Measuring and managing Protein Energy Malnutrition in Rural Communities

1 Measurements to detect PEM

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Summary

Nutritional deficiency diseases constitute a major proportion of ailments seen in the practice of medicine in developing countries.

In 1979 at the Gelukspan Community Hospital, three leading causes of child mortality were found. The most important causes were malnutrition (40%), gastro-enteritis (30%) and chest infections (15%) for children who died in the hospital. It was noticed that the majority of the children who died of gastro-enteritis or chest infections were underweight. In this study the following subjects will be discussed in six articles:

(1) anthropometric measurements to detect protein energy malnutrition (P.E.M.)
(2) possible factors contributing to the development of P.E.M.
(3) results of a nutrition survey in the Gelukspan district in 1980.
(4) intervention programmes
(5) results after 18 months intervention programme in Gelukspan district (1982)
(6) follow-up of 998 children with P.E.M.

Suggestions will be made regarding the improvement of nutritional status of pre-school children.

Severe malnutrition manifests itself by clinical signs, but because of absence of clinical signs, mild or moderate malnutrition can be easily overlooked. In children mild, moderate or severe Protein-energy Malnutrition can be assessed by relatively simple anthropometric measurements.

Strictly speaking, anthropometry does not only assess P.E.M. Genetic and disease factors, that are not yet quantifiable are additional influences on growth and body composition[26]. However, it has been suggested that environmental influences, especially nutrition, are of greater importance with regard to growth body mass and body composition than genetic background or other biological factors[22].

The most commonly used measurements for nutritional assessment are weight, height, skin fold thickness, chest, arm and head circumference. The measurement of the skin fold thickness needs a lot of experience. Therefore it is left out of the measurements used in this study. The advantages and disadvantages of the measurements used in this study and the actual significance of these measurements will be discussed below:

Weight

Weight is quickly influenced by dietary change or diseases and it can be lost or regained over a reasonably short period of time. Consequently weight for age is a very useful index in following the growth and development of a child. If it is used in a cross sectional study, it has to be compared with the weight of a normal child of the same age.

A deficit in weight for age may be indicative of either chronic or acute malnutrition [30] but one cannot decide on this, unless the height of the child has been taken into account.

The small size or stunting of a child, due to past chronic malnutrition, may be the cause of a present low weight for age. There may even be a difference in height between the whole population surveyed and the reference population. Weight for age can thus overestimate actual malnutrition by including children that are usually small for their age.

Another disadvantage of weight for age is the fact that in severely malnourished children oedema may partly compensate for weight deficit [26]. If one doesn't include the clinical signs in assessing the nutritional status of a child, these severe cases of malnutrition will not be classified as such by this index.

In a child that is underweight for age a single measurement of weight for age does not make clear whether the child has been malnourished in the past and is now on a satisfactory diet or not. Only serial measurements can shed light on whether the dietary intake is sufficient or not.

It can be concluded that the value of weight for age as an index in assessing malnutrition should not be overestimated. The distribution of weight for age of the whole population may be compared to the distribution of the standard population. The difference between these distributions can be an indication of the nutritional status of the whole population.

Height

Height is a more stable growth parameter than weight. The reasons for this are: one cannot lose height; it needs a rather long period of dietary deficiency before height growth is significantly retarded [52].

Thus, height for age is an index of the nutritional history of a child. Low height for age in a child is called 'stunting'. A stunted child has a height that is low in comparison with the height of a normal healthy child of the same age. Using height alone as an indicator of malnutrition has some disadvantages:

- In children a low height for age can indicate chronic malnutrition but it does not provide any indication of the present dietary intake of the child [52].
- Height deficit may not be manifest in infants, because it takes some time to develop;
- A low height in infants or young children may be the consequence of

small size at birth rather than an indication of postnatal malnutrition;

- The possibility of ethnic differences in height cannot be excluded [26].

Weight for height

This index indicates the degree of thinness or fatness of the child in relation to his height [52]. Weight for height measurements provide a picture of the current nutritional status of the child.

Weight deficit for height is called "wasting". A wasted child has a weight that is low in comparison with the weight of a normal healthy child of the same height.

This index has three major advantages:

- The age of the child need not to be known;
- This index is relatively independent of sex or race up to about the age of ten years;
- In young children weight for height remains quite constant under most conditions, except during periods of acute undernutrition and overnutrition[30] or illness.

A disadvantage of using this index alone is the fact that it does not separate normal healthy children from children who have had past malnutrition or chronic malnutrition and who may have retarded growth both in length and weight [52].

As for weight, height and age, "weight for height" in combination with "height for age" seems to give the most useful information about the nutritional status of a particular child. A child with low weight for height (wasted) but normal height for age may be suffering from present malnutrition. Low weight for height (wasted) and low height for age (stunted) indicate past, chronic and present malnutrition.

In this case the possibility of ethnic and non-nutritional growth limitations should be excluded. Normal weight for height, but low height for age (stunted) may also be due to earlier non-nutritional influences and/or to previous prenatal or postnatal malnutrition[26].

TABLE I - 1		PAST CHRONIC	MALNUTRITION PRESENT
Wasted	Not stunted		X
Not wasted	stunted	X	
Wasted	stunted	X	X

Chest Circumference

Measurements of the chest circumference are generally combined with measurements of the head circumference. The chest head circumference ratio is used as an indicator of P.E.M. of early childhood.

The concepts of some authors about the value of the chest head circumference ratio are rather different.

Jellife (1966) states that: "At six months of age, the circumference of the head and the chest are about the same. After this, the skull grows slowly and the chest more rapdily. Therefore, between the ages of six months and five years, a chest head circumference ratio of less than one may be due to failure to develop or to wasting of the muscle and fat of the chest wall, and can be used as community indicator of PEM of early childhood."

Keller c.s. (1976) found that there are insufficient data to justify the general use of the chest head circumference ratio as an index for P.E.M.

Head Circumference

Head circumference is related mainly to brain size and - to a small extent - to the thickness of the scalp tissues and the skull. Brain size increases rapidly during the first year, when head circumference normally reflects age rather than health or nutrition.

However, brain size and both the thickness of scalp soft tissues and the skull can vary with nutritional status, so that head circumference is slightly affected in the second year of life in P.E.M. although much less so than chest circumference [22].

Variations in skull appearance may be due to ethnic differences, to some diseases like sickle-cell anaemia and rickets, and to bossing.

Bossing may have a nutritional cause -lack of vitamin D - but it can also occur in children of African ancestry with sickle-cell anaemia and appears to be recognized by some committees as a possible familial characteristic. Cultural practices in infancy, like the head-binding of certain South American Indians, may also affect the head circumference [22].

Nelhaus (1968) made composite head circumference graphs for children. These are applicable regardless of skin-colour, race, nationality or geographic location. Improved child nutrition and other social and sanitary measures which accelerated body growth in recent years, did not affect head growth [43].

What in fact is measured by the chest and head circumference is made clear by **Seoane and Latham (1971)**. They found stronger correlation co-efficients of head and chest circumference measurements with height for age than with weight for age. This indicates that both head and chest growth are more likely to be effected by chronic long term malnutrition than by acute malnutrition.

Arm Circumference

From birth to one year the arm circumference rises steeply. From that age until five years the arm circumference of a healthy child grows only about one centimetre [28]. So from one until five years this index is relatively age-independant.

The arm circumference seems to correlate very strongly with the calculated muscle circumference as well as with weight for age [22]. Even if the lower arm of a malnourished child with kwashiorkor is swollen with fluid, the muscles of his upper arm will be thin and he will have a small arm circumference [28]. Therefore the arm circumference serves as a general anthropometric index of P.E.M.

The use of this measure has the following disadvantages:

- One needs a certain level of skill to measure accurately;
- It has insufficient inter- and intra-observer repeatability;
- It is not a sensitive indicator of recent changes in nutritional status [26].
- It gives the same information as weight for height, since a thin person tends to have a thin arm, but it is less sensitive and accurate. This is partly because the arm circumference is a linear measurement, whereas weight is a cubic one, and partly because the error in measurement is likely to be greater [63].

Anderson (1979) found in a study in five developing countries among children from one to five years old that the arm circumference showed the strongest positive correlation with weight. Arm circumference showed an equally strong positive correlation with both weight for age and weight for height.

She also reports that the arm circumference is a useful measurement in populations with high rates of severe malnutrition and stunting [1]. **Keller c.s. (1976)** came to the opposite conclusion for a less well-nourished population [26].

Standards of Reference

To assess the nutritional status of a child the anthropometric measures of that particular child are compared with those of a normal, healthy child of the same age of the same height.

On this point three main problems arise:

- Which anthropometric measurements give the most realistic view of the nutritional status of a child?

  – As mentioned before, concerning weight and height, weight- for- height together with height- for- age gives a far more realistic assessment of the prevalence of malnutrition than does weight- for- age.

- Are the standards drawn upon European or North American populations applicable to groups in developing countries; do the children in developing countries have the potential to reach these international standards if they are fed on an appropriate diet?

  – The general opinion is that the standards reached by affluent white North American children are applicable to all groups, as, when non-white children are placed in ideal nutritional surroundings they reach their growth potential and are comparable to Harvard standards [46]. The possibility of true ethnic (genetic) differences cannot be completely ruled out at present. So if international standards are used, caution in the interpretation of comparative data should be taken [26].

- Is it realistic for developing countries to use international i.e. European or North American standards, is it within reach of developing countries to spend enough money, manpower and effort etc. to institute programmes aimed at bringing the children up to the range of the international standards?

  – Local anthropometric standards should be prepared and used wherever possible, because they may often be considered a more realistic goal in respect of money and manpower available. The data for making them are however very difficult to collect. To make a local standard, a lot of measurements have to be made among the healthy, well-fed section of the community. As the best alternative, at present, international standards of reference should be employed, for they supply a yardstick with which results from surveys at different times and places can be compared. While they may be locally relevant as a goal, they are more usually valuable as a standard of reference [22].

Cut-off points

Choice of cut-off points divide "wellnourished" from "malnourished" children. They also depend on the purpose of the study. Is the aim of the study just to assess the nutritional status of the population surveyed? Or is the main aim of the study to collect figures that serve as a guide for action to improve the nutritional status of the malnourished children or the children at risk? Secondly, the choice of cut-offs points depends on the money, manpower and effort that can be spent on this subject.

Weight for age

To assess the extent of malnutrition in a community, Gomes classification of children with weight deficit may be used; the malnourished are those who are below 75% of the expected, or standard, weight- for- age; severely malnourished those below 60%. This classification is based on the **Harvard (Boston)** growth standards.

Jellife set the cut-off point for detecting malnutrition somewhat higher than that of Gomes - on or below 80% of the standard weight- for- age. This point is approximately the same as the third percentile of the Harvard standard, which in turn is the same as two standard deviations below the mean. The term "below the third percentile" became widely used to indicate which children were considered malnourished [49].

It is important to realize that for the reference population (Harvard), 3% of the population has a weight for age lower than 80% of the standard weight for age, but this is certainly not the case for every population. The mean of a particular population can even be lower than the third percentile of the Harvard standard [57].

Height for age

The generally accepted cut-off point for height- for- age in assessing malnutrition is 90% of the mean height- for- age of the Harvard standard [22, 26, 49].

Weight for height

On the basis of clinical observations the cut-off point usually recommended is 80% of the mean weight of the Harvard standard [26].

Arm circumference

In her study of comparison of anthropometric measures, **Anderson (1979)** started by using the cut-off points proposed by Shakit and Morley for diagnosing malnutrition; 12,5 cm to detect malnutrition and 13,5 cm to detect mild malnutrition. However, on the basis of her findings, Anderson suggested 13,5 cm as a cut-off point to detect severe malnutrition [1]. **King (1979)** regards a mid upperarm cicumference of less than 14 cm as an indication of malnutrition [28].

The measurement of the mid upperarm circumference is only useful as a parameter in children between 12 and 60 months [22].

Chest head circumference ratio

Jellife (1966) recommended a ratio lower than one in children between 6 and 60 months as an indicator of P.E.M. [22]. Recently however, he said that this parameter is of little value nowadays because it is not accurate enough. *(personal communication 1982).*

Mortality rates

Newborn (first 28 days of life).

During the neonatal period (0 - 27 days), the principle causes of death are stated to be low birthweight and tetanus. Other causes of death are birth injury from unskilled midwifery, prematurity and congenital abnormalities [23].

TABLE 1 - 2

Age-specific Mortality Rates of different groups in the RSA (1970). (Deaths per 1,000 population).

	AGE IN YEARS		
	1	1 - 4	5 - 14
Blacks	135,8	15,6	1,4
Coloureds	139,4	14,7	1,2
Asians	41,4	3,6	0,8
Whites	22,7	1,1	0,5

(from Wyndham, C H and Irwig, L M, 1979).

Infants (1st year of life).

The infant mortality rate is usually high in developing countries. In Europe and North America it is below 40 per thousands babies born alive. In tropical regions, it is often between 75 and 500 per thousand, although it is difficult to measure accurately when births and deaths are not registered. In the tropics, causes of death in infancy include respiratory tract infection (especially pneumonia), diarrhoea and nutritional marasmus [23].

Richardson states that a falling infant mortality rate is regarded as an indication of improving health measures [47].

Pre-school child (1 - 4 years).

There is a high death rate in this age group, largely from diseases which are preventable. Very frequently pre-school age children suffer from several conditions at once.

The most important diseases in this age-group in the tropics are P.E.M. (especially kwashiorkor), diarrhoea, pneumonia, malaria, intestinal worms, tuberculosis, anaemia, measles, whooping cough and accidents [23]. This vulnerable period is normally characterized by rapid growth and high nutritional needs.

In most developing countries the principle factor that causes a high mortality rate during the 1-4 year period is P.E.M. [22]. Therefore the 1-4 year mortality rate can be a useful index of malnutrition. Generally the 1-4 year death rate is regarded as a more accurate public health index, especially in relation to malnutrition, than infant mortality rate [47].

Depending upon such factors as the age of weaning and other infant feeding practices, the mortality rate of another age-group may yield useful information about the influence of malnutrition on mortality. In many countries it is in the second year that the child experiences the transitional dietary period. This is the period in which higher protein demands develop [22]. Generally then, the 1 to 2 years death rate is recommended as an even more sensitive index of the nutritional status of the population [19].

Richardson (1970) studied the mortality rates from birth to five years in South African black and Caucasian population. She found that in the 1 to 4 years period (1 year up to 4 years and 11 months) the great majority of deaths (50 - 70%) occurs at age 1-2 years (12 up to 35 months). Based on the results of her study it may be concluded that the rate at age 1-2 years and 11 months may even be a better indicator of the public health state[47].

References will be supplied at the end of the series

TABLE I - 3

THE INFANT MORTALITY RATES FOR SOME SOUTH AFRICAN CITIES AND TOWNS

CENTRE	YEAR	INFANT MORTALITY RATE WHITE	BLACK
PRETORIA	1971	21,5	189,0
	1973	21,8	151,3
	1974	19,8	123,0
	1975	16,6	96,8
	1976	13,9	100,3
	1977	14,1	92,1
	1978	12,1	92,2
	1979	19,7	192,0
PIETERMARITZBURG	1971	19,5	58,7
	1972	18,3	65,3
	1978	18,3	38,9
	1979	7,6	41,2
DURBAN	1976	18,2	67,9
	1977	22,8	62,2
	1979	12,0	56,44
BRAKPAN	1979	27,4	93,6
	1981	18,79	61,55
BENONI	1978	5,9	69,0
	1979	4,0	51,7
	1980	6,5	60,2
BLOEMFONTEIN	1979	12,	102,3
	1980	11,36	75,78
VEREENIGING	1979	19,81	129,84
	1980	14,3	100,51
JOHANNESBURG	1973	18,1	54,3
	1974	16,6	62,8
	1975	21,2	53,0
	1976	21,8	42,8
	1977	16,8	41,2
	1979	16,7	34,8
SPRINGS	1974	12,8	51,1
	1975	9,7	74,9
	1976	13,9	76,2
	1977	14,5	75,6
	1978	10,2	98,0
	1979	12,5	126,8
	1980	16,6	92,3
CAPE TOWN	1976	10,4	79,0
	1977	8,3	66,4
	1978	13,0	47,3
	1979	10,4	34,0
	1980	12,8	38,2
EAST LONDON	1979	11,83	43,68
	1980	13,19	40,91