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# Protein malnutrition: Correlation between Anthropometric and Biochemical Assessment

By

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Three hundred and eighty-six children aged 12—59 months, suffering from protein-calorie malnutrition were studied. Middle arm circumference and triceps skin-fold measurements were taken and from these values, middle arm muscular circumference was calculated. Simultaneously, the serum amino-acid balance was determined.

The same measurements were carried out in 132 healthy control children of the same age group. These showed that middle arm muscular circumference does not change within the age groups studied, and with its value the amino-acid balance showed an inverse correlation.

It is concluded that the severity of protein imbalance in malnutrition can be estimated on the basis of both middle arm muscular circumference and amino-acid balance. In view of its simple technique the former parameter is given preference.

## Introduction

Anthropometric measurements are of a considerable diagnostic value in protein-calorie malnutrition; weight, height, and head and middle arm circumference being the parameters most frequently employed [9, 12, 20, 23, 24, 26, 29].

In severe forms of the condition, diagnosis is easy on the basis of clinical signs and two distinct forms of the disease, marasmus and kwashiorkor, can be identified [25, 26].

There is, however, an important number of undernourished children displaying a subclinical form of the condition or exhibiting an intermediate pattern between the two extreme forms. In this case, diagnosis is difficult, especially if the degree of the impairment of protein balance has to be assessed [26]. Although the common denominator is a protein deficiency, variations in the proportion of carbohydrate in the diet and the association of several deficiencies and/or infections may modify not only the clinical picture, but also some biochemical parameters [23, 61].

The most significant anthropometric characteristic of calorie deficieny is the decrease of subcutaneous fat, and of protein imbalance, the decrease of muscular mass [11, 14, 17, 20, 27, 31, 49, 55]. The first parameter is estimated by triceps, biceps, subscapular or abdominal skin-fold measurements [15, 25, 39], and the second, by calculating middle arm

muscular circumference from middle arm circumference and triceps skin-fold [25].

Of the biochemical data employed for the assessment of protein malnutrition, the most common are the values for total serum protein [6, 19, 25, 35, 36, 38, 45, 57, 62]; serum albumin [7, 10, 25, 37, 45]; the albumin x alpha globulin product [4, 38]; the creatinine/height index [54, 55]; serum prealbumin [22], transferrin [5, 30], and amino-acid balance. Amino-acid balance has widely been employed with diverse and sometimes contradictory results [3, 17, 21, 32, 40, 44, 59, 61]. In fact, the same is valid for every biochemical value since in itself none of them has proved reliable enough for the assessment of the degree of protein-calorie malnutrition [41, 46].

On the other hand, the possibilities of anthropometric measurements for the said purpose and their relationship to biochemical parameters have not been investigated satisfactorily. A study has therefore been made to clarify these problems; preliminary results of this work have already been presented [52].

## Material and Methods

Three hundred and eighty-six children aged 12—59 months, admitted with protein-calorie malnutrition in the period 1970 to 1973, were studied. The diagnosis was based upon weight deficit for chronological age and real height.

The criterion of malnutrition was a ratio real weight/ideal weight of 90% or less, and a weight for height ratio of 90% or less, using as reference Stuart and Stevenson's weight and height standards [49].

For each patient, middle arm circumference and triceps skin-fold measurements were taken immediately after admission according to Jelliffe's prescription [25], by means of nonstretching fibre-glass tape and a Harpenden skin-fold caliper. Middle arm muscular circumference (MAMC) was calculated by the formula,

$$[\text{MAMC} = \text{MAC} - \pi S \text{ (25]},$$

where MAC = midle arm circumference; $\pi = 3.14$; and S = triceps skin-fold in cm.

From each child, a venous blood sample was obtained simultaneously, and after clotting the serum was separated by centrifugation. Amino-acid balance was determined according to Whitehead's technique [58] with some modification [2].

MAMC and amino-acid balance values obtained for each patient were correlated, and the former was considered a dependent variable.

The same anthropometric measurements were carried out in 132 healthy children of the same age group who served as controls. They were divided into four sub-groups according to age as follows: 12—23 months; 24—35 months; 36—47 months; and 48—59 months. Mean values and standard deviations for each sub-group were calculated and a test of comparison of the means was carried out [47].

## Results

Table I shows MAMC values obtained in the group of 132 well-nourished control children. Comparison of values showed no differences among the four sub-groups, so it was concluded that the MAMC value does not change significantly between 12 and 59 months of age. Thus, the sample of malnourished children of the same

age group could be considered homogeneous.

Mean MAMC in the group of 386 malnourished children was 10.8 ± ± 1.28 while in the control group, 13.2 ± 0.46. The difference was highly significant statistically ($t = 3.5340$; $p < 0.001$).

MAMC and amino-acid balance displayed an inverse correlation. The correlation coefficient r was −0.486 ($p < 0.001$) (Fig. 1).

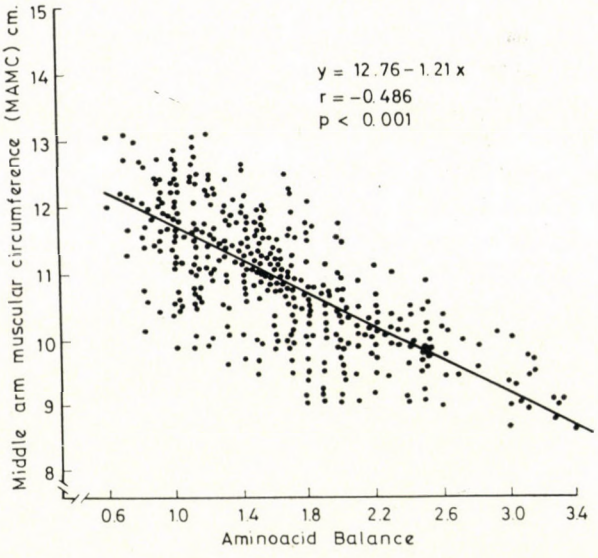


FIG. 1

TABLE 1

Comparison of mean values for middle arm muscular circumference in 132 well-nourished preschool children

| Age group (months) | N | X ± 1SD | Age groups (months) | | |
|---|---|---|---|---|---|
| | | | 48—59 | 36—47 | 24—35 |
| 12—23 | 33 | 12.7±0.22 | t = 0.7087 | t = 1.0440 | t = 1.0971 |
| | | | p > 0.10 | p > 0.10 | p > 0.10 |
| 24—35 | 34 | 13.3±0.32 | t = 0.2021 | t = 0.1506 | |
| | | | p > 0.40 | p > 0.40 | |
| 36—47 | 33 | 13.5±0.28 | t = 0.3663 | | |
| | | | p > 0.47 | | |
| 48—59 | 32 | 13.6±0.31 | | | |
| Total | 132 | 13.2±0.46 | | | |

## Discussion

Almost everyone who deals with malnutrition agrees in that a complete nutritional assessment ought to be the resultant of a comparison of different parameters [9] to allow a reliable diagnosis and a better appraisal of the nutritional status.

Loss of body muscular mass in protein-calorie malnutrition is considered a precise expression of the severity of protein imbalance [14, 17, 20, 23, 31, 34, 48, 50, 55, 56]. Information concerning the status of muscular mass is easy to obtain by the estimation of MAMC on the basis of MAC and triceps skin-fold. This method gives approximate figures only because MAC and MAMC are not exactly concentrical, but its simplicity is a practical advantage if we consider the complexity of the other procedures, neither of which is much more reliable [25].

Although MAC is also considered a fairly dependable index of the muscular mass [12, 28, 29], its decrease may be due to an exclusive loss of subcutaneous fat, more or less severe. We have, therefore, given preference to the MAMC value which excludes the interference of subcutaneous fat.

The concept that in protein-calorie malnutrition protein imbalance is always present [23, 26], was pointed out by Jelliffe when he observed that body muscle mass decreased in marasmus [25]. In the case of a nutritional imbalance, energy requirements are covered in part by gluconeogenesis from muscle protein; this leads to a progressive loss of muscle mass. In chronic malnutrition the loss may involve more than 50% of cytoplasmic protein [48].

Although amino-acid balance seems to reflect the dietary status rather than the protein nutritional status, it is doubtless that the two conditions are often coincident [12, 16, 18]. This allows to use this parameter in field studies and even in individual cases if care is taken to obtain a blood sample before any dietetic therapy has started.

Though several authors have demonstrated that in protein-calorie malnutrition amino-acid balance as well as MAMC are affected [3, 28], we have not found any previous report correlating these parameters. As asignifcant correlation could be demonstrated between them, any of the two may be chosen for assessing the nutritional status. In view of its simple technique, we give preference to MAMC measurement. Considering the contrasting opinions concerning amino-acid balance, the correlations of MAMC with some other biochemical parameter ought to be studied.

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