-age is redundant with that provided by the combination of H/A and W/H.

Other cut-off points are also frequently used : they are certain centiles and percentages of the median. A number of objections to their use have been expressed : centiles are numbers for which a corresponding percentage of the reference population has values located below that same number for the given index. For example, 10 % of the reference population has a weight-for-age equal to or below the 10th centile.

Percentile

Use of several centiles to describe the prevalence of protein-energy malnutrition has been suggested. The NCHS tables have recently been revised so as to show the 3rd centiles (corresponding to the median minus 1.881 standard deviation). However, when a high proportion of children within a population group is located below this limit, it is interesting to determine the distribution of values. This may be done easily by calculating the standard deviation, if a personal computer is available ; if not, time and patience are required.

Percentage of the median

Percentages of the median are commonly used. The classifications formulated by Gomez (see p. 32), Jelliffe (see p. 33) and Wellcome (see p. 34) are based on these. Their goal is to assess the different degrees of severity of protein-energy malnutrition.

A theoretical understanding of the meaning of percentages of the median is needed if data is to be interpreted at the population level : conventionally, 80 % of the reference median of weight-for-age and weight-for-height and 90 % of the reference median of

(1) W. KELLER, M. FILLMORE - Prevalence of protein-energy malnutrition. In : World Health Statistic Quarterly, 1983, 36, pp. 129-167.

height-for-age correspond practically to two standard deviations below these medians. This is only an approximation ; it is not very accurate for each age, and above all, it varies with the child's age.

Calculation of the percentage of the median for an individual :

$$\text{Pourcentage of the reference median} = \frac{\text{value for the individual}}{\text{reference median}} \times 100$$

Example : boy, 29 months, height : 83.3 cm. Median height of 29 month-old reference boys = 89.7 cm.

$$\text{Percentage of the median for this boy} = \frac{83.3}{89.7} \times 100 = 92.8\ \%$$

Calculation of the standard deviation score or Z-score for a child :

$$\text{Z-score} = \frac{\text{measured value for the individual} - \text{reference median}}{\text{standard deviation of the reference value (above or below the median depending on the situation)}}$$

Example : boy, 29 months, height : 83.3 cm. Median height of 29 month-old reference boys : 89.7 cm.

$$\text{Z-score} = \frac{83.3 - 89.7}{3.5} = -1.83\ \text{SD}$$

An example is helpful in illustrating this remark. At 18 months, the median reference weight for boys is 11.5 kg. 80 % of the median is therefore :

$$\frac{80 \times 11.5}{100} = 9.2\ \text{kg}$$

When expressed as a Z-score, this finding, 9.2 kg, corresponds to (see appendix) :

$$\frac{9.2 - 11.5}{1.2} = -1.92\ \text{SD}$$

At 40 months, the median reference weight for boys is 15.3 kg. 80 % of the median = 12.24 kg, corresponding to a Z-score of −1.8 SD.

The same type of calculation shows that :

− 80 % of the median W/H for girls measuring 55 cm = 3.44 kg, representing a Z-score of −1.72 SD ;

− 80 % of the median W/H for girls measuring 90 cm = 10.32 kg, representing a Z-score of −2.34 SD.

Or again, for height-for-age :

– 90 % of the median for 24 month-old girls = 76 cm, representing – 2.64 SD ;

– 90 % of the median for 50 month-old girls = 92.5 cm, representing – 2.5 SD.

These examples show that in comparison with a fixed cut-off point of minus 2 standard deviations, at which 2.3 % of individuals within the reference population are located on one side and 97.7 % on the other, regardless of their age, a fixed percentage of the mean cuts off varying percentages of individuals within the reference population, depending on their age : nearly 6 % of girls in the 55 cm reference population have a weight-for-height below 80 % of the median, whereas only 1 % are in this case when they measure 90 cm (see figure 10). Percentages of the median do not furnish any indication of the proportion of the reference population that may be statistically expected to be located below the cut-off point (1).

The weight-for-height chart

This tool, described by Nabarro in 1980 (2), makes use of the weight-for-height index. The chart itself is a panel on which vertical stripes are drawn : each stripe represents a half-kilo, in rising order, between 5 to 25 kg, from left to right. Horizontal stripes show heights : these are coloured dark red, red, yellow and green, and respectively represent intervals corresponding to 60-69, 70-79, 80-89, 90-109 % of the NCHS reference median of weight-for-height. The child is weighed, then placed against the panel, as if for measuring height, next to the vertical stripe corresponding to his or her weight. W/H may then be read directly, according to the colour at which the top of the child's head is located.

This chart is useful, since :

– no tables of figures are required ;
– the W/H interval in which the child is located may be read directly ;
– selection of children who are candidates for specific programmes may be done rapidly ;
– there is no need to know the child's age.

It has some drawbacks (3) :

– children must stand up, the ground must be flat, the chart correctly placed on the ground. Extreme accuracy in height measurement is required ;

– only acute malnutrition is detected ;

(1) *WHO Working Group. Op. cit.*

(2) *NABARRO D., MAC NAB S. A simple technique for identifying thin children. In : Journal of Tropical Medicine and Hygiene, 1980, 8, pp. 21-3.*

(3) *BINKIN N.J. et al. The weight-for-height chart : is it accurate enough for field surveys ? In : Journal of Tropical Pediatrics, 1985, 31, pp. 152-157.*

SOETERS R. Pitfalls with weight-for-height measurements in surveys of acute malnutrition. In : Tropical Doctor, 1986, 16, pp. 173-176.

— only the W/H interval is mentioned. The mean and distribution of this indicator, at the population level, cannot be calculated.

Various errors found in the practical utilization of the weight-for-height chart are described in the following works (1).

Prevalence and age

In developing countries, studies generally show a peak in the prevalence of wasting (weight-for-height below the reference median minus 2 standard deviations) during the 2nd year of life. Prevalence tends downward thereafter. By contrast, the prevalence of stunting (height-for-age below the reference median minus 2 standard deviations) increases during the 2nd year of life and remains stable thereafter (2). Does this mean that acute malnutrition is more frequent between 12 and 24 months and chronic malnutrition at its peak after age 24 months ?

The velocity of weight growth declines rapidly, and may even become negative as a result of an imbalance between requirements and dietary intake. A drop in W/H therefore expresses an acute occurrence, which may be corrected rapidly. On the other hand, the effect on the velocity of height growth is only evidenced much later : malnutrition is then chronic, and has begun long before the height is found to be below the cut-off value for height-for-age.

The chronic malnutrition process began much earlier, but its consequence, shown by the figures for the prevalence of stunting (defined as a H/A below the mean minus 2 standard deviations) has gradually affected an increasing number of children.

Figure 11 illustrates this phenomenon : curve B shows the evaluation of height in a child whose height at birth corresponded to the reference mean. From age 2 months on, the conjugated effects of insufficient dietary intake and repeated infections caused the velocity of height growth to decline to only 65 % of the median velocity of growth of reference children, instead of 100 %. Consequently, the child's height curve deviated, and crossed the curve representing 90 % of the height of reference children toward the age of 14 months. If the velocity of the child's growth had been 80 % of the reference, he or she would not have been considered to suffer from stunting at the age of 3 years, on the sole basis of an H/A indicator below 90 % of the median. And yet, chronic malnutrition is actually present (3).

(1) BINKIN N.J. et al.- Op. cit.

SOETERS R. Op. cit.

(2) KELLER W., FILLMORE M. Op. cit.

(3) WATERLOW J.C. Observations on the natural history of stunting. In : WATERLOW J.C. Linear growth in less developed countries. New York, Raven Press, Nestlé Nutrition Workshop Series, 1988, n 14, pp. 1-16.

Prevalence figures should therefore not lead to the conclusion that chronic malnutrition is a greater problem in childien over two years old than in those under two.

Setting cut-off points on the basis of functional consequences

Rapid intervention requires that a limit be set, at which an immediate decision is automatically made. This is the case when children or families requiring dietary supplementation must be selected, either during famine periods or in nutritional rehabilitation centres. The use of this type of cut-off has direct consequences for individuals. Analysis on the community level also determines the number of candidates for an intervention, and whether this figure changes with time.

Many studies have dealt with the relation between certain anthropometric indicators and the risk of death. Their objective is to determine, through longitudinal surveys, the value of an indice which permit to distinguish those children who will survive and those who will die during the period studied. The sensitivity and the specificity of the indicator chosen are evaluated, in order to quantify the findings. Sensitivity corresponds to the percentage of deceased children classed as at high risk on the basis of the indicator. Specificity is the percentage of survivors classed as at low or moderate risk. These two risks are separated by a specific value for the index : this is the cut-off value.

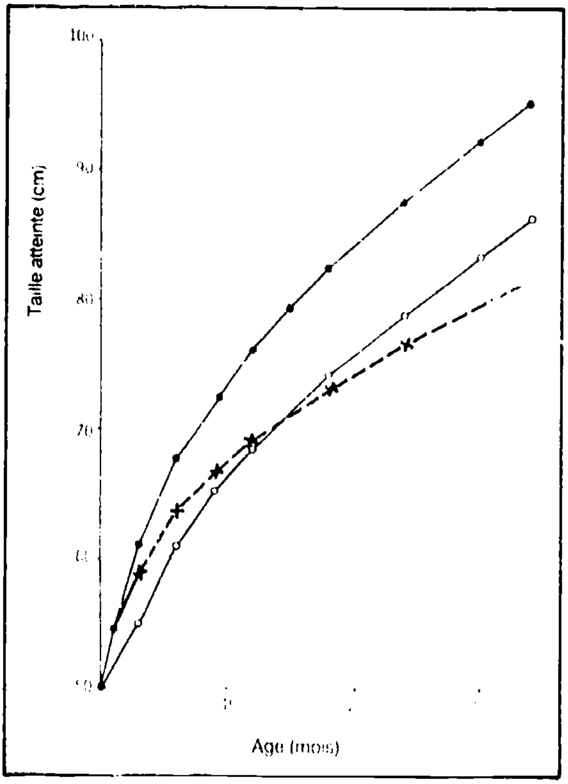

Figure 11 : Height-for age
Height reached (cm)Age (months)
•*Median of the reference population (NCHS)*
Curve A : 90 % of the reference median
× *Curve B : height reached by a child with a velocity of height growth corresponding to 65 % of the median velocity of height growth of the reference population*

	deceased children	Surviving children
High risk	a	b
Moderate risk	c	d

a, b, c, d : number of children in each category.

$$\text{Sensitivity} = \frac{a}{a + c} \times 100$$

$$\text{Specificity} = \frac{d}{b + d} \times 100$$

The higher the sensitivity and the specificity of indicator, the better it responds to the objective, which is to differentiate individuals at high risk of death. However, a higher specificity of the indicator corresponds to a lower sensitivity, and vice versa.

If the cut-off value for the index is raised, the number of individuals classed as "at risk" increases, the value $\frac{a}{a+c}$ increases, and $\frac{d}{b+d}$ decreases. A drop in specificity results in increased sensitivity, then. The opposite is true when the cut-off value is lowered. The most useful indicator is one whose sensitivity is highest for high levels of specificity (1).

This type of study raises many methodological and ethical issues. Can one abstain from any intervention aimed at improving the health status of children considered to be at high risk of death ? If the survey is conducted in hospitals, can the results be generalized to the population as a whole ? Should deaths occurring 1 week, 1 month, 1 year, or 2 years after the anthropometric measurements were made be considered ? Can the results of a survey done in a given context be transposed to another group with different living conditions ? Additional difficulties are specific to each type of longitudinal study. The findings ensuing from investigations may be contradictory, as a result of such problems. Analyses conducted in different environments would be necessary, but such studies are so wieldy as to make that approach unrealistic.

Further, this research generally does not take the child's nutritional history into account. Nothing is known of the conditions that led to the initially measured good or poor nutritional status, of the children's infectious status, nor of the mother's influence on the child's health.

The Gomez classification (2), widely used some years ago, was derived from a hospital study conducted in Mexico, where deaths were analysed on the basis of various criteria including an anthropometric index measured at hospital entrance

Gomez classification

Weight-for-age (as % of reference median)	Nutritional status
Above 90 %	Satisfactory nutritional status
Between 75 % and 90 %	1st degree malnutrition
Between 61 % and 75 %	2nd degree malnutrition
60 % or under	3rd malnutrition

(1) BRIEND A. - *Utilisation de l'anthropometrie pour la detection des enfants ayant un haut risque de deces. In : Les carences nutritionnelles dans les PVD. 3emes journées du GERM. Paris, Karthala ACCT. 1989. pp. 30 38*

(2) GOMEZ F., RAMOS GALVAN R. et al. - *Mortality in second and third degree malnutrition. In : Journal of Tropical Pediatrics, 1956, 2, pp. 77-83.*

In this survey, 56 % of the 733 children aged 31 plus or minus 17 months showed signs of dehydration, whose effects on weight are well known. Deaths were significantly more frequent in children with a weight-for-age of 60 % or under (33.5 %) than in those with a weight-for-age comprised between 61 % and 75 %.

However, this difference was only significant for the first two days of monitoring. After 48 hours, the number of deaths was no longer a function of weight-for-age. The presence of oedema or of skin lesions did not increase mortality figures. The existence of hydroelectrolytic disorders was very closely linked with mortality, however, even beyond the first 48 hours. Similarly, there were more fatalities among children suffering from diarrhoea or bronchopneumonia. In this study weight-for-age was compared with references whose origin is not mentioned. Initially, then, this classification had a prognostic value for malnourished hospitalized children. It was later used not for its prognostic value, but often for a descriptive interpretation of the nutritional status of a group of non-dehydrated, uninfected children, using references in the United States, following a cross-sectional study.

D.B. Jelliffe has also proposed a 4-degree classification (1) based on the weight-for-age index. He does not provide any functional explanation for the cut-off points chosen.

The Jelliffe classification

Weight-for-age (as % of reference median)	Nutritional status
Above 90 %	Satisfactory nurtional status
Between 81 and 90 %	1st degree weight deficit
Between 71 and 80 %	2nd degree weight deficit
Between 61 et 70 %	3rd degree weight deficit
60 % or under	4th degree weight deficit

The weight-for-age index does not provide a sufficiently accurate differentiation between children suffering from kwashiorkor and those with nutritional dwarfing. This led a group of experts to suggest another classification, in 1968, known as the Wellcome classification, in which the functional consequences are not considered.

(1) JELLIFFE D.B. - Op. cit.

The Wellcome classification

Weight-for-age (as % of reference median)	Oedema	Weight/height deficit	Nutritional status
80-60	0	slight	Underweight children
< 60	0	slight	Nutritional dwarfing
< 60	0	+ +	Marasmus
80-60	+	+ +	Kwashiorkor
< 60	+	+ +	Marasmic kwashiorkor

Malnourished children are divided into 5 groups, here. This classification is rarely used, since conditions in which marasmus, kwashiorkor and marasmus with kwashiorkor are distinct from each other are quite infrequent in comparison with the number of malnourished children. Further, the practical value of distinguishing kwashiorkor from marasmus has been called into question. The "dogma" according to which kwashiorkor is linked with protein deficiency and marasmus with energy deficiency is now controverted (1).

Arm circumference

Briend, in Bangladesh, used arm circumference as a prognostic factor for death. In a hospital study covering children under 5 years old, the distribution of children on the basis of the Waterlow or Wellcome classifications is no better than that obtained with the measurement of arm circumference only. with respect to risk of death. An analysis of earlier, non-hospital-collected data also shows that for 1 to 5 year-olds, the correction of the arm circumference figure according to age or height does not notably improve the estimation of risk of death within the forthcoming 18 months. Between ages 6 and 36 months - in Bangladesh - measurement of arm circumference by community health workers is the best anthropometric examination for estimating the risk of death during the coming month (2).

Other considerations plead in favour of this index : for a given degree of malnutrition, measured using the usual anthropometric criteria, younger children have a higher risk of death. Consequently, a child with a weight-for-age equal to 60 % of the reference median at 12 months has a worse prognosis than one with the same percentage at 36 months. The weight-for-age figure should therefore be interpreted with respect to age, but the data required to do so are not available. This is not true of arm circumference, for which the age effect seems to be insignificant between ages 1 and 5 : measurement of arm circumference puts younger children more readily in the high risk category. This tends to correct the effect of age on the risk of death linked with malnutrition.

There remains the question of the cut-off point. The commonly accepted figure of 12.5 cm, separating the severely malnourished

(1) KELLER W., FILLMORE C.M. - Op. cit.
(2) BRIEND A. - Op. cit.

from other children, seems to be too high, at least in Bangladesh, since it puts a great many children in supplementation programmes.

In Zaire, on the other hand, the Kasongo Project Team conducted a prospective study on the mortality of 6 to 59 month-old children within 100 days of anthropometric measurement-taking (W/A, W/H, AC/A, AC/H) ; no cut-off point was found for any of these indices that would signal a definite increase in the risk of mortality (1).

The determination of cut-off points for the different anthropometric indices, aimed at orienting children toward appropriate programmes, is an extremely difficult operation requiring much additional research. Study designs must be carefully analysed so as to avoid hasty generalizations which may result in serious errors compromising children's future.

Emphasis should also be placed on the absence of any satisfactory pathophysiological explanation advanced to justify the recommended cut-off points.

The cut-off curve

Quite recently, new light has been shed on the controversy surrounding the cut-off points for each anthropometric index used to separate well nourished children from the malnourished : J.O. Mora has suggested a new method for analysing indices ; one that is valid only for population research, and not for assessment of individual nutritional status. It is used for the analysis of the distribution, within a population group, of values for the indices measured, and its comparison with the reference population.

Distribution curves for the index in terms of Z-scores in the observed population and the reference population may be drawn on the same chart.

In the example cited by J.O. Mora to illustrate his method (figure 12), the median (or mean) of the index for the target population corresponds to the value of the median minus 1 standard deviation of the index in the reference population, and the standard deviation of the observed distribution is identical with that of the reference population. The two curves overlap somewhat, as in all anthropometric studies, regardless of the index studied.

WHO recommends (see p. 26) that the prevalence of malnutrition be calculated either on the basis of the proportion of individuals in the observed population whose index is equal to or below minus 2 standard deviations of the index for the reference population : this corresponds to surfaces a + d of figure 12. However, this mode of calculation neglects two facts :

(1) KASONGO PROJECT TEAM . Anthropometric assessment of young children's nutritional status as an indicator of subsequent risk of dying. In : Journal of Tropical Pediatrics, 1983, 29, pp. 69-75.

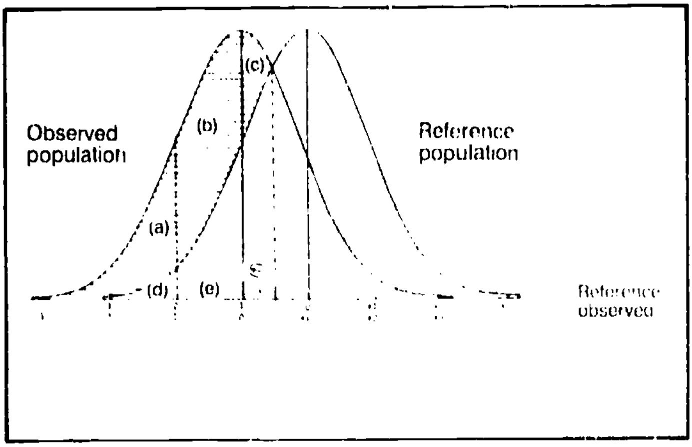

Figure 12 : Overlapping of the Gaussian distributions of an anthropometric indicator in the observed and in the reference population.

— first, in the distribution of the reference population, considered to be capable of fully expressing its genetic potential as a result of optimal environmental conditions, 2.3 % of individuals have an index located below this cut-off point. They are nonetheless not malnourished. These people, located in area d of figure 12, are false positives for the observed population. This means that as a result of the cut-off point used, they are defined as malnourished but in fact are not ;

— secondly, the proportion of individuals located in areas b + c represents the false negatives : that is, the percentage of people who are not defined as malnourished because of the cut-off point used, but who are nonetheless outside of the distribution of the index for the reference population.

The normalized prevalence of malnourished individuals within the observed population is therefore equal to :

$SP = MP - FP + FN$

where SP = standardized prevalence ; that is, the proportion of individuals whose index is located outside of the normal distribution of the reference population (a + b + c in figure 12).

FP = false positives : d in figure 12

FN = false negatives : b + c in figure 12.

The proportions b and c may be calculated on the basis of the mathematical properties of the laws governing the normal, or Gaussian, distributions.

This type of analysis, which may be done whenever data on the observed population are expressed as Z-scores with respect to the reference population, and when the two distributions are nearly normal, eliminates the controversy over what cut-off points to use in malnutrition prevalence studies, since the proportion of malnourished individuals necessarily corresponds to areas a + b + c of figure 12.

In this case the tendency is to speak of a cut-off curve. It should also be remembered that this method cannot be used for monitoring nutritional status, since it is not applicable to the assessment of individual nutritional status. Further, this type of analysis requires computerization, and adequate computer software.

In the article in which this method is described, J.O. Mora (1) presents a table in which the prevalences of malnutrition have been calculated for various Z-scores of the observed mean (between 0 and − 2.5 SD) and for various standard deviations of the observed distribution (between 1 and 2 SD), covering practically all cases existing anywhere in the world.

Early detection of protein-energy malnutrition is a priority health activity, both for promoting health in children and for economic reasons. It should be achieved through monitoring of individual nutritional status, as an integral part of the activities performed by health teams, including auxiliaries. Malnutrition control action centred around the screening of most severely affected children is only a last resort solution to be reserved for nutritional emergency situations. Anthropometry is only a last-minute means of detecting such situations, whereas other information such as meteorological, agronomic or economic data may be much earlier indicators of a deteriorated situation.

Supplementation and cut-off point

Unfortunately emergencies are still the everyday lot of many extremely disadvantaged populations. The most frequently implemented nutritional activity in those cases is dietary supplementation. There is much debate as to the value of distributing food to children and/or pregnant and lactating women, or to entire families. There is also disagreement as to the most relevant indicators and cut-off values for screening. Since specific research on the particular context is not available, the decision to include a child (and in some cases, his or her family) in a supplementation 3
programme on the basis of one anthropometric index (or several indices) is a somewhat arbitrary one, which should nevertheless take the following elements into consideration :

- an estimation of the period of time and of the total number of children who may be helped, given the human and logistic resources available ;
- the efficacy of supplementation for the rehabilitation of children who enter the programme with various levels for the anthropometric indices ;
- the ability of the teams to take measurements accurately.

The main difficulty in this type of programme resides in the decision to terminate them or to limit the number of children in them once the acute phase is over : that is, when the local food supply improves. One possibility is the lowering of the cut-off value, since there is less of a risk that each individual situation will deteriorate.

Aside from such emergency cases, which may in fact become permanent in certain regions, the perverse long-term consequen-

(1) MORA J.O. - A new method for estimating a standardized prevalence of child malnutrition from anthropometric indications. In : Bulletin of World Health Organization, 1989, 67, pp. 133-142.

ces of these distribution and supplementation programmes should be balanced against their short-range, desirable effects, which require assessment, in any event.

Other indicators

Every anthropometric indicator used at the individual level should be interpreted with reference to all other clinical, anthropometric or biochemical data available.

The Kanawati and Mac Laren classification (1)

In 1970, Kanawati and Mac Laren proposed a classification for 1 to 4 year-olds, based on the arm circumference to head circumference ratio. This ratio remains practically constant in 3 to 48 month-olds, and is not sex-linked. The values recommended for the classification of children within this age group are as follows :

- $>$ 0.31 : satisfactory nutritional status ;
- 0.28 to 0.31 : mild protein-energy malnutrition ;
- 0.25 to 0.27 : moderate protein-energy malnutrition ;
- $<$ 0.25 : severe protein-energy malnutrition.

The value of this ratio is that it is independent of age between 3 and 48 months, and requires little equipment.

However, there are some risks of error in measurement-taking, which are amplified in the calculation of the ratio. Too few studies have examined the specificity and sensitivity of this method as yet. This ratio is not easy to use for monitoring nutritional status, and particularly by personnel with a low level of literacy.

Arm circumference

Arm circumference is a measurement that scarcely varies between the ages of 1 and 5 years, and shows little intersex variation in that age group. Its variability in healthy children is slight.

The commonly accepted cut-off points for children aged 1 to 5 years are :

- $<$ 12.5 cm : severe malnutrition ;
- 12.5 cm - 13.5 cm : moderate malnutrition ;
- $>$ 13.5 cm : satisfactory nutritional status.

The value of this measurement resides in the fact that it is independent of age for 1-4 year-olds, and requires only inexpensive material that is readily available and easy to carry. It is also performed and interpreted rapidly.

This is a valuable system of classification for health workers with little training, or when screening of children to select beneficiaries of an action must be done extremely rapidly. Corroboration of the results using weight or height measurement is recommended, however.

(1) KANAWATI A.A., MAC LAREN D.S. - Assessment of marginal malnutrition. Nature, Nov. 1970, 228, n 5771, pp. 573-574

On the other hand, this indicator is not very sensitive and is useless in children under 1 year old. Erroneous measurements due to variable tautness of the tape measure do occur, and the slightest error may class a child as malnourished, given the slight variability. It is unable to detect malnutrition at its onset, nor to indicate the type of protein-energy malnutrition.

Arm circumference/height

The Quac (Quaker arm circumference) (1) stick requires measurement of height and arm circumference. The percentage interval for arm circumference/height in which the child is located may be read directly.

A cut-off point of 80 % of the Boston (Stuart and Stevenson) reference median has been recommended for prevalence studies. According to Shakir's research (1) in Bagdad, this cut-off separates 3 to 72 month-old children into two groups practically equivalent to those determined by W/A with a cut-off point of 80 %.

The main advantage of this indicator is that it is independent of age between 3 and 72 months.

It has some drawbacks, however. Since both measurements are delicate, the risks of error are great. This ratio does not seem to yield more information than the arm circumference alone between ages 1 and 4.

Head circumference for age

This index mainly reflects growth of the brain, which is extremely rapid during the first year of life, and to a lesser degree during the second year (2).

The great difficulty in achieving an international consensus on the type and location of cut-off points to be utilized to determine the prevalence of protein-energy malnutrition has led each country, and sometimes each team, to make its own choice, rarely based on accurate, specific research into the real-life situation of the populations studied.

This interferes with the possibilities of comparing results found in different parts of the world, within a given country and even in the course of time for a single place. Figures may then be "manipulated", the aim no longer being the objective description of the situation. A team, an association or a government may have its own reasons to exaggerate the prevalence of malnutrition or on the contrary, to minimize it. Cut-off points tend to slide upward or downward, blurring the situation, whereas an uninformed, non-critical public views data analysis as objective, scientific work.

(1) SHAKIR A. *The surveillance of proteino-caloric malnutrition by simple and economical means.* In : Environmental Child Health, April 1975, pp. 69-85.

(2) DOBBING J., SANDS J. *Head circumference, biparietal diameter and brain growth in fetal and postnatal life.* In : Early Human Development, 1978, 2, pp. 81-87.

VARIABILITY OF FINDINGS DEPENDING ON THE INDICATORS CHOSEN

The quantification of prevalence, of severity or even of the type of protein-energy malnutrition leads to different conclusions depending on the classifications or indicators used. Assessment of nutritional status at a given time using one indicator or another may lead to quite different dietary and health policy decisions. The choices are in no way unimportant, then (1).

In India, S. Rao and A. Kanade (2) studied 2 groups of children under 5, in a rural area and a city slum area. They compared the estimations of severity of malnutrition as calculated using different indices and cut-off levels.

Degrees	Degree 0 (%)	Degree 1 (%)	Degree 2 (%)	Degree 3 (%)
W/A	> 90	75-90	60-75	< 60
W/H	> 90	80-90	70-80	< 70
H/A	> 90	90-95	85-90	< 85

The following table shows the findings for the slum-dwelling children.

Degrees	Degree 0 (%)	Degree 1 (%)	Degree 2 (%)	Degree 3 (%)
W/A	9.4	35.1	47.3	8.1
W/H	43.2	39.2	16.2	1.4
H/A	23	32.4	23	21.6

The W/A indicator finds much lower figures for the 1st and 2nd degrees than the other two indicators, for the chosen cut-offs, while a much higher percentage of children are considered to be severely malnourished (3rd degree) on the basis of H/A than on the basis of W/A or W/H. Only 65 % of children are classed in the same degree of malnutrition by W/A and at least one of the other two indicators.

In this study, the authors analysed the evolution of indicators in the same children one year after the first investigation. It was concordant for only :

66.7 % of children when W/A and W/H are compared ;
52.1 % of children when W/A and H/A are compared.

(1) *GOPALAN C. - Classifications of Undernutrition - Their limitations and fallacies. In : Journal of Tropical Pediatrics 1984, 30 pp. 7-10.*

(2) *RAO S., KANADE A. - Comparison of Gomez and Waterlow classifications in a follow study among pre-school children. In : European Journal of Clinical Nutrition, 1986, 42, pp. 863-869.*

Other studies comparing indicators such as arm cicumference and weight-for-height at different cut-off levels also show that many children are classed differently depending on which indicator is used (1).

By mathematically determining cut-offs for W/A and selecting identical percentages of children located below these as well as below various cut-off points for arm circumference, Zeitlin, in Manilla, was able to prove that 30 to 35 % of children thus identified were not the same (2).

(1) GAYLE H.O., BINKIN N.J., STAEHLING N.W. et al. - Arm circumference v weight for height in nutritional assessment : are the findings comparable ? In : Journal of Tropical Pediatrics, 1988, 34, n. 5, pp. 213-217.

(2) ZEITLIN M.F. - Comparison of malnourished children selected by weight for age, mid-upper arm circumference and maximum thigh circumference. In : Journal of Tropical Pediatrics, 1986, 32, pp. 190-195.

NEONATES

Birth weight

Birth weight is the index of choice for assessing the course of a pregnancy and of pregnancies in general within a community. Further, birth weight is a means of assessing the prognosis for the neonate's development, growth and survival.

The neonate's birth weight depends on a series of factors that condition the health status of the expectant mother: her height "mirror of her nutritional history", her weight at the onset of pregnancy, her weight gain in the course of pregnancy, her physical activity and occupational activity, especially during the last three months of pregnancy, prenatal infections, smoking, hypertension and gravidic toxaemia. Sociodemographic factors such as age, parity, interbirth interval (the lapse of time separating two consecutive births), level of education, etc, also play a role.

In all maternity wards, and whenever childbirth is attended by trained personnel, the birth weight should therefore be taken as accurately as possible, and recorded both on the mother's and the child's individual health cards and on the health unit register. This makes it possible to follow birth weights as a whole, and this should be a high priority ojective for health programmes aimed at mothers and children, the most vulnerable population groups.

Analysis of this most important index serves to orient activities toward screening and early care for at-risk pregnancies, so as to prevent low birth weight.

At present, birth weight is too rarely known, owing to the frequency of home deliveries, the lack of scales or their poor functioning.

One of the main factors contributing to birth weight is the duration of gestation, which is normally 38 to 42 weeks. However, since reliable information on the date of last menstruation is so often lacking, the internationally recognized cut-off point for low birth weight is now 2,500 g. A number of studies have shown that neonates with a lower weight had higher risks of mortality, and morbidity, as well as of adverse effects on their physical and intellectual development.

According to estimations made by WHO in 1980 (1), 20.6 million of the 122 million children born in 1979 had a birth weight of 2,500 g or less, and 19 million of these were born in developing countries. The percentage of these low-birth-weight babies is quite variable from one region to another, however : 7 % in North America, 8 % in Europe and the Soviet Union 11 % in Latin America, 15 % in Africa and 20 % in Asia. On the latter continent, the percentage is much higher in India, Pakistan and Bangladesh, with 31 %, than in East Asia (and China and Japan, in particular), with 6 %. These figures seem to indicate that this cut-off may not be valid for Asian populations, and more specially for southern Asia, and raise the question of a genetic influence on birth weight : some scientists recommend a cut-off value of 2,250 g.

(1) WHO, Geneva. The incidence of low birth weight. A critical review of available information. WHO, Geneva, World Health Statistic Quarterly, 1980, 33, pp. 197-224.

Gestational age

Since foetal weight gain peaks during the last three months of pregnancy, preterm birth has a major effect on birth weight. A distinction should therefore be made between low birth weight linked with prematurity (duration of pregnancy less than 37 weeks) and intrauterine growth retardation (small-for-date or small for gestational age baby, or at-term IUGR baby).

According to Belizan and Villar (1), small-for-date babies are 6.6 times as frequent in developing countries and the incidence of prematurity is twice as high. The high percentages of low birth weight (that is, of weight below 2,500 g) in developing countries seem to be mostly due to the high incidence of small-for-date babies.

The consequences of these two types of low birth weight on the growth of surviving children have been studied by S.K. Bhargava and V. Kapani in India (2). As opposed to small-for-date babies, prematures recuperate their initial height and weight lag ; this phenomenon is observed regardless of the level of family income within this population group (table 1).

Table 1
HEIGHT AND WEIGHT, FROM BIRTH TO 14 YEARS, OF PREMATURE INDIAN CHILDREN HARMONIOUS FOR GESTATIONAL AGE (HGA), AT-TERM SMALL-FOR-GESTATIONAL AGE (SGA) AND AT-TERM HGA

Age	Premature HGA		At-term SGA		At-term HGA	
	Height	Weight	Height	Weight	Height	Weight
Naissance	44.6	1.8	43.4	1.3	49.3	3.0
1	69.3	7.3	67.9	6.7	73.7	8.8
2	79.3	9.4	77.5	8.7	83.0	10.7
3	87.0	11.4	85.4	10.5	90.7	12.4
4	94.3	12.9	92.6	12.0	96.5	13.7
5	100.5	14.3	96.9	13.1	102.3	15.2
6	106.6	15.8	100.3	15.1	107.4	16.5
7	112.9	18.6	109.6	16.2	115.8	19.1
8	121.0	20.6	114.5	17.6	121.5	21.5
9	126.4	23.2	119.7	19.8	124.3	23.8
10	131.6	24.1	125.3	22.0	126.4	26.9
11	136.6	26.4	131.6	24.9	131.7	28.4
12	142.6	27.2	137.0	28.9	140.0	30.5
13	148.4	33.3	145.0	34.0	146.9	35.9
14	154.5	42.0	147.0	35.6	156.4	43.6

(1) BELIZAN J.M., VILLAR J. El crecimiento fetal y su repercusion sobre el desarollo del nino. In : CUSMINSKY M., MORENO S.M., SUAREZ OJEDA E.N. Crecimiento y Desarollo. Hechos y tendencias. OPS Publicacion Cientifica, 1988, n 510, pp. 102 119

(2) GOPALAN C. - Stunting : significance and implications for public health policy. In : WATERLOW J.C. Linear growth retardation in less developed countries. New York, Raven Press, Nestle Nutrition Workshop 1988, 14, pp. 265 279.

Certain studies have also demonstrated the value of differentiating several types of small-for-date babies. Velocity of foetal height and weight growth shows peaks at different points in pregnancy. For height, the peak occurs toward the 20th week of gestation, during the 2nd trimester, whereas weight peaks towards the 34th week, during the last trimester (figure 13). Retardation will affect the child's height and/or weight depending on when the event leading to retarded intrauterine growth takes place. The foetus is harmonious, with a low weight and a small height in the case of a continuous process such as chronic maternal malnutrition or smoking, lasting throughout pregnancy ; it is dysharmonious with a low weight-for-height if the mother suffered during the last three months (toxaemia, low weight gain, intense physical work, etc).

It seems important to distinguish between these 2 types of IUGR, since their respective consequences differ. Dysharmonious neonates have a higher incidence of neonatal complications (hypothermia, hypoglycaemia, asphyxiation, etc) but their velocity of weight growth during the first months of extrauterine life is higher than that of infants who experienced chronic suffering during their foetal period. Last, mental development seems to be more satisfactory in the former, according to the different tests passed at ages 4-5 and 7 years (1).

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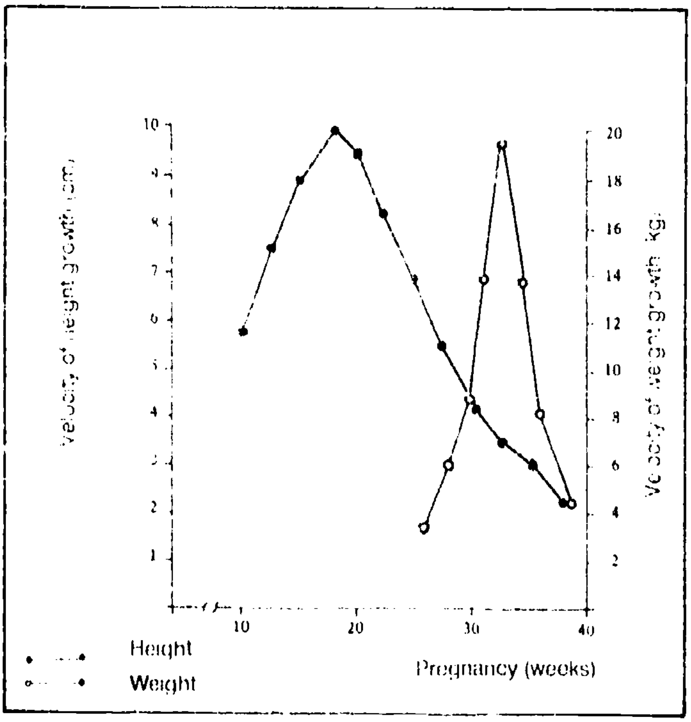

Figure 13 : Velocity of foetal height and weight growth during the prenatal period

Source : VILLAR D.J., BELIZAN J.M. - Crecimiento y desarollo de ninos con retardo del crecimiento intrauterino. In : Archivos Argentinos de Pediatria, 1986, 84, pp. 77-91.

An index, the Rorher index - weight-/cube of height - has been suggested for the identification of these two types of IUGR. Complementary research seems necessary to confirm the value of this classification. Practically speaking, not only is it difficult to reliably determine birth weight, but it is even more complicated to accurately define the term of a pregnancy. Measurement of height at birth should only be performed in maternity wards run by trained personnel.

(1) VILLAR J., ALTOBELLI L. et al - A Health priority for developing countries : the prevention of chronic fetal malnutrition. In : Bulletin of World Health Organization, 1986, 64, pp. 847-851.

PREGNANT WOMEN

What are the consequences of the nutritional status of pregnant women on foetal growth and on the health status of the neonate and the mother during the post partum period ? Which nutritional indicators should be used to evaluate the nutritional status of pregnant women and to decide how to manage each individual situation, and at the collective level, what specific actions are needed ?

Actually, the influence of protein-energy malnutrition during pregnancy on maternal mortality has never been thoroughly investigated (1). It may act as a contributive factor hastening death caused by another pathology. Even less is known of its influence on post partum morbidity (1).

A number of studies, and more particularly those conducted in Zaire (2), have shown that malnourished lactating women secrete less milk than do women with a satisfactory nutritional status. A small amount of fat stored in the course of pregnancy seems to play a role in reducing the volume of milk.

The influence of the mother's nutritional status on neonatal birth weight has been repeatedly studied throughout the world. A great many interdependent factors explain much of the variability of birth weight. These factors are well known ; they are of several types (3) :

– socio-demographic : age, socioeconomic status, mother's educational level ;

– preconceptional : parity, weight, height, chronic diseases, obstetrical history ;

– gestational : multiple pregnancies, weight gain during pregnancy, interbirth interval, infections, congenital anomalies ;

– behavioural : smoking, abuse of alcohol, stress (hard physical labour during the last three months of pregnancy).

(1) GOUYER J., BREART G., DELECOUR M. et al. - Réduire la mortalité maternelle dans les pays en développement. Paris, INSERM/CIC, 1989, 237

(2) HENNART Ph. - Allaitement en situation nutritionnelle critique : adaptations et limites. In : Courrier, ICC 1984, pp. 317-319.

(3) FESCINA R.H., SCHWARCZ R. - Crecimiento intra-uterino. La mujer gestante. In : CUSMINSKY M., MORENO E.M., SUREZ OJEDA E.N. - Crecimiento y desarollo. Hechos y tendencias. OPS Publicacion Cientifica, 1988, n° 510, pp. 71-89.

Non-nutritional maternal factors apparently account for 20 to 50 % of the variability of birth weight (1). Those linked with the mother's nutritional status seem to play a major role in groups where malnutrition prevails. Conversely, they are of little importance in communities whe... men's nutritional status at the onset of pregnancy tends to be satisfactory. A number of analyses of dietary supplementation programmes for expectant mothers have confirmed these findings (2).

Most studies indicate the existence of a link between some anthropometric parameters that may be relatively easily obtained during prenatal consultations and birth weight. Tall or heavy women tend to give birth to heavier children. Heavier women tend to have heavier infants than lighter women of the same height. The effect of a low weight increment in the course of pregnancy on the child's birth weight is more marked in women whose weight was low at the onset of pregnancy.

Mothers' height

Weight

As we know, the mother's height reflects her nutritional history since early childhood, her weight at the onset of pregnancy is an indication of her "reserves", while her weight gain during pregnancy measures the evolution of the growth of her foetus and of its appendages, as well as of her own reserves. P. Rosso (3) has proposed a chart for the individual monitoring of pregnancies, so as to take into account the interrelations between these multiple, dynamic and measurable occurrences in mothers. It has been tested on low-income women in both the United States and Chile.

The percentage of reference weight-for-height is calculated for the expectant mother before the 12th week of pregnancy, using a nomogram (figure 14). The curve reproduced in figure 15 (4) may then be used to determine the adequacy of the evolution of this weight-for-height during the course of pregnancy.

Weight gain

This chart clearly shows that a woman whose weight is low at the beginning of pregnancy must gain more weight than a woman with 100 % of the reference weight-for-height before the 12th week. This tool is a bit difficult to handle for basic health workers, and has apparently never been tested in field conditions ; in any case, there are no published accounts of such testing.

(1) VILLAR D.J., BELIZAN J.M. - *Crecimiento y desarollo de ninos con retardo del crecimiento intrauterino. In : Archivos Argentinos de Pediatria. 1986, 84, pp. 77-91*
(2) LECHTIG A., KLEIN R.E. - *Prenatal Nutrition and birth weight : is there causal association ? In : DOBBING J. (Ed.) - Maternal nutrition in pregnancy. Eating for two ? London, Academic Press. 1981, pp. 131-156.*

(3) ROSSO P. - *A new chart to monitor weight gain during pregnancy. In : American Journal of Clinical Nutrition, 1985, 41, pp. 644-652*

(4) CHAULIAC M., MASSE-RAIMBAULT A.M. - *Women's lives, mothers' health. In : Children in the Tropics. Paris, International Children's Centre. 1985, n. 159, 65 pp.*

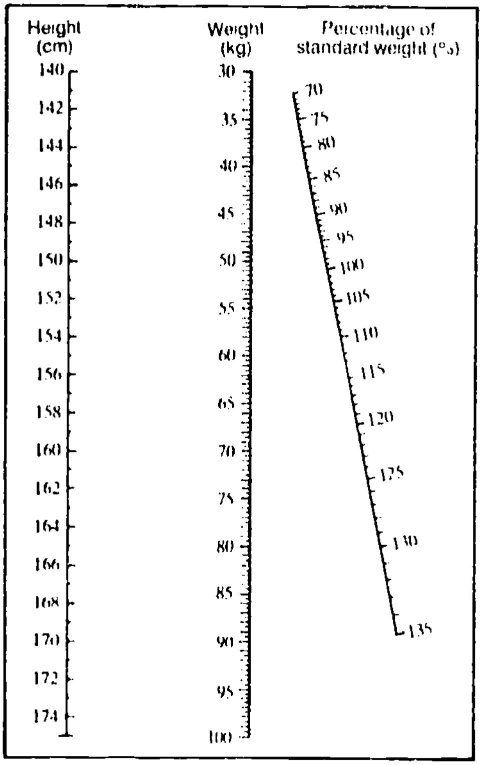

Figure 14 : Nomogram to determine adequacy of weight for-height and to calculate desirable total weight gain during pregnancy.

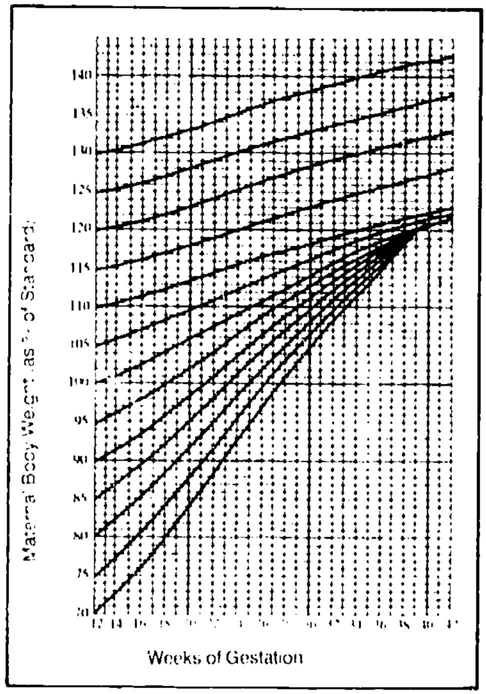

Figure 15 : Chart to monitor weight gain during pregnancy considering pre-pregnancy weight and height.

Uterine height

Use of so simple a method as the measurement of uterine height, routinely recorded on a curve (figure 16) during monitoring of a pregnancy, may detect certain lags in intrauterine growth. A birth weight for gestational age below the 10th centile of the reference is prognosticated in 70 to 85 % of cases. False positives — that is, low figures for uterine height in pregnant women who give birth to children with satisfactory birth weight — represent 10 % of cases (1).

A number of curves have been established showing the evolution of uterine height during pregnancy. Their comparison (1) shows them to be quite similar, and any one of them may be used. By contrast, the criteria proposed for the assessment of low height and the definition of a woman as "at risk" vary, and they result in differing interpretations and conclusions (2). For instance, should a value below the 10th centile be chosen ? Or two consecutive or three non-consecutive measurements below the 10th centile ? Or three values showing no increase in height ?

(1) BELIZAN J.M., FITCH K. The evaluation of nutritional status during pregnancy In : Clinical Nutrition, 1988, 7, n° 4, pp. 137-146

(2) CALVERT J.P., CREAN E.E. et al. Antenatal screening by measurement of symphysis-fundus height. In : British Medical Journal, 1982, 285, pp. 846-859.

Specific analyses of the sensitivity and specificity of different criteria may be useful in determining which of these are most relevant in the local context.

Other anthropometric indicators have been suggested for the assessment of the nutritional status of pregnant women. These include the Quetelet index (the body masse index), which is the ratio of weight (in kg) to the square of height (in meters), and the evolution of the triceps skinfold during pregnancy. While this type of information may be of value in the framework of epidemiological research, where proper measurement may be closely monitored, it seems too complicated for use in routine antenatal monitoring by basic health workers.

Biologically speaking, the physiological transformations connected with pregnancy, and especially the increased blood volume, representing an increase of about 50 % in plasmal volume during the last 6 to 8 weeks of gestation and a 20 to 30 % increase in erythrocyte volume at term, result in a modification of what is considered "normal" values for biological parameters in non-pregnant women. For instance, a woman is considered to be anaemic with a haemoglobin concentration below 12 g/dl if she is not pregnant, and below 11 g/dl if she is pregnant.

Many questions must be answered if a better understanding of the relations between the nutritional status of pregnant women and foetal health, as well as between the nutritional status of mother and child during the post partum period are to be elucidated.

On the epidemiological level, what is the significance of the different values attributed to anthropometric parameters, given the enormous variations in living and dietary conditions of women around the world ?

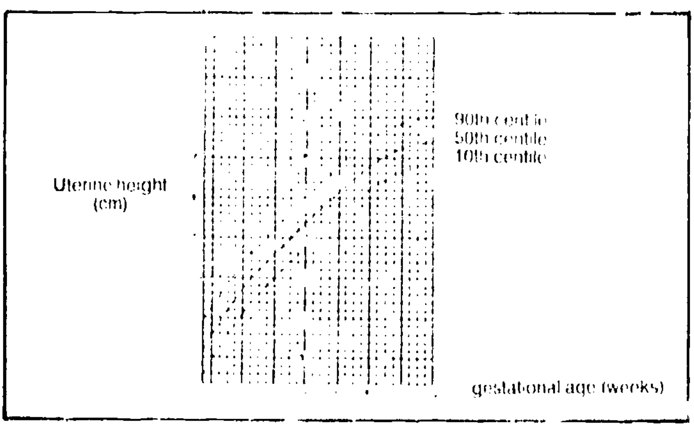

Figure 16 : Evolution of uterine height. Reference curve.
Source : CALVERT J.P., CREAN E.E. et al. - Op. cit.

On the biological level, what metabolic transformations actually take place in pregnant women ? Are they modified by nutritional status at the onset of pregnancy ? What are the components of the mother's weight gain (fat, water, etc) in different contexts ?

Improved knowledge in these fields should lead to the development of one or several more reliable indicators for the nutritional monitoring of these future mothers.

PRESENTATION OF DATA

Once data has been collected, there are a number of useful rules for drawing as much information as possible from them. The designing of an epidemiological survey will not be discussed here. This design conditions subsequent analysis and sets the limits of what interpretations may be made (1).

A clear presentation of data simplifies their interpretation and the communication of findings. Computerization facilitates complex processing of data (relations between two or more variables, statistical tests, selection of certain individuals). The necessary material is still in scarce supply, and requires special skills. A simple calculator capable of doing additions, substractions, multiplications and divisions usually suffices for the processing of data by workers.

As the type of analysis required becomes more elaborate, use of personnel higher in the health pyramid is required. This means that documents must be filled out regularly by health agents, and sent up to the next level.

Such exercises in data processing may be done at the health centre level, however. This provides the best guarantee that programmes which are often established at a national level and are therefore unable to deal with all situations may be adjusted to local situations. Another advantage is the obtaining of objective, quantified information that may be used to illustrate the situation at meetings with representatives of the community and of other development sectors. Last, this provides the means for monitoring the long-term evolution of nutritional status.

J.C. Waterlow et al. (2) have formulated a number of recommendations as to the presentation of data pertaining to weight-for-height, height-for-age and weight-for-age for a group of children. Since the type of malnutrition tends to change with the child's age, it is valuable and necessary to group data by age group, but to do so a sufficient number of measurements (about 100) must be available for each age group. If the number is insufficient, broader age ranges should be defined.

At best, age groups for data analysis should cover 3-month periods from birth to 12 months, then one year between 1 and 6 years ; if not, the first year should be divided into 2 groups : birth to 6 months, and 6-12 months, followed by 1-2, 2-4 and 4-6 years. At worst, data should be analysed for children from birth to 12 months, from 1 to 2 years, and from 2 to 6 years.

(1) LAVOIPIERRE G.J., KELLER W., DIXON M.H. et al. - Op. cit

(2) WATERLOW J.C., BUZINA R., KELLER W. et al. - Op. cit

Each sex is analysed separately, since the references are different. Data for each age group and sex should be presented either in the form of centiles or of Z-scores (see p. 28). Tables of figures and/or charts and curves should be established to facilitate reading. If possible, the number of individuals belonging to the various categories defined as well as their percentage with respect to the total should be mentioned.

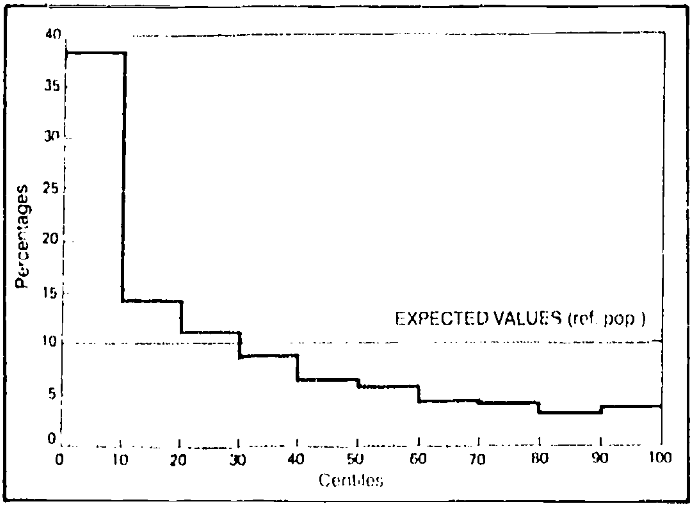

 Figure 17 : Centile chart.
Source : LAVOIPIERRE G.J., KELLER W., DIXON M.H. et al. - Op. cit.

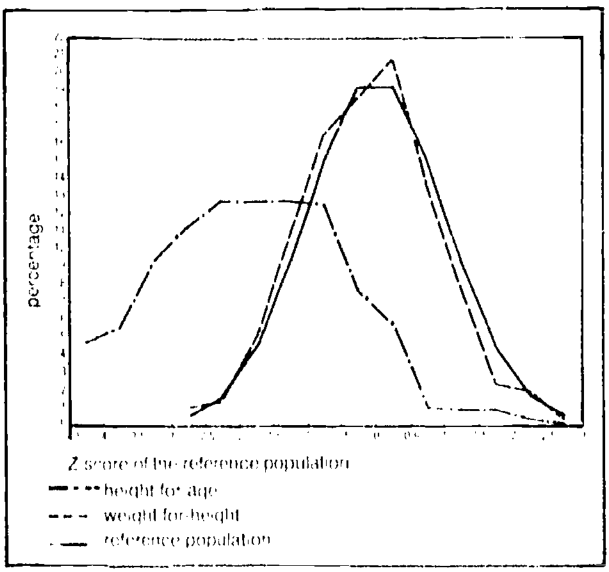

Figure 18 : Curves showing the distribution of weight-for-height and height-for-age, expressed as Z scores, in comparison with the reference population
Source : WHO Working Group - Op. cit.

Examples of presentation :

- table of centiles (table 2) ;
- chart of centiles (figure 17) ;
- table of standard deviations (table 3) ;
- curve of standard deviations (figure 18) ;
- curve of mean weight-for-age of children seen in consultations (figure 19).

Often this type of analysis and presentation is too complex for a health centre. If this is the case, an effort should be made to calculate, for each anthropometric parameter measured, at least the mean for the different age groups, and if possible the standard deviations, both in pregnant women and in children. To facilitate this work, information-collecting tools such as health centre records should be designed so that calculations may be done rapidly, with a minimum of errors. Data processing thus provides a general idea of the evolution of weight (and/or height) growth in the community's children, and in particular of the point at which curves begin to falter.

When done repeatedly, this work makes it possible to follow the temporal evolution of the situation.

Table 2

CENTILE DISTRIBUTION OF HEIGHT-FOR-AGE
IN A GROUP OF 1 TO 2 YEAR-OLDS

Centile (reference population)		boys	girls	total
0-3	n	15	23	38
	%	2.4	3.4	2.9
0-5	n	86	59	145
	%	13.9	8.7	11.2
0-10	n	211	208	419
	%	34.0	30.6	32.3
10-20	n	77	107	184
	%	12.4	15.8	14.2
20-30	n	81	100	181
	%	13.1	14.7	13.9
30-40	n	67	54	121
	%	10.8	8.0	9.3
40-50	n	48	46	94
	%	7.7	6.8	7.2
50-60	n	45	47	92
	%	7.3	6.9	7.1
60-70	n	26	41	67
	%	4.2	6.0	5.2
70-80	n	25	29	54
	%	4.2	6.0	5.2
80-90	n	18	23	41
	%	2.9	3.4	3.2
90-100	n	22	24	46
	%	3,5	3.5	3.5
95-100	n	10	9	19
	%	1.6	1.3	1.5
97-100	n	2	4	6
	%	0.3	0.6	0.5

n = number of children

Source : WATERLOW J. C., BUZINA R., KELLER W. et al. - Op. cit.

Table 3

DISTRIBUTION OF WEIGHT-FOR-HEIGHT
IN A GROUP OF 2 YEAR-OLDS
BASED ON Z-SCORES

Z-Score	Weight-for-height (%)	Distribution in the reference population (%)
3.5 to 3.0	0.0	0.1
3.0 to 2.5	1.0	0.5
2.5 to 2.0	1.3	1.7
2.0 to 1.5	5.0	4.4
1.5 to 1.0	10.7	9.2
1.0 to 0.5	16.4	15.0
0.5 to 0	18.6	19.1
0.0 to 0.5	20.8	19.1
0.5 to 1	13.5	15.0
1.0 to 1.5	7.6	9.2
1.5 to 2	2.3	4.4
2.0 to 2.5	1.8	1.7
2.5 to 3.0	0.3	0.5
3.0 to 3.5	0.0	0.1

Source : WHO Working Group - Op. cit.

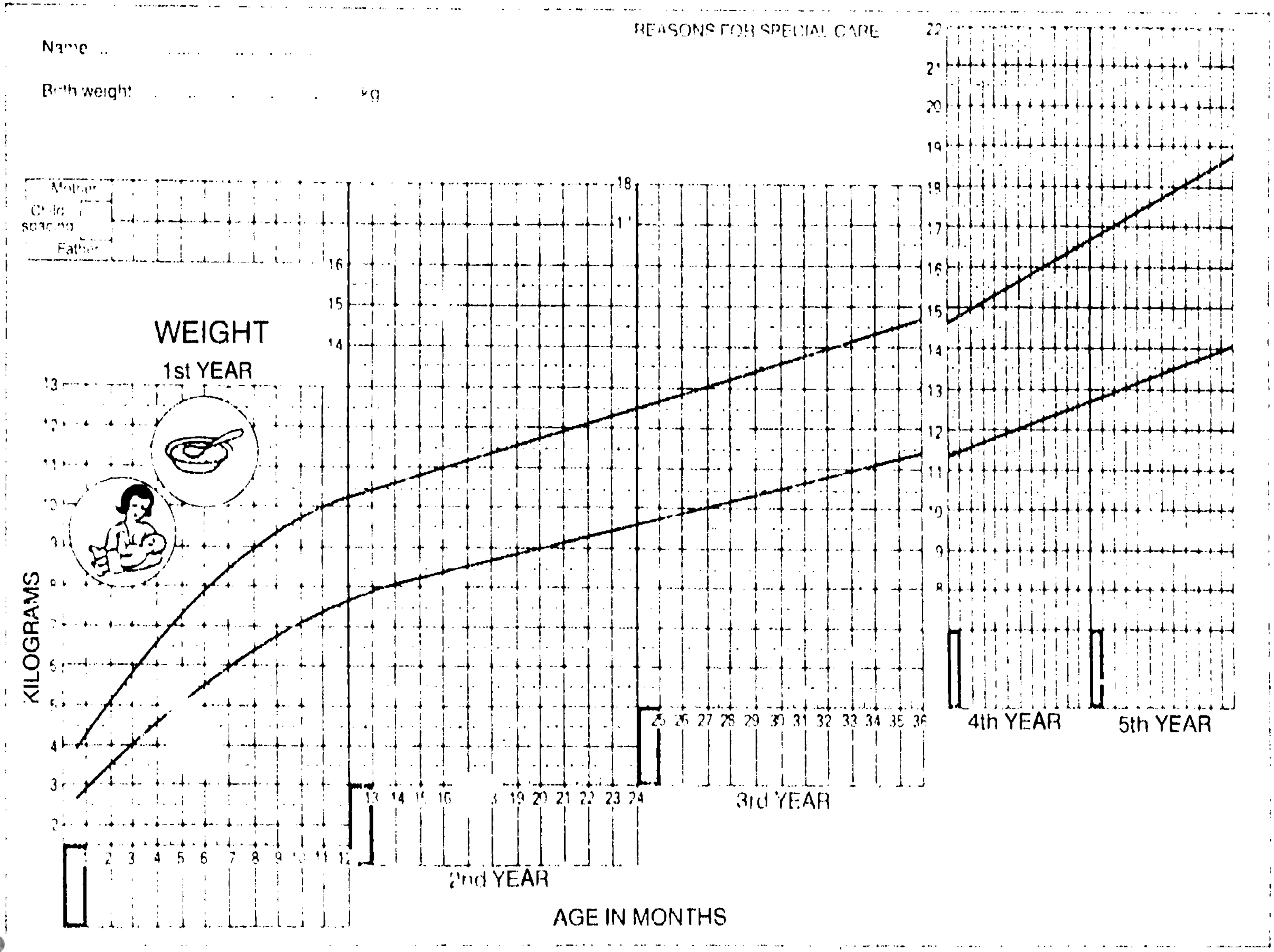

Figure 19 Mean weight-for-age curve of children seen at a health unit consultation in the course of one year

Table 4

DETAIL OF THE DATA SHOWN IN FIGURE 19

Age (months)	Number of measurements	Mean weight (kg)
0	25	2.7
2	32	4.2
4	30	5.3
6	29	6
8	29	6.6
10	34	7.1
12	28	7.6
14	25	8.2
16	22	8.6
18	20	9
20	18	9.2
22	19	9.6
24	20	10

In table 4, age is given to the nearest 2 weeks. Salient features include the low mean birth weight, the "faltering" of the curve at 4 months, the absence of calculation of standard deviations for values at each age.

Another possibility, at the local level, consists of counting the number of individuals located below the cut-off value chosen for a given index, and calculating the percentage: for instance, the number and percentage of children with a birth weight below 2,500 g, or a weight-for-height below the reference median minus 2 standard deviations between the ages of 12 and 24 months, and in other age groups, or with an arm circumference of less than 12.5 cm between ages 1 and 4 years. A double-entry table may also be designed, using the Waterlow classification.

Table 5

PRESENTATION, USING THE WATERLOW CLASSIFICATION OF MEASUREMENTS TAKEN ON 154 6 TO 12 MONTH-OLDS ATTENDING A HEALTH CENTRE (PERCENTAGE AND NUMBER OF CHILDREN)

	W/H ≥ −2 SD*	W/H < −2 SD
H/A ≥ −2 SD	63.6 (1) (98) (2)	6.5 (10)
H/A < −2 SD	26.6 (41)	3.3 (5)

* *NCHS references*

(1) Percentage

(2) Number of children

Care must be taken to avoid hasty generalizations of findings made in specific contexts. Each figure yields a piece of information, and nothing more should be demanded of it.

For example, in a consultation, the percentage of malnourished children (determined using one indicator) is 30 %. There is no reason to conclude that the percentage of malnourished children in the entire region is also 30 %. On the other hand, this definitely indicates the existence of a problem, and the need to take action, in accordance with local resources, to achieve better understanding of it and to improve the situation. Similarly, if only 5 % of children consulting six months later are malnourished, the validity of comparing the two figures should be questioned. Perhaps the indicator used was not the same. Are the latter figures based on a comparable population of children ? Has the agricultural, economic or health situation changed ? Have the children gone elsewhere to consult ?

A critical attitude should always be maintained with respect to the figures found, and these should be interpreted with reference to the overall context in the geographic area involved.

BIOLOGICAL ASSAYS IN THE ASSESSMENT OF NUTRITIONAL STATUS

The value of anthropometry for the assessment of nutritional status is universally recognized. However, it cannot be used for the very early detection of silent or beginning cases of malnutrition. Much research has therefore been undertaken in order to discover biochemical indicators for each type of malnutrition.

Albumin

Plasmatic albumin, a protein with a relatively long half-life - 18 to 20 days - seems to be the best indicator of the body's protein reserves. Its assay is valuable in populations with a protein-deficient diet and a high prevalence of severe protein-energy malnutrition clinically expressed in the form of kwashiorkor. P. Hennart, studying hospitalized and non-hospitalized children in the Kivu region of Zaire, has shown that lower plasmal albumin concentrations correspond to higher risk of death (1).

Similarly, the lower the albumin concentrations in lactating women, the less milk they secrete. In this population, whose dietary staple is tubers, the mean serum albumin concentrations are particularly low, and vary with age between 3.16 plus or minus 0.6 and 3.62 plus or minus 0.5 g/dl.

The concentration of plasmatic proteins is not a good indicator of PEM, since the hyperglobulinaemia connected with infections, which are so frequent in groups suffering from extensive malnutrition, compensates for any decrease in serum albumin.

Other serum proteins with a shorter half-life than albumin and which rapidly reflect insufficient protein and/or caloric intakes have been suggested : the main ones are retinol-binding protein (which carries retinol in the blood), transferrin (the iron-transporting protein), transthyretin (also known as prealbumin) and somatomedin-C (a protein playing a mediating role in the action of the growth hormone).

The concentrations of these different proteins in the blood are considerably influenced by other factors (2). however, such as infections, inflammations, iron deficiency or renal failure. Further,

(1) HENNART Ph. The ongoing evaluation of protein-energy malnutrition. In : Children in the Tropics. Paris, International Children's Centre. 1984, n° 149 150, 96 p.

(2) WADE S., BLEIBERG-DANIEL F. - Intérêt du dosage de la transthyrétine et des protéines de la réaction inflammatoire dans l'évaluation de la malnutrition protéino-énergétique modérée. In : Les carences nutritionnelles dans les PVD. Paris, Karthala ACCT, 1989, pp. 106-113.

studies are still required to determine their actual diagnostic value in children under 5. Also, to be correctly interpreted they must be used in conjunction with other biological assays, and more specifically with the assay of proteins linked with inflammatory reactions (orosomucoid and C-reactive proteins).

However valuable these biological indicators may be, their use must clearly be restricted to surveys within hospitals or covering very limited population samples, both because of their high cost and because of the difficulty in performing these assays and controlling their quality. Their routine use in the framework of nutritional status monitoring is still far beyond reach for the immense majority of health centres, and beyond the competency of most field workers.

CONCLUSION

Monitoring of physical growth, using anthropometry, is the only currently available means of performing ongoing individual and collective assessment of the nutritional status of mothers and children in health centres. Anthropometric measurements, which in themselves are quite approximate with respect to biological development, must be extremely accurate ; this pertains both to measurement-taking itself and to the selection of data and their interpretation. This means that the choice of anthropometric data should depend on the local context, human resources and the feasible types of action.

This paper has dealt essentially with nutritional monitoring. This approach considers the individual aspect of nutritional status, and the data thus collected may be used to guide treatment, dietary counselling and educational action aimed at the milieu. The problems encountered may then be recentred - in the family context, for instance, when a child is involved - so as to understand the reasons for a given problem, and to attempt to improve his or her living conditions. The examination of a series of individual findings may yield a description of the collective situation, making it posible to develop dietary, sanitary and prevention programmes, with the participation of families and various officials.

Nutrition surveys only cover a sample group, which is representative of the population at large, when possible. Their interpretation tends to present an overall profile of a province or a country, on the basis of which collective programmes will be oriented, independently of the peculiarities of certain individuals or families. The shortcoming of the "survey" as a tool is that some families with specific problems may be neglected, since they are masked by the statistical analysis, although their problem may be most relevant to attempts to improve the situation.

Further, in the field of nutrition, the responsibility for budgetary choices, for the type of food consumed, the daily diet and its distribution lies with the family unit rather than with the individual or the community. The nutrition problem is therefore truly a family one : it is at this level that situations should be studied and the phases of monitoring, increasing awareness, education, prevention and action planned.

This does not mean that nutrition surveys should be eliminated from health programmes in general ; no, such surveys may be quite valuable for the in-depth exploration of a specific problem - vitamin A or iron deficiency, for instance - uncovered within a population group in the course of monitoring. These two methods, monitoring and surveys, are complementary.

Monitoring the nutritional status of families is one part of public health programmes, and all of the information yielded by it should be analysed and compared with other findings on morbidity, mortality, programmes on infectious or diarrhoeal diseases, etc. Monitoring of nutrition is a part of primary health care action.

GLOSSARY

Anthropometry — the study of the proportions of the human body, using techniques for the measurement of its different parts.

Cohort — a group of individuals placed under observation at the same time, for a same period of time.

Cross-sectional servey — aims at determining the percentage of a population with a specific characteristic at a given point in time.

Descriptive epidemiology — studies the frequency and distribution of health problems within population groups.

Epidemiological monitoring — the sum of activities involved in the ongoing collection, presentation and analysis of data pertaining to health, as well as the communication of information and the resulting decision-making.

Epidemiology — a science studying the frequency and distribution in time and space of health problems within human population groups, as well as the role of determinant factors.

Longitudinal survey — aims at following the evolution of a phenomenon in the course of time, by observing a cohort.

Mean — measures the central trend of a distribution of values. It is equal to the sum of all measurements, divided by the number of these. Its calculation is illustrated in the reference document (1). In the case of a "normal" distribution, the mean is equal to the median.

Median — value, for a measurement, that divides the distribution into two equal parts. It corresponds to the 50th centile.

Prevalence — frequency of cases or of a disease at a given time, or during a given period.

$$\text{Prevalence} = \frac{\text{Number of cases in the population studied}}{\text{Population studied}}$$

Representative sample — a subdivision of a population of population that accurately reflects the whole.

Sample — a subdivision of a population utilizable for sample surveys.

Standard deviation (SD) — a measure of the scattering of a (SD) distribution of values. It characterizes the degree of variability of measurements with respect to the mean. The greater the standard deviation, the greater the scattering. Its calculation is illustrated in (1) It is equal to the square root of the variance.

(1) *CHAULIAC M . MASSE-RAIMBAULT A.M · Op. cit.*

APPENDIX

ANTHROPOMETRIC REFERENCES (1)

DISTRIBUTION OF VALUES FOR INDICES EXPRESSED AS STANDARD DEVIATIONS

Tables N°	Indices	Sex	Age
1	Weight-for-age	Male	0 - 48 months
2	Weight-for-age	Female	0 - 48 months
3	Length-for-age	Male	0 - 23 months
4	Length-for-age	Female	0 - 23 months
5	Height-for-age	Male	24 - 48 months
6	Height-for-age	Female	24 - 48 months

Tables N°	Indices	Sex	Height
7	Weight-for-length	Male	49 - 90 cm
8	Weight-for-length	Female	49 - 90 cm
9	Weight-for-height	Male	65 - 107 cm
10	Weight-for-height	Female	65 - 107 cm

DISTRIBUTION OF VALUES FOR WEIGHT-FOR-LENGTH AND WEIGHT-FOR-HEIGHT EXPRESSED AS PERCENTAGES OF THE MEDIAN

Tables N°	Indices	Sex	Height
11	Weight-for-length	Male and female	49 - 84.5 cm
12	Weight-for-height	Male and female	85 - 107 cm

(1) Source : National Center for Health Statistics. Center for disease control.

Table 1

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-AGE (KG) IN BOYS AGED 0 TO 48 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+ 1.0 SD	+ 2.0 SD	+ 3.0 SD	Above + 3.0 SD
0.0	0.4	2.0	2.4	2.9	3.3	3.8	4.3	4.8	0.5
1.0	0.7	2.2	2.9	3.6	4.3	5.0	5.6	6.3	0.7
2.0	0.9	2.6	3.5	4.3	5.2	6.0	6.8	7.6	0.8
3.0	1.0	3.1	4.1	5.0	6.0	6.9	7.7	8.6	0.9
4.0	1.0	3.7	4.7	5.7	6.7	7.6	8.5	9.4	0.9
5.0	1.0	4.3	5.3	6.3	7.3	8.2	9.2	10.1	0.9
6.0	1.0	4.9	5.9	6.9	7.8	8.8	9.8	10.8	1.0
7.0	1.0	5.4	6.4	7.4	8.3	9.3	10.3	11.3	1.0
8.0	1.0	5.9	6.9	7.8	8.8	9.8	10.8	11.8	1.0
9.0	1.0	6.3	7.2	8.2	9.2	10.2	11.3	12.3	1.0
10.0	1.0	6.6	7.6	8.6	9.5	10.6	11.7	12.7	1.1
11.0	1.0	6.9	7.9	8.9	9.9	10.9	12.0	13.1	1.1
12.0	1.0	7.1	8.1	9.1	10.2	11.3	12.4	13.5	1.1
13.0	1.0	7.3	8.3	9.4	10.4	11.5	12.7	13.8	1.1
14.0	1.1	7.5	8.5	9.6	10.7	11.8	13.0	14.1	1.2
15.0	1.1	7.6	8.7	9.8	10.9	12.0	13.2	14.4	1.2
16.0	1.1	7.7	8.8	10.0	11.1	12.3	13.5	14.7	1.2
17.0	1.1	7.8	9.0	10.1	11.3	12.5	13.7	14.9	1.2
18.0	1.2	7.9	9.1	10.3	11.5	12.7	13.9	15.2	1.2
19.0	1.2	8.0	9.2	10.5	11.7	12.9	14.1	15.4	1.2
20.0	1.2	8.1	9.4	10.6	11.8	13.1	14.4	15.6	1.3
21.0	1.3	8.3	9.5	10.8	12.0	13.3	14.6	15.8	1.3
22.0	1.3	8.4	9.7	10.9	12.2	13.5	14.8	16.0	1.3
23.0	1.3	8.5	9.8	11.1	12.4	13.7	15.0	16.2	1.3
24.0	1.1	9.0	10.1	11.2	12.3	14.0	15.7	17.4	1.7
25.0	1.2	9.0	10.2	11.4	12.5	14.2	15.9	17.6	1.7
26.0	1.2	9.1	10.3	11.5	12.7	14.4	16.1	17.8	1.7
27.0	1.3	9.1	10.4	11.7	12.9	14.6	16.3	18.0	1.7
28.0	1.3	9.2	10.5	11.8	13.1	14.8	16.6	18.3	1.7
29.0	1.3	9.3	10.6	12.0	13.3	15.1	16.8	18.5	1.7
30.0	1.4	9.4	10.7	12.1	13.5	15.3	17.0	18.7	1.7

Continued

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
31.0	1.4	9.4	10.9	12.3	13.7	15.5	17.2	18.9	1.7
32.0	1.5	9.5	11.0	12.4	13.9	15.7	17.4	19.2	1.8
33.0	1.5	9.6	11.1	12.6	14.1	15.9	17.6	19.4	1.8
34.0	1.5	9.7	11.2	12.7	14.3	16.0	17.8	19.6	1.8
35.0	1.6	9.7	11.3	12.9	14.4	16.2	18.0	19.8	1.8
36.0	1.6	9.8	11.4	13.0	14.6	16.4	18.3	20.1	1.8
37.0	1.6	9.9	11.5	13.2	14.8	16.6	18.5	20.3	1.8
38.0	1.7	10.0	11.7	13.3	15.0	16.8	18.7	20.5	1.8
39.0	1.7	10.1	11.8	13.5	15.2	17.0	18.9	20.7	1.9
40.0	1.7	10.2	11.9	13.6	15.3	17.2	19.1	21.0	1.9
41.0	1.7	10.3	12.0	13.8	15.5	17.4	19.3	21.2	1.9
42.0	1.8	10.4	12.1	13.9	15.7	17.6	19.5	21.4	1.9
43.0	1.8	10.5	12.3	14.1	15.8	17.8	19.7	21.7	1.9
44.0	1.8	10.6	12.4	14.2	16.0	18.0	19.9	21.9	2.0
45.0	1.8	10.7	12.5	14.4	16.2	18.2	20.1	22.1	2.0
46.0	1.9	10.8	12.6	14.5	16.4	18.4	20.4	22.4	2.0
47.0	1.9	10.9	12.8	14.6	16.5	18.6	20.6	22.6	2.0
48.0	1.9	11.0	12.9	14.8	16.7	18.7	20.8	22.8	2.0

Table 2

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-AGE (CM) IN GIRLS AGED 0 TO 48 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
0,0	0.5	1.8	2.2	2.7	3.2	3.6	4.0	4.3	0.4
1.0	0.6	2.2	2.8	3.4	4.0	4.5	5.1	5.6	0.5
2.0	0.7	2.7	3.3	4.0	4.7	5.4	6.1	6.7	0.7
3.0	0.7	3.2	3.9	4.7	5.4	6.2	7.0	7.7	0.8
4.0	0.8	3.7	4.5	5.3	6.0	6.9	7.7	8.6	0.8
5.0	0.8	4.1	5.0	5.8	6.7	7.5	8.4	9.3	0.9
6.0	0.9	4.6	5.5	6.3	7.2	8.1	9.0	10.0	0.9
7.0	0.9	5.0	5.9	6.8	7.7	8.7	9.6	10.5	0.9
8.0	0.9	5.4	6.3	7.2	8.2	9.1	10.1	11.1	1.0
9.0	1.0	5.7	6.6	7.6	8.6	9.6	10.5	11.5	1.0
10.0	1.0	5.9	6.9	7.9	8.9	9.9	10.9	11.9	1.0
11.0	1.0	6.2	7.2	8.2	9.2	10.3	11.3	12.3	1.0
12.0	1.0	6.4	7.4	8.5	9.5	10.6	11.6	12.7	1.0
13.0	1.1	6.6	7.6	8.7	9.8	10.8	11.9	13.0	1.1
14.0	1.1	6.7	7.8	8.9	10.0	11.1	12.2	13.2	1.1
15.0	1.1	6.9	8.0	9.1	10.2	11.3	12.4	13.5	1.1
16.0	1.1	7.0	8.2	9.3	10.4	11.5	12.6	13.7	1.1
17.0	1.2	7.2	8.3	9.5	10.6	11.8	12.9	14.0	1.1
18.0	1.2	7.3	8.5	9.7	10.8	12.0	13.1	14.2	1.1
19.0	1.2	7.5	8.6	9.8	11.0	12.2	13.3	14.5	1.2
20.0	1.2	7.6	8.8	10.0	11.2	12.4	13.5	14.7	1.2
21.0	1.2	7.7	9.0	10.2	11.4	12.6	13.8	15.0	1.2
22.0	1.2	7.9	9.1	10.3	11.5	12.8	14.0	15.2	1.2
23.0	1.2	8.1	9.3	10.5	11.7	13.0	14.2	15.5	1.3
24.0	1.2	8.3	9.4	10.6	11.8	13.2	14.6	16.0	1.4
25.0	1.2	8.4	9.6	10.8	12.0	13.5	14.9	16.4	1.5
26.0	1.2	8.5	9.8	11.0	12.2	13.7	15.2	16.8	1.5
27.0	1.3	8.7	9.9	11.2	12.4	14.0	15.6	17.1	1.6
28.0	1.3	8.8	10.1	11.3	12.6	14.2	15.9	17.5	1.6
29.0	1.3	8.9	10.2	11.5	12.8	14.5	16.1	17.8	1.7
30.0	1.3	9.0	10.3	11.7	13.0	14.7	16.4	18.1	1.7

Continued

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
31.0	1.4	9.1	10.5	11.9	13.2	15.0	16.7	18.5	1.7
32.0	1.4	9.2	10.6	12.0	13.4	15.2	17.0	18.8	1.8
33.0	1.4	9.4	10.8	12.2	13.6	15.4	17.2	19.1	1.8
34.0	1.4	9.5	10.9	12.3	13.8	15.6	17.5	19.4	1.9
35.0	1.5	9.6	11.0	12.5	13.9	15.8	17.8	19.7	1.9
36.0	1.5	9.7	11.2	12.6	14.1	16.1	18.0	20.0	2.0
37.0	1.5	9.8	11.3	12.8	14.3	16.3	18.3	20.2	2.0
38.0	1.5	9.9	11.4	12.9	14.4	16.5	18.5	20.5	2.0
39.0	1.5	10.0	11.5	13.1	14.6	16.7	18.7	20.8	2.1
40.0	1.6	10.1	11.6	13.2	14.8	16.9	19.0	21.1	2.1
41.0	1.6	10.2	11.8	13.3	14.9	17.0	19.2	21.3	2.1
42.0	1.6	10.3	11.9	13.5	15.1	17.2	19.4	21.6	2.2
43.0	1.6	10.4	12.0	13.6	15.2	17.4	19.2	21.8	2.2
44.0	1.6	10.5	12.1	13.7	15.4	17.6	19.8	22.1	2.2
45.0	1.6	10.6	12.2	13.9	15.5	17.8	20.1	22.3	2.3
46.0	1.7	10.7	12.3	14.0	15.7	18.0	20.3	22.6	2.3
47.0	1.7	10.8	12.5	14.1	15.8	18.1	20.5	22.8	2.3
48.0	1.7	10.9	12.6	14.3	16.0	18.3	20.7	23.1	2.4

Table 3

DISTRIBUTION OF STANDARD DEVIATIONS FOR LENGTH-FOR-AGE (CM) IN BOYS AGED 0 TO 23 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
0.0	2.2	43.4	45.5	47.7	49.9	52.0	54.2	56.4	2.2
1.0	2.3	46.7	49.0	51.3	53.5	55.8	58.1	60.4	2.3
2.0	2.4	49.6	52.0	54.4	56.8	59.2	61.6	64.0	2.4
3.0	2.5	52.1	54.6	57.1	59.5	62.0	64.5	67.0	2.5
4.0	2.5	54.3	56.9	59.4	62.0	64.5	67.1	69.6	2.5
5.0	2.6	56.3	58.9	61.5	64.1	66.7	69.3	71.9	2.6
6.0	2.6	58.0	60.6	63.3	65.9	68.6	71.2	73.9	2.6
7.0	2.7	59.5	62.2	64.9	67.6	70.2	72.9	75.6	2.7
8.0	2.7	60.9	63.7	66.4	69.1	71.8	74.5	77.2	2.7
9.0	2.7	62.2	65.0	67.7	70.4	73.2	75.9	78.6	2.7
10.0	2.8	63.5	66.2	69.0	71.8	74.5	77.3	80.1	2.8
11.0	2.8	64.7	67.5	70.3	73.1	75.9	78.7	81.5	2.8
12.0	2.8	65.8	68.6	71.5	74.3	77.1	80.0	82.8	2.8
13.0	2.9	66.9	69.8	72.6	75.5	78.4	81.2	84.1	2.9
14.0	2.9	67.9	70.8	73.7	76.7	79.6	82.5	85.4	2.9
15.0	2.9	68.9	71.9	74.8	77.8	80.7	83.7	86.6	2.9
16.0	3.0	69.9	72.9	75.9	78.9	81.8	84.8	87.8	3.0
17.0	3.0	70.8	73.8	76.9	79.9	82.9	86.0	89.0	3.0
18.0	3.1	71.7	74.8	77.9	80.9	84.0	87.1	90.1	3.1
19.0	3.1	72.6	75.7	78.8	81.9	85.0	88.1	91.2	3.1
20.0	3.1	73.4	76.6	79.7	82.9	86.0	89.2	92.3	3.1
21.0	3.2	74.3	77.4	80.6	83.8	87.0	90.2	93.4	3.2
22.0	3.2	75.1	78.3	81.5	84.7	87.9	91.1	94.4	3.2
23.0	3.2	75.9	79.1	82.4	85.6	88.9	92.1	95.3	3.2

Table 4

DISTRIBUTION OF STANDARD DEVIATIONS FOR LENGTH-FOR-AGE (CM) IN GIRLS AGED 0 TO 23 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
0.0	2.3	43.6	45.9	48.2	50.5	52.8	55.1	57.3	2.3
1.0	2.5	47.2	49.7	52.1	54.6	57.0	59.5	61.9	2.5
2.0	2.6	50.4	52.9	55.5	58.1	60.7	63.2	65.8	2.6
3.0	2.6	53.2	55.8	58.5	61.1	63.7	66.4	69.0	2.6
4.0	2.7	55.6	58.3	61.0	63.7	66.4	69.1	71.7	2.7
5.0	2.7	57.8	60.5	63.2	65.9	68.6	71.3	74.0	2.7
6.0	2.7	59.8	62.4	65.1	67.8	70.5	73.2	75.9	2.7
7.0	2.7	61.5	64.1	66.8	69.5	72.2	74.8	77.5	2.7
8.0	2.7	63.0	65.7	68.3	71.0	73.6	76.3	78.9	2.7
9.0	2.6	64.4	67.0	69.7	72.3	75.0	77.6	80.3	2.6
10.0	2.6	65.7	68.3	71.0	73.6	76.3	78.9	81.6	2.6
11.0	2.7	66.9	69.6	72.2	74.9	77.5	80.2	82.9	2.7
12.0	2.7	68.0	70.7	73.4	76.1	78.8	81.5	84.2	2.7
13.0	2.7	69.0	71.8	74.5	77.2	80.0	82.7	85.4	2.7
14.0	2.8	70.0	72.8	75.6	78.3	81.1	83.9	86.7	2.8
15.0	2.8	70.9	73.7	76.6	79.4	82.3	85.1	87.9	2.8
16.0	2.9	71.7	74.6	77.5	80.4	83.4	86.3	89.2	2.9
17.0	3.0	72.5	75.5	78.5	81.4	84.4	87.4	90.4	3.0
18.0	3.0	73.3	76.3	79.4	82.4	85.4	88.5	91.5	3.0
19.0	3.1	74.0	77.1	80.2	83.3	86.4	89.5	92.6	3.1
20.0	3.2	74.7	77.9	81.1	84.2	87.4	90.6	93.7	3.2
21.0	3.2	75.4	78.7	81.9	85.1	88.4	91.6	94.8	3.2
22.0	3.3	76.1	79.4	82.7	86.0	89.3	92.5	95.8	3.3
23.0	3.3	76.8	80.2	83.5	86.8	90.2	93.5	96.8	3.3

Table 5

DISTRIBUTION OF STANDARD DEVIATIONS FOR HEIGHT-FOR-AGE (CM) IN BOYS AGED 24 TO 48 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD.	Above +3.0 SD
24.0	3.2	76.0	79.2	82.4	85.6	88.8	92.0	95.1	3.2
25.0	3.2	76.7	79.9	83.2	86.4	89.7	92.9	96.2	3.2
26.0	3.3	77.3	80.6	83.9	87.2	90.5	93.8	97.1	3.3
27.0	3.4	78.0	81.3	84.7	88.1	91.4	94.8	98.1	3.4
28.0	3.4	78.6	82.0	85.4	88.9	92.3	95.7	99.1	3.4
29.0	3.5	79.3	82.7	86.2	89.7	93.1	96.6	100.0	3.5
30.0	3.5	79.9	83.4	86.9	90.4	94.0	97.5	101.0	3.5
31.0	3.6	80.5	84.1	87.6	91.2	94.8	98.3	101.9	3.6
32.0	3.6	81.1	84.7	88.3	92.0	95.6	99.2	102.8	3.6
33.0	3.7	81.7	85.4	89.1	92.7	96.4	100.1	103.7	3.7
34.0	3.7	82.3	86.0	89.7	93.5	97.2	100.9	104.6	3.7
35.0	3.8	82.9	86.7	90.4	94.2	98.0	101.7	105.5	3.8
36.0	3.8	83.5	87.3	91.1	94.9	98.7	102.5	106.3	3.8
37.0	3.8	84.1	87.9	91.8	95.6	99.5	103.3	107.2	3.8
38.0	3.9	84.7	88.6	92.4	96.3	100.2	104.1	108.0	3.9
39.0	3.9	85.2	89.2	93.1	97.0	101.0	104.9	108.8	3.9
40.0	4.0	85.8	89.8	93.8	97.7	101.7	105.7	109.6	4.0
41.0	4.0	86.4	90.4	94.4	98.4	102.4	106.4	110.4	4.0
42.0	4.1	86.9	91.0	95.0	99.1	103.1	107.2	111.2	4.1
43.0	4.1	87.5	91.6	95.7	99.7	103.8	107.9	112.0	4.1
44.0	4.1	88.0	92.2	96.3	100.4	104.5	108.6	112.8	4.1
45.0	4.2	88.6	92.7	96.9	101.0	105.2	109.4	113.5	4.2
46.0	4.2	89.1	93.3	97.5	101.7	105.9	110.1	114.3	4.2
47.0	4.2	89.6	93.9	98.1	102.3	106.6	110.8	115.0	4.2
48.0	4.3	90.2	94.4	98.7	102.9	107.2	111.5	115.7	4.3

Table 6

DISTRIBUTION OF STANDARD DEVIATIONS FOR HEIGHT-FOR-AGE (CM) IN GIRLS AGED 24 TO 48 MONTHS

Age (months)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
24.0	3.2	74.8	78.0	81.3	84.5	87.7	90.9	94.2	3.2
25.0	3.3	75.5	78.8	82.1	85.4	88.6	91.9	95.2	3.3
26.0	3.3	76.2	79.6	82.9	86.2	89.5	92.9	96.2	3.3
27.0	3.4	76.9	80.3	83.7	87.0	90.4	93.8	97.2	3.4
28.0	3.4	77.6	81.0	84.4	87.9	91.3	94.7	98.1	3.4
29.0	3.5	78.3	81.7	85.2	88.7	92.1	95.6	99.1	3.5
30.0	3.5	79.0	82.5	86.0	89.5	93.0	96.5	100.0	3.5
31.0	3.5	79.6	83.2	86.7	90.2	93.8	97.3	100.9	3.5
32.0	3.6	80.3	83.8	87.4	91.0	94.6	98.2	101.7	3.6
33.0	3.6	80.9	84.5	88.1	91.7	95.4	99.0	102.6	3.6
34.0	3.6	81.5	85.2	88.8	92.5	96.1	99.8	103.4	3.6
35.0	3.7	82.2	85.8	89.5	93.2	96.9	100.6	104.2	3.7
36.0	3.7	82.8	86.5	90.2	93.9	97.6	101.3	105.1	3.7
37.0	3.7	83.4	87.1	90.9	94.6	98.4	102.1	105.8	3.7
38.0	3.8	84.0	87.7	91.5	95.3	99.1	102.8	106.6	3.8
39.0	3.8	84.6	88.4	92.2	96.0	99.8	103.6	107.4	[illegible]
40.0	3.8	85.1	89.0	92.8	96.6	100.5	104.3	108.1	3.8
41.0	3.9	85.7	89.6	93.4	97.3	101.1	105.0	108.9	3.9
42.0	3.9	86.3	90.2	94.1	97.9	101.8	105.7	109.6	3.9
43.0	3.9	86.8	90.7	94.7	98.6	102.5	106.4	110.3	3.9
44.0	3.9	87.4	91.3	95.3	99.2	103.1	107.1	111.0	3.9
45.0	4.0	87.9	91.9	95.9	99.8	103.8	107.7	111.7	4.0
46.0	4.0	88.5	92.5	96.4	100.4	104.4	108.4	112.4	4.0
47.0	4.0	89.0	93.0	97.0	101.0	105.0	109.1	113.1	4.0
48.0	4.0	89.5	93.5	97.6	101.6	105.7	109.7	113.8	4.0

Table 7

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-LENGTH (KG) IN BOYS MEASURING 49 TO 90 CM

Length (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
49.0	0.3	2.1	2.5	2.8	3.1	3.7	4.2	4.7	0.5
50.0	0.4	2.2	2.5	2.9	3.3	3.8	4.4	4.9	0.5
51.0	0.4	2.2	2.6	3.1	3.5	4.0	4.6	5.1	0.5
52.0	0.5	2.3	2.8	3.2	3.7	4.2	4.8	5.4	0.6
53.0	0.5	2.4	2.9	3.4	3.9	4.5	5.0	5.6	0.6
54.0	0.5	2.6	3.1	3.6	4.1	4.7	5.3	5.9	0.6
55.0	0.5	2.7	3.3	3.8	4.3	5.0	5.6	6.2	0.6
56.0	0.6	2.9	3.5	4.0	4.6	5.2	5.9	6.5	0.6
57.0	0.6	3.1	3.7	4.3	4.8	5.5	6.1	6.8	0.7
58.0	0.6	3.3	3.9	4.5	5.1	5.8	6.4	7.1	0.7
59.0	0.6	3.5	4.1	4.8	5.4	6.1	6.7	7.4	0.7
60.0	0.6	3.7	4.4	5.0	5.7	6.4	7.1	7.8	0.7
61.0	0.7	4.0	4.6	5.3	5.9	6.7	7.4	8.1	0.7
62.0	0.7	4.2	4.9	5.6	6.2	7.0	7.7	8.4	0.7
63.0	0.7	4.5	5.2	5.8	6.5	7.3	8.0	8.8	0.7
64.0	0.7	4.7	5.4	6.1	6.8	7.6	8.3	9.1	0.8
65.0	0.7	5.0	5.7	6.4	7.1	7.9	8.7	9.4	0.8
66.0	0.7	5.3	6.0	6.7	7.4	8.2	9.0	9.8	0.8
67.0	0.7	5.5	6.2	7.0	7.7	8.5	9.3	10.1	0.8
68.0	0.7	5.8	6.5	7.3	8.0	8.8	9.6	10.4	0.8
69.0	0.7	6.0	6.8	7.5	8.3	9.1	9.9	10.7	0.8

Continued

Length (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
70.0	0.8	6.3	7.0	7.8	8.5	9.4	10.2	11.1	0.8
71.0	0.8	6.5	7.3	8.1	8.8	9.7	10.5	11.4	0.9
72.0	0.8	6.8	7.5	8.3	9.1	9.9	10.8	11.7	0.9
73.0	0.8	[illegible].0	7.8	8.6	9.3	10.2	11.1	12.0	0.9
74.0	0.8	7.2	8.0	8.8	9.6	10.5	11.4	12.3	0.9
75.0	0.8	7.4	8.2	9.0	9.8	10.7	11.6	12.5	0.9
76.0	0.8	7.6	8.4	9.2	10.0	11.0	11.9	12.8	0.9
77.0	0.8	7.8	8.6	9.4	10.3	11.2	12.1	13.1	0.9
78.0	0.8	8.0	8.8	9.7	10.5	11.4	12.4	13.3	0.9
79.0	0.8	8.2	9.0	9.9	10.7	11.7	12.6	13.6	1.0
80.0	0.9	8.3	9.2	10.1	10.9	11.9	12.9	13.8	1.0
81.0	0.9	8.5	9.4	10.2	11.1	12.1	13.1	14.1	1.0
82.0	0.9	8.7	9.6	10.4	11.3	12.3	13.3	14.3	1.0
83.0	0.9	8.8	9.7	10.6	11.5	12.5	13.5	14.6	1.0
84.0	0.9	9.0	9.9	10.8	11.7	12.7	13.8	14.8	1.0
85.0	0.9	9.2	10.1	11.0	11.9	13.0	14.0	15.0	1.0
86.0	0.9	9.3	10.3	11.2	12.1	13.2	14.2	15.3	1.0
87.0	0.9	9.5	10.5	11.4	12.3	13.4	14.4	15.5	1.0
88.0	1.0	9.7	10.6	11.6	12.5	13.6	14.7	15.7	1.1
89.0	1.0	9.9	10.8	11.8	12.8	13.8	14.9	16.0	1.1
90.0	1.0	10.0	11.0	12.0	13.0	14.0	15.1	16.2	1.1

Table 8

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-LENGTH (KG) IN GIRLS MEASURING 49 TO 90 CM

Length (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
49.0	0.4	2.2	2.6	2.9	3.3	3.6	4.0	4.3	0.3
50.0	0.4	2.3	2.6	3.0	3.4	3.8	4.2	4.6	0.4
51.0	0.4	2.3	2.7	3.1	3.5	4.0	4.4	4.9	0.4
52.0	0.4	2.4	2.8	3.3	3.7	4.2	4.7	5.1	0.5
53.0	0.5	2.5	3.0	3.4	3.9	4.4	4.9	5.4	0.5
54.0	0.5	2.7	3.1	3.6	4.1	4.6	5.2	5.7	0.5
55.0	0.5	2.8	3.3	3.8	4.3	4.9	5.4	6.0	0.6
56.0	0.5	3.0	3.5	4.0	4.5	5.1	5.7	6.3	0.6
57.0	0.5	3.1	3.7	4.2	4.8	5.4	6.0	6.6	0.6
58.0	0.6	3.3	3.9	4.4	5.0	5.7	6.3	7.0	0.6
59.0	0.6	3.5	4.1	4.7	5.3	5.9	6.6	7.3	0.7
60.0	0.6	3.7	4.3	4.9	5.5	6.2	6.9	7.6	0.7
61.0	0.6	3.9	4.6	5.2	5.8	6.5	7.2	7.9	0.7
62.0	0.7	4.1	4.8	5.4	6.1	6.8	7.5	8.2	0.7
63.0	0.7	4.4	5.0	5.7	6.4	7.1	7.8	8.5	0.7
64.0	0.7	4.6	5.3	6.0	6.7	7.4	8.1	8.9	0.7
65.0	0.7	4.8	5.5	6.3	7.0	7.7	8.4	9.2	0.7
66.0	0.7	5.1	5.8	6.5	7.3	8.0	8.7	9.5	0.7
67.0	0.8	5.3	6.0	6.8	7.5	8.3	9.0	9.8	0.7
68.0	0.8	5.5	6.3	7.1	7.8	8.6	9.3	10.1	0.8
69.0	0.8	5.8	6.5	7.3	8.1	8.9	9.6	10.4	0.8

Continued

Length (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
70.0	0.8	6.0	6.8	7.6	8.4	9.1	9.9	10.7	0.8
71.0	0.8	6.2	7.0	7.8	8.6	9.4	10.2	11.0	0.8
72.0	0.8	6.4	7.2	8.1	8.9	9.7	10.5	11.2	0.8
73.0	0.8	6.6	7.5	8.3	9.1	9.9	10.7	11.5	0.8
74.0	0.8	6.8	7.7	8.5	9.4	10.2	11.0	11.8	0.8
75.0	0.9	7.0	7.9	8.7	9.6	10.4	11.2	12.0	0.8
76.0	0.9	7.2	8.1	8.9	9.8	10.6	11.4	12.3	0.8
77.0	0.9	7.4	8.3	9.2	10.0	10.8	11.7	12.5	0.8
78.0	0.9	7.6	8.5	9.3	10.2	11.1	11.9	12.7	0.8
79.0	0.9	7.8	8.7	9.5	10.4	11.3	12.1	13.0	0.9
80.0	0.9	8.0	8.8	9.7	10.6	11.5	12.3	13.2	0.9
81.0	0.9	8.1	9.0	9.9	10.8	11.7	12.6	13.4	0.9
82.0	0.9	8.3	9.2	10.1	11.0	11.9	12.8	13.7	0.9
83.0	0.9	8.5	9.4	10.3	11.2	12.1	13.0	13.9	0.9
84.0	0.9	8.7	9.6	10.5	11.4	12.3	13.2	14.1	0.9
85.0	0.9	8.8	9.7	10.6	11.6	12.5	13.4	14.3	0.9
86.0	0.9	9.0	9.9	10.8	11.8	12.7	13.6	14.6	0.9
87.0	0.9	9.2	10.1	11.0	11.9	12.9	13.9	14.8	1.0
88.0	0.9	9.4	10.3	11.2	12.2	13.1	14.1	15.0	1.0
89.0	0.9	9.5	10.5	11.4	12.4	13.3	14.3	15.3	[illegible]
90.0	0.9	9.7	10.7	11.6	12.6	13.6	14.5	15.5	[illegible]

Table 9

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-HEIGHT (KG) IN BOYS MEASURING 65 TO 107 CM

Height (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
65.0	1.0	4.5	5.5	6.4	7.4	8.6	9.8	11.1	1.2
66.0	1.0	4.7	5.7	6.7	7.7	8.9	10.1	11.3	1.2
67.0	1.0	5.0	5.9	6.9	7.9	9.1	10.4	11.6	1.2
68.0	1.0	5.2	6.2	7.2	8.2	9.4	10.6	11.9	1.2
69.0	1.0	5.4	6.4	7.4	8.4	9.6	10.9	12.1	1.2
70.0	1.0	5.6	6.6	7.6	8.6	9.9	11.1	12.4	1.2
71.0	1.0	5.8	6.8	7.9	8.9	10.1	11.4	12.6	1.2
72.0	1.0	6.0	7.1	8.1	9.1	10.3	11.6	12.8	1.2
73.0	1.0	6.2	7.3	8.3	9.3	10.6	11.8	13.1	1.3
74.0	1.0	6.5	7.5	8.5	9.5	10.8	12.1	13.3	1.3
75.0	1.0	6.7	7.7	8.7	9.7	11.0	12.3	13.5	1.3
76.0	1.0	6.9	7.9	8.9	10.0	11.2	12.5	13.8	1.3
77.0	1.0	7.1	8.1	9.1	10.2	11.5	12.7	14.0	1.3
78.0	1.0	7.3	8.3	9.3	10.4	11.7	13.0	14.2	1.3
79.0	1.0	7.5	8.5	9.5	10.6	11.9	13.2	14.5	1.3
80.0	1.0	7.7	8.7	9.8	10.8	12.1	13.4	14.7	1.3
81.0	1.0	7.9	8.9	10.0	11.0	12.3	13.6	15.0	1.3
82.0	1.0	8.1	9.1	10.2	11.2	12.5	13.9	15.2	1.3
83.0	1.1	8.3	9.3	10.4	11.4	12.8	14.1	15.4	1.3
84.0	1.1	8.4	9.5	10.6	11.6	13.0	14.3	15.7	1.4
85.0	1.1	8.6	9.7	10.8	11.8	13.2	14.6	15.9	1.4
86.0	1.1	8.8	9.9	11.0	12.0	13.4	14.8	16.2	1.4
87.0	1.1	9.0	10.1	11.2	12.3	13.7	15.1	16.4	1.4
88.0	1.1	9.2	10.3	11.4	12.5	13.9	15.3	16.7	1.4
89.0	1.1	9.3	10.5	11.6	12.7	14.1	15.6	17.0	1.4

Continued

Height (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
90.0	1.1	9.5	10.7	11.8	12.9	14.4	15.8	17.2	1.4
91.0	1.2	9.7	10.8	12.0	13.2	14.6	16.1	17.5	1.5
92.0	1.2	9.9	11.0	12.2	13.4	14.9	16.3	17.8	1.5
93.0	1.2	10.0	11.2	12.4	13.6	15.1	16.6	18.1	1.5
94.0	1.2	10.2	11.4	12.6	13.9	15.4	16.9	18.4	1.5
95.0	1.2	10.4	11.6	12.9	14.1	15.6	17.2	18.7	1.5
96.0	1.3	10.6	11.8	13.1	14.3	15.9	17.5	19.0	1.6
97.0	1.3	10.7	12.0	13.3	14.6	16.2	17.8	19.3	1.6
98.0	1.3	10.9	12.2	13.5	14.9	16.5	18.1	19.6	1.6
99.0	1.3	11.1	12.4	13.8	15.1	16.7	18.4	20.0	1.6
100.0	1.4	11.3	12.7	14.0	15.4	17.0	18.7	20.3	1.6
101.0	1.4	11.5	12.9	14.3	15.6	17.3	19.0	20.7	1.7
102.0	1.4	11.7	13.1	14.5	15.9	17.6	19.3	21.0	1.7
103.0	1.4	11.9	13.3	14.7	16.2	17.9	19.6	21.4	1.7
104.0	1.5	12.1	13.5	15.0	16.5	18.2	20.0	21.7	1.8
105.0	1.5	12.3	13.8	15.3	16.7	18.5	20.3	22.1	1.8
106.0	1.5	12.5	14.0	15.5	17.0	18.9	20.7	22.5	1.8
107.0	1.5	12.7	14.3	15.8	17.3	19.2	21.0	22.9	1.9

Table 10

DISTRIBUTION OF STANDARD DEVIATIONS FOR WEIGHT-FOR-HEIGHT (KG) IN GIRLS MEASURING 65 TO 107 CM

Height (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
65.0	1.0	4.6	5.6	6.5	7.5	8.7	9.9	11.2	1.2
66.0	1.0	4.9	5.8	6.8	7.7	9.0	10.2	11.5	1.2
67.0	1.0	5.1	6.1	7.0	8.0	9.3	10.5	11.8	1.3
68.0	1.0	5.3	6.3	7.3	8.3	9.5	10.8	12.1	1.3
69.0	1.0	5.6	6.6	7.5	8.5	9.8	11.1	12.4	1.3
70.0	1.0	5.8	6.8	7.8	8.8	10.1	11.4	12.7	1.3
71.0	1.0	6.0	7.0	8.0	9.0	10.3	11.6	12.9	1.3
72.0	1.0	6.3	7.2	8.2	9.2	10.6	11.9	13.2	1.3
73.0	1.0	6.5	7.5	8.5	9.5	10.8	12.1	13.5	1.3
74.0	1.0	6.7	7.7	8.7	9.7	11.0	12.4	13.8	1.4
75.0	1.0	6.9	7.9	8.9	9.9	11.3	12.7	14.0	1.4
76.0	1.0	7.1	8.1	9.1	10.1	11.5	12.9	14.3	1.4
77.0	1.0	7.3	8.3	9.3	10.4	11.8	13.2	14.5	1.4
78.0	1.0	7.5	8.5	9.6	10.6	12.0	13.4	14.8	1.4
79.0	1.0	7.7	8.7	9.8	10.8	12.2	13.6	15.1	1.4
80.0	1.0	7.9	8.9	10.0	11.0	12.4	13.9	15.3	1.4
81.0	1.0	8.1	9.2	10.2	11.2	12.7	14.1	15.5	1.4
82.0	1.1	8.3	9.4	10.4	11.5	12.9	14.3	15.8	1.4
83.0	1.1	8.5	9.6	10.6	11.7	13.1	14.6	16.0	1.4
84.0	1.1	8.7	9.7	10.8	11.9	13.3	14.8	16.2	1.5
85.0	1.1	8.9	9.9	11.0	12.1	13.6	15.0	16.5	1.5
86.0	1.1	9.0	10.1	11.2	12.3	13.8	15.3	16.7	1.5
87.0	1.1	9.2	10.3	11.5	12.6	14.0	15.5	16.9	1.5
88.0	1.1	9.4	10.5	11.7	12.8	14.3	15.7	17.2	1.5
89.0	1.1	9.6	10.7	11.9	13.0	14.5	15.9	17.4	1.5

Continued

Height (cm)	Below -3.0 SD	-3.0 SD	-2.0 SD	-1.0 SD	Mean	+1.0 SD	+2.0 SD	+3.0 SD	Above +3.0 SD
90.0	1.2	9.8	10.9	12.1	13.3	14.7	16.2	17.6	1.5
91.0	1.2	9.9	11.1	12.3	13.5	15.0	16.4	17.9	1.5
92.0	1.2	10.1	11.3	12.5	13.7	15.2	16.7	18.1	1.5
93.0	1.2	10.3	11.5	12.8	14.0	15.4	16.9	18.4	1.5
94.0	1.2	10.5	11.7	13.0	14.2	15.7	17.2	18.6	1.5
95.0	1.3	10.7	11.9	13.2	14.5	15.9	17.4	18.9	1.5
96.0	1.3	10.9	12.1	13.4	14.7	16.2	17.7	19.2	1.5
97.0	1.3	11.0	12.4	13.7	15.0	16.5	17.9	19.4	1.5
98.0	1.3	11.2	12.6	13.9	15.2	16.7	18.2	19.7	1.5
99.0	1.4	11.4	12.8	14.1	15.5	17.0	18.5	20.0	1.5
100.0	1.4	11.6	13.0	14.4	15.7	17.3	18.8	20.3	1.5
101.0	1.4	11.8	13.2	14.6	16.0	17.5	19.1	20.6	1.5
102.0	1.4	12.0	13.5	14.9	16.3	17.8	19.4	20.9	1.5
103.0	1.4	12.2	13.7	15.1	16.6	18.1	19.7	21.3	1.6
104.0	1.5	12.5	13.9	15.4	16.9	18.4	20.0	21.6	1.6
105.0	1.5	12.7	14.2	15.6	17.1	18.8	20.4	22.0	1.6
106.0	1.5	12.9	14.4	15.9	17.4	19.1	20.7	22.4	1.6
107.0	1.5	13.1	14.7	16.2	17.7	19.4	21.1	22.7	1.7

Table 11

DISTRIBUTION OF VALUES FOR WEIGHT-FOR-LENGTH AND WEIGHT-FOR-HEIGHT EXPRESSED AS PERCENTAGES OF THE MEDIAN

		Percentage of the median									
Height (cm)	Median (kg)	85 % (kg)	80 % (kg)	75 % (kg)	70 % (kg)	Height (cm)	Median (kg)	85 % (kg)	80 % (kg)	75 % (kg)	70 % (kg)
49.0	3.2	2.7	2.6	2.4	2.3	64.5	6.9	5.9	5.5	5.2	4.8
49.5	3.3	2.8	2.6	2.5	2.3	65.0	7.0	6.0	5.6	5.3	4.9
50.0	3.4	2.9	2.7	2.5	2.4	65.5	7.2	6.1	5.7	5.4	5.0
50.5	3.4	2.9	2.7	2.6	2.4	66.0	7.3	6.2	5.9	5.5	5.1
51.0	3.5	3.0	2.8	2.6	2.5	66.5	7.5	6.4	6.0	5.6	5.2
51.5	3.6	3.1	2.9	2.7	2.5	67.0	7.6	6.5	6.1	5.7	5.3
52.0	3.7	3.1	3.0	2.8	2.6	67.5	7.8	6.6	6.2	5.8	5.4
52.5	3.8	3.2	3.0	2.8	2.6	68.0	7.9	6.7	6.3	5.9	5.5
53.0	3.9	3.3	3.1	2.9	2.7	68.5	8.0	6.8	6.4	6.0	5.6
53.5	4.0	3.4	3.2	3.0	2.8	69.0	8.2	7.0	6.6	6.1	5.7
54.0	4.1	3.5	3.3	3.1	2.9	69.5	8.3	7.1	6.7	6.2	5.8
54.5	4.2	3.6	3.4	3.2	2.9	70.0	8.5	7.2	6.8	6.3	5.9
55.0	4.3	3.7	3.5	3.2	3.0	70.5	8.6	7.3	6.9	6.4	6.0
55.5	4.4	3.8	3.5	3.3	3.1	71.0	8.7	7.4	7.0	6.5	6.1
56.0	4.6	3.9	3.6	3.4	3.2	71.5	8.9	7.5	7.1	6.6	6.2
56.5	4.7	4.0	3.7	3.5	3.3	72.0	9.0	7.6	7.2	6.7	6.3
57.0	4.8	4.1	3.8	3.6	3.4	72.5	9.1	7.7	7.3	6.8	6.4
57.5	4.9	4.2	3.9	3.7	3.4	73.0	9.2	7.9	7.4	6.9	6.5
58.0	5.1	4.3	4.0	3.8	3.5	73.5	9.4	8.0	7.5	7.0	6.5
58.5	5.2	4.4	4.2	3.9	3.6	74.0	9.5	8.1	7.6	7.1	6.6
59.0	5.3	4.5	4.3	4.0	3.7	74.5	9.6	8.2	7.7	7.2	6.7
59.5	5.5	4.6	4.4	4.1	3.8	75.0	9.7	8.2	7.8	7.3	6.8
60.0	5.6	4.8	4.5	4.2	3.9	75.5	9.8	8.3	7.9	7.4	6.9
60.5	5.7	4.9	4.6	4.3	4.0	76.0	9.9	8.4	7.9	7.4	6.9
61.0	5.9	5.0	4.7	4.4	4.1	76.5	10.0	8.5	8.0	7.5	7.0
61.5	6.0	5.1	4.8	4.5	4.2	77.0	10.1	8.6	8.1	7.6	7.1
62.0	6.2	5.2	4.9	4.6	4.3	77.5	10.2	8.7	8.2	7.7	7.2
62.5	6.8	5.4	5.0	4.7	4.4	78.0	10.4	8.8	8.3	7.8	7.2
63.0	6.5	5.5	5.2	4.8	4.5	78.5	10.5	8.9	8.4	7.8	7.3
63.5	6.6	5.6	5.3	5.0	4.6	79.0	10.6	9.0	8.4	7.9	7.4
64.0	6.7	5.7	5.4	5.1	4.7	79.5	10.7	9.1	8.5	8.0	7.5

Table 12

Percentage of the median											
Height (cm)	Median (kg)	85 % (kg)	80 % (kg)	75 % (kg)	70 % (kg)	Height (cm)	Median (kg)	85 % (kg)	80 % (kg)	75 % (kg)	70 % (kg)
80.0	10.8	9.1	8.6	8.1	7.5	94.0	14.0	11.9	11.2	10.5	9.8
80.5	10.9	9.2	8.7	8.1	7.6	94.5	14.2	12.0	11.3	10.6	9.9
81.0	11.0	9.3	8.8	8.2	7.7	95.0	14.3	12.1	11.4	10.7	10.0
81.5	11.1	9.4	8.8	8.3	7.7	95.5	14.4	12.2	11.5	10.8	10.1
82.0	11.2	9.5	8.9	8.4	7.8	96.0	14.5	12.4	11.6	10.9	10.2
82.5	11.3	9.6	9.0	8.4	7.9	96.5	14.7	12.5	11.7	11.0	10.3
83.0	11.4	9.6	9.1	8.5	7.9	97.0	14.8	12.6	11.8	11.1	10.3
83.5	11.5	9.7	9.2	8.6	8.0	97.5	14.9	12.7	11.9	11.2	10.4
84.0	11.5	9.8	9.2	8.7	8.1	98.0	15.0	12 8	12.0	11.3	10.5
84.5	11.6	9.9	9.3	8.7	8.2	98.5	15.2	12.9	12.1	11.4	10.6
85.0	12.0	10.2	9.6	9.0	8.4	99.0	15.3	13.0	12.2	11.5	10.7
85.5	12.1	10.3	9.7	9.1	8.5	99.5	15.4	13.1	12.3	11.6	10.8
86.0	12.2	10.4	9.8	9.1	8.5	100.0	15.6	13.2	12.4	11.7	10.9
86.5	12.3	10.5	9.8	9.2	8.6	100.5	15.7	13.3	12.6	11.8	11.0
87.0	12.4	10.6	9.9	9.3	8.7	101.0	15.8	13.5	12.7	11.9	11.1
87.5	12.5	10.6	10.0	9.4	8.8	101.5	16.0	13.6	12.8	12.0	11.2
88.0	12.6	10.7	10.1	9.5	8.8	102.0	16.1	13.7	12.9	12.1	11.3
88.5	12.8	10.8	10.2	9.6	8.9	102.5	16.2	13.8	13.0	12.2	11.4
89.0	12.9	10.9	10.3	9.7	9.0	103.0	16.4	13.9	13.1	12.3	11.5
89.5	13.0	11.0	10.4	9.7	9.1	103.5	16.5	14.0	13.2	12.4	11.6
90.0	13.1	11.1	10.5	9.8	9.2	104.0	16.7	14.2	13.3	12.5	11.7
90.5	13.2	11.2	10.6	9.9	9.2	104.5	16.8	14.3	13.4	12.6	11.8
91.0	13.3	11.3	10.7	10.0	9.3	105.0	16.9	14.4	13.6	12.7	11.9
91.5	13.4	11.4	10.8	10.1	9.4	105.5	17.1	14.5	13.7	12.8	12.0
92.0	13.6	11.5	10.8	10.2	9.5	106.0	17.2	14.6	13.8	12.9	12.1
92.5	13.7	11.6	10.9	10.3	9.6	106.5	17.4	14.8	13.9	13.0	12.2
93.0	13.8	11.7	11.0	10.3	9.7	107.0	17.5	14.9	14.0	13.1	12.3
93.5	13.9	11.8	11.1	10.4	9.7						

Note : children measuring over 85 cm who are too ill to remain standing may be measured lying down, but 1 cm should then be substracted from their height before using this table.

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NUTRITIONAL STATUS : THE INTERPRETATION OF INDICATORS

1989 - N 181 - 182

In primary health care programmes, one approach is still underdeveloped, although it is an excellent source of information : this is the knowledge of the nutritional status of families, or at least of at-risk groups, so as to better adjust treatment to each individual, and to guide preventive action at the family and community level, to evaluate nutrition programmes and provide the information needed for planning in the field of food policy.

This approach involves the use of judiciously selected indicators or indices, each measuring a specific phenomenon and yielding a well-defined piece of knowledge. In the interpretation of the findings, certain rules must be applied if the exact signification of each tool or measurement is to be respected.

Periodical longitudinal monitoring of the nutritional status of families, extended to the in-depth interpretation of qualitative and quantitative findings is needed for the early detection of malnutrition, the regular observation of the evolution of the nutritional situation in each region over the years, and the gradual development of interventions aimed at improving living conditions through action in the many sectors involved, including food and agriculture, health, economics, education, etc.