GLOBAL JOURNAL OF MEDICAL SCIENCES VOL. 5, NO. 1, 2006: 7-11
 ISSN 1596 - 2911

ANTHROPOMETRIC MEASUREMENTS AND PLASMA PROTEINS IN PROTEIN ENERGY MALNUTRITION

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(Received 25August, 2004; Revision Accepted 22 June, 2005)

ABSTRACT

Anthropometric measurements and Albumin levels commonly used as indicators of the body's nutritional status were assessed in sixty-nine (69) Protein-Energy-Malnourished (PEM) – children, classified using the modified Wellcome classification into Kwashiorkor (32) Marasmic Kwashiorkor (15) Marasmus (11) and Underweight (11) Twenty Six well nourished children served as controls.
The mean midarm circumference, chest circumference, occipito- frontal circumference, body weight and height were significantly decreased in the malnourished group when compared with the control group ($p< 0.05$). Inter –group variations within the malnourished groups were also observed. Similarly, Albumin and total plasma proteins were significantly reduced in the malnourished group when compared with the control group($p<0.05$). It is concluded from this study that anti-oxidants and anthropometric values are decreased in Protein Energy malnourished children.

KEYWORDS: Anthropometric measurement, Kwashiorkor, Marasmus, Protein Energy malnutrition.

INTTRODUCTION

The free radical hypothesis suggests that the derangement of free radical metabolism is the underlying cause of both biochemical and clinical changes in kwashiorkor (Golden and Ramdath, 1985). The individual serum proteins like albumin and transferrrin are known to have anti-oxidant properties (Davis and Pacht, 1991). The role of transferrin as an anti-oxidant consists in its ability to bind iron thus making it unavailable for the Fenton reactions (Aruoma and Halliwell, 1987). In addition to the above proteins, it is known that serum proteins "en mass" have anti-oxidant protective effects by virtue of their presence in large amounts (Halliwell, 1988). This concept holds good in that serum proteins act as sacrificial anti-oxidants reacting with a variety of reactive oxygen species thereby sparing host cells and tissues(Halliwell, 1988).

Anthropometric measurements and albumin levels are usually used as indicators of the body nutritional status (Chevassus and Marcoux, 1991; Nogueira de Almeid *et al*, 1999). In the present study, the anthropometric measurements and albumin levels were measured in malnourished children to assess the extent of malnutrition.

MATERIALS AND METHODS

The study subjects consisted of (69) malnourished children attending the Children's Out Patients Clinic of The University College Hospital Ibadan, Oyo State, Nigeria. Using the modified Wellcome Classification (Wellcome Trust working Party, 1970), they were divided into Kwashiorkor (32) Marasmic Kwashiorkor (15), Marsmus (11) and Underweight (11) groups. The control group consisted of children of members of staff of the the University of Ibadan, who came to the clinic for routine normal check-up. The age range of the children was between 7months – 5 years.

The anthropometric measurements were determined using the method of Janes (Janes, 1974). For children who are 3.5 years old and below, the supine length was measured because the children at this age could not co-operate to stand still and have their heights determined. To determine the supine length, the child was made to lie down on a board with a fixed head piece at one end at right angles to the board. The foot piece consisted of a moveable right angled block. From the head piece, a metre rule was fixed to one side of the length of the board. The soles of the feet were kept firmly pressed against the foot piece and the height was read. When the child was able to stand, the feet were made to touch the back board. There was also a head block perpendicular to the floor. The children were made to stand straight without raising their heels and measurement was then taken.

For the head circumference, a tape measure was used. It was placed on the lower forehead just above the supra orbital ridges, was passed round the head and placed over the occiput. It was then moved slightly up and down to find the maximum reading before being pulled firmly to compress the hair and the reading was taken.

In the case of the midarm circumference, the Child's left hand was held with elbow flexed at right angles, midway between acronium process and olecranon. A tape was

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passed round the arm so that it was in contact with the skin, but did not compress the tissues and the measurement was taken. The chest circumference was determined by placing a tape around the chest and taking the measurement without compressing the tissues. The body weight of each child was read off on a weighing machine after placing each child on it.

With respect to the determination of total plasma proteins, albumin and globulin, Ten millilitres of blood was collected by clean venepuncture from the femoral vein and dispensed into bottles containing Lithium heparin as anticoagulant.

The blood was mixed gently to ensure that no clot was formed. The sample was centrifuged at 3,000g for 5mins and plasma was obtained and used for the analysis. The dye binding capacity method of Doumas and Bhris (Doumas and Bhris, 1972), based on the ability of albumin to bind bromocresol green (BCG) was used to determine plasma albumin concentration. Total Protein was determined by the Biuret method, (Cornal *et al*,1949) while globulin values were obtained by taking the difference between the Total Protein and albumin values. Pair wise comparisons were carried out using the student's t-test and differences were regarded as significant at $p<0.05$.

RESULTS

The mean physical parameters for all the subjects are shown on Table 1, while Table 2 shows the mean values for total plasma protein, plasma globulin and albumin in malnourished and control children respectively. The mean midarm circumference was significantly decreased in Marasmus, Marasmic Kwashiorkor, Kwashiorkor and Underweight children when compared with the corresponding value in the control group($p<0.05$). There was inter-group variation within the malnourished groups. For instance the difference between values for Marasmus and Kwashiorkor and Marasmic Kwashiorkor and Kwashiorkor were significant ($P<0.05$). The mean chest circumference was also significantly reduced in Marasmus, Marasmic Kwashiorkor, Kwashiorkor and Underweight groups when compared with that in the control group ($p<0.05$). Differences within the malnourished groups were also observed with the mean chest circumference.

With respect to other physical parameters, inter-group comparison showed that the mean Occipito-frontal circumference in the Marasmic group was significantly lower than the corresponding values in Kwashiorkor and Underweight groups respectively($p<0.05$). The malnourished children were significantly shorter than the

Table1: Anthropometric Measurements

	Marasmus n=11	Marasmic Kwashiorkor n=15	Kwashiorkor n=32	Underweight n=11	Control n=26	F – Value	P
Midarm Circumference (cm)							
Mean ± SD	10.3 ± 1.1	11.3 ± 1.6	12.6 ± 1.0	11.8 ± 2.6	14.7 ± 1.3	26.7	<0.001
Range	8.5 – 12.0	8.0 – 15.5	11.0 – 15 0	4.3 – 14.0	12.0 – 16.5		
Chest Circumference(cm)							
Mean ± SD	41.2 ± 2.5	44.2 ± 3.0	45.9 ± 3.0	46.1 ± 3.0	50.2 ± 3.1	27.2	<0.001
Range	37.5–44.5	39.0 – 51.0	40.0 – 51.0	43.0 – 52.5	42.0 – 56.0		
Occipito Frontal Circumference (cm)							
Mean ± SD	43.7 ± 2.2	44.0 ± 4.1	46.5 ± 1.4	46.3 ± 2.4	48.5 ± 2.5	12.2	<0.001
Range	40.5-47.0	34.0 – 56 5	43.5 – 50.0	43.0 – 50.0	43.0-53.0		
Height (cm)							
Mean ± SD	71.6 ± 6.7	78.2 ± 9.9	77.9 ± 5.0	78.7 ± 8.0	86.6±14.1	12.7	<0.001
Range	58.0-85.0	60.0 – 96.5	70.0 – 92.5	69.5 - 98.0	61.0 – 105.0		
Weight (kg)							
Mean ± SD	5.7 ± 0.9	7.0 ± 1.8	8.4 ± 1.1	7.9 ± 1.4	11.9 ± 2.8	30.8	<0.001
Range	4.1 – 7.0	4.6 - 10.2	6.9 10.9	6.1 10.9	7.7 19.0		
Age (months)							
Mean ± SD	20.5±10.3	29.6 ± 18.1	23.7 ± 8.5	24.1 ± 14.7	32.2 ± 13.7	5.3	<0.001
Range	7.0 – 39.0	8.0 – 60.0	12.0-48.0	10.0 – 60.0	7.0 – 54.0		

n = No of subjects studied.

Marasmic Kwashiorkor, Kwashiorkor and Underweight children respectively ($p<0.05$). In respect of body weight, the mean weight of the malnourished groups was significantly lower than the control value while inter-group variations were also observed. For example the mean weight of Marasmic children was significantly lower than the corresponding value in Kwashiorkor, Marasmic Kwashiorkor and Underweight children ($p<0.05$). Also the Marasmic Kwashiorkor group had a significantly lower body weight when compared with the Kwashiorkor group ($p<0.05$).

With respect to plasma protein parameters, the total protein levels in both Marasmic Kwashiorkor and Kwashiorkor groups were significantly reduced when compared with the corresponding control value ($p<0.05$), Table 2. The total plasma protein concentration was also significantly lower in the underweight when compared to the control group ($p<0.05$). Inter-group variations also were observed within the malnourished group: Marasmic and Marasmic Kwashiorkor and between the Marasmic and kwashiorkor groups. There were also inter-group variations between the values in the Marasmic Kwashiorkor and Underweight groups and between the Kwashiorkor and Underweight groups ($p<0.05$). The mean plasma albumin was significantly decreased while the mean globulin was significantly increased in all the malnourished groups when compared with the corresponding values in control group ($p<0.05$). Both the albumin and globulin mean values showed significant inter-group variations within the malnourished groups. Significant differences in plasma albumin were observed between the Marasmic Kwashiorkor and Underweight children, and between Kwashiorkor and Underweight children. Similarly, inter-group variations existed in plasma globulin values between Marasmus and Marasmic Kwashiorkor, and Underweight children ($p<0.05$).

Table 2: Total Proteins, Albumin and Globulin

	Marasmus n=11	Marasmic Kwashiorkor n=15	Kwashiorkor n=32	Underweight n=11	Control n=26	F Value	P
Total Protein (g/l)							
Mean ± SD	65.5 ± 14.7	49.9 ± 11.0	51.5 ± 7.7	65.9 ± 10.4	58.9 ± 7.1	9.8	0.001
Range	48.0 – 89.0	37.0 – 70.0	35.0 – 68.0	42.0 – 78.0	43.0 – 69.0		
Albumin (g/l)							
Mean ± SD	28.7 ± 10.5	23.7 ± 7.7	25.8 + 5.0	32.2 + 5.4	39.9 ± 4.0	24.4	<0.001
Range	18.0 – 50.0	12.0 – 37.0	19.0 – 36.0	24.0 – 40.0	32.0 – 49.0		
Globulin (g/l)							
Mean ± SD	36.9 ± 9.8	26.1 ± 6.7	25.7 ± 6.9	33.7 ± 8.7	19.2 ± 6.5	14.9	<0.001
Range	20.0 – 55.0	17.0 – 38.0	8.0 – 41.0	18.0 – 44.0	6.0 – 30.0		

n = No of subjects studied.

DISCUSSION

In this study, anthropometric measurements and plasma albumin concentrations were used as indicators of the body nutritional status. The anthropometric parameters showed significant differences between the malnourished groups and the control group of children. It was observed that the midarm circumference of each of the different groups of malnourished children were significantly lower than that of the control group. The lowest value was found in the Marasmic children, where growth failure and weight loss due to depletion of subcutaneous muscle fat had previously been documented (Behar and Viteri, 1978).

From results of previous field surveys, midarm circumference was shown to be independent of age but correlated well with the mutual weight-for-age and weight-for-height parameters among children aged between 6-59 months (Yost and Pust 1988; Jellife, 1969). From these earlier studies, 16.5cm was used as the standard median midarm circumference, while any value below 13.5cm was regarded as indicating the presence of protein energy malnutrition in children aged between 12-59 months (Jellife, 1969). In this study, the mean midarm circumference of children in each of the malnourished groups was below 13.5cm, while the control value was greater than 13.5cm. Also using Janes Chart (Janes, 1980), the mean head circumference, height and weight in the different malnourished groups were below the fiftieth percentile while those of the controls were well above the fiftieth. These indicate that malnutrition causes growth retardation.

In the present study, the Marasmic and Kwashiorkor children were younger than the control children. This is not unexpected since Kwashiorkor is commonest among children aged between 12 and 36 months when the diet consists mainly of starchy gruels and pasts with little or no protein supplement (Jellife and Standfield,1978) such as milk. Marasmus on the other hand, occurs commonly among children aged between 6months to 1 year who consume diets inadequate in both protein and calorie content (Jellife and Standfield, 1978). On the other hand the Marasmic Kwashiorkor and Underweight children were similar in age to the control children.

The observed reduction in anthropometric parameters in Marasmus and Kwashiorkor children therefore may not be solely attributed to age differences between the control and these groups of malnourished children since similar significant reductions in the anthropometric parameters were found in Marasmic Kwashiorkor and Underweight children who had similar mean ages with the control. The reduction in anthropometric measurements must have been as a result of the nutritional deficiencies.

Plasma albumin levels were found to be significantly decreased in the malnourished groups whereas globulin levels were significantly increased in these groups. Previous reports of changes in plasma albumin concentration in malnourished children had been attributed to a decrease in the rate of synthesis of proteins in these patients(Jellife and Standfield,1978). Also it has been observed that inactivation of proteins can occur in the presence of excess free radical (Janes, 1980). The aromatic amino acids, tyrosine, phenylalanine and tryptophane were reported to be the most sensitive amino acids to oxidative damage. These amino acids are known to contain unsaturated structures, which are extremely sensitive to oxidation (Kleinveld *et al*, 1989). This enhanced oxidation of amino acids could lead to the decreased rate of synthesis of albumin and it could well be responsible for further nutrient deficiency in the malnourished child. This nutrient deficiency produces retardation of growth and underdevelopment of the intellect causing major difficulties in learning and behaviour (Muralt, 1972) in malnourished children. Previous studies in malnourished patients have attributed the elevation of globulin to the presence of infection (Gabig and Babior, 1982; Whitehead, 1969). The elevated levels of globulin in the present study probably suggest the presence of infection in the malnourished group. Although specific infections were not identified by microbiological technique, clinical investigation showed that 68.7% of the malnourished groups came to the hospital with some infection.

It is shown in this study that albumin, which is an anti-oxidant which acts to combat the effect of excess free radicals, is deficient in Protein Energy Malnutrition (PEM). Other anti-oxidants such as B-Carotene, and Vitamin A had been observed to be deficient (Etukudo *et al* 1999) in PEM. If the free radical theory of Kwashiorkor is correct, then the malnourished child stands the risk of the free radicals over-whelming the anti-oxidant capability and this could prove deleterious to cells and tissues.

ACKNOWLEDGEMENT

The authors are grateful to Sisters Ofodile and Harrison, both of the Malnutrition Clinic, University College Hospital, Ibadan, Oyo State, Nigeria for assistance in recruiting the malnourished patients. The first author (MHE) gratefully acknowledges the financial assistance received from the University of Calabar, Calabar, CRS – Nigeria.

REFERENCES

Aruoma, O. T. and Halliwell B., 1987. Superoxide Dependent and Ascorbate Dependent Formation of OH: from hydrogen peroxide in the presence of iron. Are lactoferrin promoters of OH- generation? Biochemistry Journ. 241: 237-278.

Behar, M. and Viteri, F. E., 1979. In The Malnourished Child, Suskind, R. M. Lewinter-Suskind (Ed.) Nestle Nutr. Workshop Series 19 Nestle Ltd. Vevey, Raven Press Ltd. NY., pp30.

Chevassus Agnes S., and Marcoux A., 1999. Anthropometric, health and demorgraphic indicators in assessing nutritional status and Food consumption. Sustainable Development Department (SD) FAO UN., 1-8.

Cornal, A. G. Bardawill, L. J. and David, M. M., 1949. Determination of Serum Proteins by means of Biuret method: In Tietz N. W.(Ed) Textbook of Clinical Chemistry W. B. Saunders Company London, 1986. 518-520.

Davis, B. W. and Pacht E. R., 1991. Extracellular anti-oxidant defences. The Lung Scientific Foundations Crystal R.G. West J. B. (Ed) Raven Press Ltd. NY., 1821-1927.

Doumas, B. T. and Bhris H. G., 1972. Determination of Serum albumin. Standard methods of Clinical Chemistry. Croper, C. A. (Ed.0 New York Acad. Press, 71-75.

Etukudo M. H., Agbedana E. O., Akinyinka, O. O., Osifo B.O.A., 1999. Plasma electrolytes, total Cholesterol, Liver enzymes and selected anti-oxidant status in protein energy malnutrition. African Journal of Medicine and Medical Sciences 28: 81-85.

Gabig, T. G. and Baboir B. M., 1982. Oxygen dependent microbial killing by neutrophils in superoxide dismutase vol 2. Oberley L. W. Ed Bola Raton CRC Press, pp 1-15.

Golden, M. H. N. and Ramdath D., 1985. Free radicals in the pathogenesis of kwashiorkor Proc. Of the X111 Inter Congress of Nutrition Taylor T. G., Jenkins N.K.J. (Ed) J. L. Libbey London, 597

Halliwell, B., 1988. Albumin, an important extracellular anti-oxidant Biochem. Pharmacol 37: 569-571.

Janes, M. D., 1974. Physical Growth of Nigerian Yoruba Children Trop. Journ of Med. 26: 386-398.

Janes, M. D., 1962. Growth and Development Survey, 76.

Institute of Child Health, 1980. University of Ibadan, Ibadan Nigeria, 8.

Jellife, D. B., 1969. The arm circumferences as a public health index of protein calorie malnutrition of early childhood. Journ. Paediatr. 15: 179-189.

Jellife, D. B. and Standfield, J. P., 1978. In Diseases of Children in the Sub Tropics and Tropics (3rd Edition) Edward Arnold Publ. London, 6: pp200.

Kleinveld, H. A., Swaak, A.J.G., Hack C. E. and Koster J. F., 1989. Interaction between Oxygen Free Radicals and Proteins. Implications for rheumatoid arthritis. An overview. Scand Journ. Rheumatol 18: 341-352.

Muralt, A. V. I., 1972. Lipid malnutrition and developing brain. A Ciba Foundation Symposium. Elsevier Excerpta media. North Holland Association Scientific Publ. Armsterdam, pp50.

Nogueira, de Almeida, C. A., Ricco, R.G., Cescato Nogueira M. P., Del Ciampo L. A. and Mucillo, G., 1999. Comparison of Four anthropometric methods of nutritional Assessment and evaluation of the Agreement between two reference populations. Journal of Tropical Paeditrics 45: 345-350

Wellcome Trust Working Party, 1970. Classification of infantile malnutrition Lancet 2: 302-303

White head, R.G., 1969. The Assessment of nutritional status in protein malnourished children Proc. Nutr. Soc. 28: 1-16

Yost, D. A. and Pust, R. E., 1988. Arm circumference as an index of protein energy malnutrition in 6-11 month old rural Tanzanian Children. Journ Trop. Paedtr. 34(6): 275-281.