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Original Paper

The Relationship between Nutritional Status and Anthropometric Measurements of Preschool Children in a Sierra Leonean Clay Factory Displaced Camp.

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ABSTRACT
Weight is a sensitive index for the evaluation of nutritional status of preschool children, particularly where their precise ages are known. Regrettably in Sierra Leone there are no known local standards of weight of preschool children and their ages are most times difficult to obtain. Thus weight alone cannot be the most suitable index in the evaluation of the nutritional status of preschool children in Sierra Leone. Thus the current study was undertaken to determine the relative merits of anthropometric measurements commonly used in nutrition survey for the evaluation of the nutritional status of preschool children in the clay factory displaced camp. Three hundred and six (306) children of both sexes aged 1-5 years were classified into three groups: Normal, protein-energy malnutrition (PEM) and vitamin deficiency (VD). The relative importance of the various anthropometric measurements was assessed in these three categories of children through comparison of their mean values and correlation coefficients. A close relationship was observed between the severity of PEM on the one hand and weight, weight-height ratio and mid-upper arm circumference (MUAC) on the other. The indices weight and weight-height ratio were found to be very sensitive in the assessment of nutritional status of the children. Moreover, these indices showed a close association with other measurements. It was concluded that the weight-height ratio which is independent of age, is the most suitable index for the detection of early cases of PEM in our environment.

Keywords: **Nutritional status, Protein-Energy malnutrition, Vitamin deficiency, Preschool children, Weight-Height Ratio and Mid-upper arm circumference.**

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INTRODUCTION
Malnutrition is still a major public health problem over large areas of the world, especially developing countries and particularly amongst low socio-economic groups. Half of the children born in low-income societies die before they are five years of age. A significant proportion of these deaths are attributed directly or indirectly to malnutrition (Jelliffe *et al.,* 1985). In the assessment of the nutritional status of individuals, any one or a combination of two or more of the following methods are used: dietary assessment, feeding assessment, clinical assessment and physical signs, biochemical or laboratory tests and anthropometric measures. The selection of methods to be used often depends on the age of the individual, the reason for assessment, and the resources and expertise available.

The World Health Organization in 1963 listed eleven clinical signs as being suggestive of PEM (WHO, 1963). However, most of these clinical signs have the disadvantage of being difficult to standardize and expressed quantitatively. In addition, these signs are not always present particularly in mild-moderate PEM and they are usually the last to appear and are often non-specific (McCann, 1973).

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Thus clinical assessment alone cannot be used to assess the nutritional status of individuals. In practice however, the nutritionally labile tissues in PEM are protein and calorie stores. Consequently, skeletal muscle and subcutaneous fat are often assessed by the use of anthropometric measurements.

Anthropometry provides non-invasive, easy and cheap but yet valuable information on nutritional status. Anthropometric measures of most significance in children include: weight and height (Smith and Brown, 1970; Joint FAO/WHO, 1971; Waterlow, 1972; Sudesh, 2000) weight-height ratio (Robinson and Jelliffe, 1966; Shantha *et al.,* 1967; Sharma *et al*., 2006), skin-fold thickness at selected sites (Marilyn *et al*., 1984; Delarue *et al.,* 1994; Durnin *et al.,* 1997), mid-upper arm (Smith and Brown, 1970; Marilyn *et al*., 1984; Sharma *et al*., 2006), chest (Jelliffe *et al.,*1985) and head (Gouge and Ekvall, 1975, Marilyn *et al*., 1984) circumferences. Although these anthropometric parameters have been collected in many cross-sectional and longitudinal studies aimed at assessing nutritional status of various communities, there have been few attempts to evaluate the relative merits of each of these measurements as an index of nutritional status.

Thus, the main objective of this study was to establish a relationship between nutritional status and the following anthropometric parameters- weight, height, weight-height ratio, mid-upper arm, chest, and head circumferences among preschool children in the clay factory displaced camp in Freetown. In addition, based on the relationship between nutritional status and anthropometric measurements, an index suitable for the early detection of PEM was described.

METHODOLOGY

A clinical nutrition survey was conducted on 306 preschool children between the ages 1 and 5 years in the Clay factory displaced camp. The children belonged to families of low socio-economic groups who were displaced by the rebel war from the provinces, and were therefore reasonably considered as a homogenous sample.

The children were examined for the presence of deficiencies and were classified as belonging to one of two broad groups- (a) children apparently normal without any deficiency signs (normal children) and (b) children having one or more signs of deficiency states (deficient children). The deficient children were further sub-divided into two groups: (i) children with one or more signs of PEM and (ii) children with signs of either vitamin A and/or vitamin B-complex deficiency (vitamin-deficient children). However, a child who had one or more deficiency signs belonging to a major deficiency group was classified in that group.

A child who had one or more of the following signs was considered as suffering from PEM- pedal oedema, apathy, dyspigmentation of the hair, easy pluckability of the hair, thin sparse hair, muscle wasting, moon face and dermatosis (WHO, 1963). However, xerosis of the conjunctiva and cornea and/or bitot's spots were considered as signs of vitamin A deficiency, whereas, angular stomatitis, cheilosis, glossitis and atrophic or hypertrophic lingual papillae were considered as signs of deficiency of the B-complex vitamins. In addition, the following anthropometric measurements were recorded for each child in the various groups and the mean computed for each group: weight (kg), height (cm), weight-height ratio, mid-upper arm, chest and head circumferences (cm). These measurements were done in a standard manner as previously described (Jelliff, 1963; Marilyn *et al*., 1984; Sudesh *et al*., 2000; Sharma *et al*., 2006).

The relative importance of the anthropometric measurements in assessing the differences between the groups of children by clinical status was attempted through: (a) comparison of the magnitude of the differences in the mean value of each measurement using one way ANOVA followed by Dunnett's post test and (b) estimation of the interrelationships between the anthropometric measurements. The interrelationships between anthropometric measurements were estimated through computation of a simple correlation coefficient between all possible combinations of two anthropometric measurements. Correlation coefficients denote mutual association between two variables. A simple average of all correlation coefficients which each measurement had with others under each clinical group was taken to represent the extent of relationship that the measurement had with other measurements in assessing the nutritional status (Rao and Singh, 1970). Furthermore, the mean correlation coefficient of each measurement was taken as the basis for judging the importance of the measurement in assessing the growth status of the children.

Based on these two criteria and classification of the children by clinical status, the relative importance of the anthropometric measurements in the assessment of nutritional status was evaluated. The data were analyzed with the commercially available software (Graphpad Prism, version 3.0, Graphpad Software, San Diego, CA, USA) and the *P*-value was set at 0.05.

RESULTS AND DISCUSSION

A total of three hundred and six (306) preschool children of both sexes between the ages of 1-5 years were recruited in this study. These children were subdivided into normal, PEM and VD based on their clinical status (Table 1). The anthropometric measurements of the normal children were used as a “standard” in the discussion of each of the deficient groups.

Table 1: Clinical nutritional status of preschool children in the different age group surveyed

Age (years)	Sex	Normal	PEM	Vitamin Deficient	Total
1-3	Male	25 (21.4%)	80 (68.4%)	12 (10.2%)	117 (100%)
	Female	25 (22.7%)	77 (70.0%)	8 (7.3%)	110 (100%)
3-5	Male	20 (43.3%)	16 (34.7%)	10 (21.7%)	46 (100%)
	Female	20 (60.6%)	7 (21.2%)	2 (18.2%)	33 (100%)
All ages (1-5)	Male	45 (27.6%)	96 (58.9%)	22 (13.5%)	163 (100%)
	Female	45 (31.5%)	84 (58.7%)	14 (9.8%)	143 (100%)

The anthropometric measurement of the normal children and those with VD in the 1-3 year age group of both sexes were found to be statistically similar (*P*>0.05) (Table 2). This may be due to the fact that vitamin deficiency has little or no effect on the various anthropometric parameters, except when there is superimposed PEM (Robinson and Jelliffe, 1966; Shantha *et al.,* 1967; Dugdale, 1971; Joint FAO/WHO, 1971). However, the weight, weight-height ratio of the male and the weight and chest circumference of the female VD children in the 3-5 year age group were noted to be significantly lower than those of the corresponding normal children (*P*<0.05). In addition, the weight of the female vitamin deficient children in the 1-5 year age group was significantly higher than their normal counterparts (*P*<0.05) (Table 2).

In our environment because there are no known predetermined weight for age of the normal children, it is possible that the weight of the VD children which appears to be higher than that of the “normal” children could well be within the normal limits. Moreover because the physical signs of PEM are not always present particularly in mild to moderate PEM and because these signs are usually the last to appear (McCann, 1973), it could also be possible that some of the children who were considered to be “normal” were either in the pre-malnutrition stage or had mild to moderate PEM which was not clinically detectable. Similarly, it is probable that those VD children with low weight, weight-height ratio and chest circumference, were either in the pre-malnutrition stage or had superimposed mild to moderate PEM which was not clinically detected.

Almost all the anthropometric measurements of the normal children of both sexes in each age group were found to be significantly higher than those of the PEM children in the same age group (*P*<0.05) (Table 2). In order of magnitude of the differences, the parameters that were greatly affected were weight > weight-height ratio > MUAC > height > head circumference > chest circumference. Thus the weight and weight-height ratio and MUAC were affected to a greater extent; whereas the height, head and chest circumferences were only slightly affected. This appears to be true for both sexes (Table 2).

There were considerable variations observed in the measurements among the normal children. However, in order to determine whether the differences observed between the normal children on the one hand and those with signs of PEM and vitamin deficiencies on the other were real; correlation coefficients between various combinations of the anthropometric measurements were calculated for each age group and sex of these broad clinical groups. Comparison of the mean value obtained from correlation coefficients that each measurement had with others demonstrated that weight, height, weight-height ratio, mid-upper arm and chest circumferences showed a good correlation with other measurements in all groups of children irrespective of age and sex. Furthermore, the magnitude of correlation of each measurement with others was found to be greater in the PEM children than the normal (Table 3).

This may be due to the fact that PEM affects all anthropometric measurements. Similar findings have been reported by Robinson and Jelliffe (Robinson and Jelliffe, 1966), and Rao and Singh (Rao and Singh, 1970). The former authors observed a slight difference in the order of measurement in rural Uganda children between the ages 2.5 - 33.0 months that were suffering from PEM. They found the order of measurements as body weight, weight-height ratio, arm, chest and calf circumferences. However the latter authors reported that body weight, calf circumference, weight-height ratio, arm and chest circumferences showed a good correlation with other measurements in that order in normal and malnourished preschool children between the ages of 1-5 years in rural areas around Hyerabad city.

From a comparison of the magnitude of differences in measurements and correlation coefficients between normal children and those with PEM, it was evident that in children with PEM, the order of the measurements that showed maximal variations were weight, weight-height ratio, MUAC and to a small extent height. These measurements are therefore the most sensitive indices in the assessment of PEM (Robinson and Jelliffe, 1966; Rao and Singh, 1970). Body weight and height have however long been used for the assessment of nutritional status, especially in growing children. However, in most developing countries like Sierra Leone, not only are local standards of body weight and height for different age groups are frequently unavailable, but also correct ages of children are hard to obtain. This information is essential for proper interpretation of data on weight and height. Furthermore, in some areas of the world it seems very likely that what has been termed “nutritional dwarfing” by Jelliffe may be common and difficult to detect without knowledge of the children’s ages. In fact, in these “bonsai babies”, there may be a general growth failure and a body weight relatively proportional to height (Jelliffe, 1966). Since weight-height ratio is independent of age and taking into consideration weight in relation to height, it may be considered to have advantage over using either weight or height singly as an index of growth or nutritional status. Moreover, because most of the anthropometric parameters had a close relationship with this index, it may be employed for the detection of early cases of PEM.

CONCLUSION

In conclusion, body weight alone is probably not a useful index for the early detection of PEM in our environment since there are no local standards of weight for the different age groups and because the correct ages of the children are hard to obtain. Thus the weight-height ratio which is independent of age and takes into consideration weight in relation to height is probably the most useful index for the evaluation of the nutritional status of preschool children in our environment.

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Table 2: Shows the mean anthropometric measurements of preschool children of both sexes.

Age group	*Clinical Status*	*Sex*	*Weight (kg)*	*Height (cm)*	*Wt/Ht ratio (kg/cm)*	*MUAC (cm)*	*Chest Cir. (cm)*	**Head Cir. (cm)**
1-3	Normal	M	11.88	74.74	0.16	11.66	41.68	44.94
		F	11.14	72.76	0.15	11.83	41.62	44.61
	PEM	M	6.3*	70.9*	0.09*	9.9*	40.28	43.44
		F	5.96*	70.86	0.08*	9.91*	40.45*	43.26
	VD	M	11.7	72.7	0.15	11.1	41.92	44.17
		F	11.81	72.38	0.16	11.13	41.25	43.50
3-5	Normal	M	14.93	100.15	0.15	12.80	45.32	46.06
		F	14.10	96.10	0.15	12.61	45.49	46.08
	PEM	M	9.10*	88.29*	0.10*	10.54*	45.61	43.63*
		F	9.10*	88.29*	0.10*	10.11*	43.61*	43.30*
	VD	M	13.72*	97.65	0.14*	11.92	44.7	45.77
		F	13.41*	96.67	0.14	11.52	44.00*	45.35
1-5	Normal	M	13.41	87.45	0.16	12.23	43.50	45.5
		F	12.76	84.43	0.15	12.22	43.56	45.35
	PEM	M	7.72*	79.64*	0.10*	10.26*	42.95	43.53*
		F	7.53*	79.58*	0.09	10.11*	42.03*	43.78
	VD	M	12.73*	85.16*	0.15	11.49	43.30	44.97
		F	13.76*	84.53	0.15	11.33	42.63*	44.43

Note: ***** *P<0.05* vs. the mean of the corresponding anthropometric parameters of the normal children.

Table 3: Shows the relationships of each anthropometric measurement with others, mean correlation coefficients.

Age group	Clinical Status	Sex	Weight (kg)	Height (cm)	Wt/Ht ratio (kg/cm)	MUAC (cm)	Chest Cir. (cm)	Head Cir. (cm)
1-3	Normal	M	0.83	0.60	0.77	0.50	0.60	0.24
		F	0.29	0.17	0.57	0.08	0.11	0.55
	PEM	M	0.87	0.61	0.88	0.50	0.60	0.41
		F	0.60	0.56	0.82	0.35	0.36	0.74
	VD	M	0.82	0.56	0.68	0.50	0.60	0.34
		F	0.63	0.53	0.75	0.34	0.32	0.58
3-5	Normal	M	0.12	0.37	0.63	0.19	0.19	0.18
		F	0.33	0.41	0.46	0.12	0.26	0.36
	PEM	M	0.29	0.40	0.81	0.50	0.19	0.28
		F	0.67	0.51	0.51	0.28	0.31	0.63
	VD	M	0.22	0.40	0.63	0.36	0.19	0.25
		F	0.60	0.46	0.24	0.25	0.18	0.62
1-5	Normal	M	0.49	0.47	0.66	0.30	0.39	0.21
		F	0.60	0.29	0.49	0.10	0.19	0.47
	PEM	M	0.56	0.50	0.79	0.50	0.39	0.35
		F	0.65	0.52	0.64	0.31	0.32	0.67
	VD	M	0.52	0.48	0.76	0.35	0.39	0.29
		F	0.31	0.51	0.54	0.30	0.27	0.59

REFERENCES

Delarue J, Constans T, Malvy D, Iradignac A, Couet C and Lamisse F (1994). Anthropometric values in an elderly French population. *Br. J. Nutri.* **71**: 295-302.

Dugdale AE (1971). An age-independent anthropometric index of nutritional status. *Am. J. Clin. Nutri.* **24**: 174.

Durnin JVGA De Bruin H and Feunekes GIJ (1997). Skinfold thickness: Is there a need to be very precise in their location? *Br J Nutri.* **77**: 3-7.

Gouge AL and Ekvall SW (1975). Diets of handicapped children, physical, psychological and socio-economic correlations. *Am. J. Mental Deficiency*. **80**:149-157

Jelliffe DB, Stanfield P, Brueton M, Chan M, Parkin M and Waterson T (1985). Diseases of children in the tropics and subtropics (4th. edition). Pp: 351

Jelliffe DB (1966). The assessment of the nutritional status of the community. *WHO monograph No. 53.* Pp: 271

Joint FAO/WHO Expert Committee on malnutrition (1971). *WHO technical report*. **477**:34-70.

Marilyn D, Johnson, MS, William K, Yamanaka, PHD, Candelaria S and Formacion MS (1984). A Comparison of Anthropometric Methods for Assessing Nutritional Status of Preschool

Children: The Philippines Study. *J Trop Pediatr.* **30**:96-104

McCann M (1973). Evaluation of nutritional status. *Pediatr Ann*. **2**:64

Rao VK and Singh D (1970). An evaluation of the relationship between nutritional status and anthropometric measurements. *Am J Clin Nutri.* **23**: 83.

Robinson M and Jelliffe DB (1966). Intercorrelations between anthropometric variables. A contribution to nutritional anthropometry of infancy and early childhood in developing countries. Proceedings of the VIII International Congress on Nutrition, Hamburg. Pp: 8

Shantha M, Susheela TP and Swamineth MC (1967). Association of growth status and the prevalence of nutritional deficiency signs among preschool children. *Indian J Med Res.* **55**:497.

Sharma B, Mitra M, Chakrabarty S and Bharati P (2006). Nutritional Status of Preschool Children of Raj Gond - a Tribal Population in Madhya Pradesh, India*. Malaysian J. Nutri.* **12**:147-155

Smith DS and Brown ML (1970). Anthropometry in preschool children in Hawaii. *Am J Clin Nutri*. **23**:7.

Sudesh J, Saroj B and Salil S (2000). Nutritional status of rural pre-school children of Haryana state. *Indian J Pediatr.* **67**: 189-196

Waterlow JC (1972). Classification and definition of protein-calorie malnutrition. *Br Med.J*. **3**:566-9.

WHO Technical Report Series No. 258 (1963) Expert Committee on Medical Assessment of Nutritional Status. WHO, Geneva.