Nigerian Journal of Paediatrics 1996; 23 (2): 33-6

Serum Calcium, Inorganic Phosphorus and Magnesium levels in Malnourished pre-school Children

IS Ighogboja+ MC Okonji* BKU Onyeocha**

Summary

Ighogboja IS, Okonji MC, Onyeocha BKU. Serum Calcium, Inorganic Phosphorus and Magnesium levels in Malnourished pre-school Children. *Nigerian Journal of Paediatrics 1996;* **23**:33. The serum levels of calcium, inorganic phosphorus and magnesium in 50 pre-school age children presenting with protein-energy malnutrition (PEM) were compared with those of 50 sex and age-matched well nourished controls. There was no difference in the mean serum levels of inorganic phosphorus between the malnourished (1.38 ± 0.45 mmol/1) and the well nourished (1.27 ± 0.29mmol/1) children. The mean serum calcium and magnesium levels in the malnourished children (1.66 ± 0.31 and 1.03 ± 0.30mmol/1, respectively) were however, significantly lower than those (2.17 ± 0.29 and 1.31 ± 0.21mmol/l, respectively) in the controls ($p<0.02$). Asymptomatic hypocalcaemia was found in 12 percent of the controls. It is recommended that calcium and magnesium supplementation be incorporated into the management of children with PEM. There should also be nutritional education directed at improving the consumption of locally available food items that are rich sources of these elements.

Introduction

INFANCY and pre-school age represent a particularly dynamic phase of growth and development. In the tropical and subtropical regions of the world, nutritional deficiencies in children under five years of age constitute major public health problems due to inadequate diets and poor socio-economic and environmental conditions.[1] It has been established that vitamin and mineral deficiencies are associated with protein-energy malnutrition (PEM).[2-4] In particular, reduction in the levels of calcium, phosphorus and magnesium have been shown to exist in malnourished children.[2,3] In view of the apparent lack of reports from Plateau state showing the extent of this problem, we have undertaken a study to determine the serum levels of these macroelements in children with PEM, in the hope that our findings may help its management.

Jos University Teaching Hospital, Jos

Department of Paediatrics

\+ Senior Lecturer

** Student

Federal School of Medical Laboratory Sciences

* Lecturer

Correspondence: I S Ighogboja

Patients and Methods

One hundred children aged between 12 months and five years attending the Jos University Teaching Hospital (JUTH), were studied. The subjects comprised 50 children, 24 of whom had kwashiorkor, 13 had marasmic-kwashiorkor and 13 were marasmic, according to the Wellcome classification. [5] The controls, matched for age and sex with the subjects, were 50 apparently healthy children with weight-for-age over 80 percent and weight-for-height over 90 percent of the Harvard Standards.[6] The study was approved by the JUTH Ethical Committee and informed consent was obtained from the parents or guardians. About four millilitres of venous blood sample was collected from each subject and placed into a dry chemically clean container and allowed to clot and retract. The sample was then centrifuged at 1200rpms for five minutes. Each sample yielded about 2.5ml of serum which was delivered into a dry labelled container and used for the analysis of calcium, inorganic phosphorus and magnesium. Any sample not assayed immediately was stored in the freezer at - 4°C. Serum calcium was determined using the O-cresolphthalein complexone method;[7] the Gomori method[8] was used for the determination of inorganic phosphorus, while the level of magnesium was determined using the Titan yellow method.[9] Statistical analysis was carried out, using the Student's t test

Results

The mean serum calcium level of 1.66mmol/l in the malnourished group (Table I), was significantly lower than the mean level of 2.17mmol/l in the controls ($p<0.02$). More importantly, 45 (90 percent) of the 50 subjects had hypocalcaemia (serum calcium <2.1mmol/l) compared to six (12 percent) of the controls. Similarly, the mean serum level of magnesium in the malnourished group (1.03mmol/l) was significantly lower than that (1.31mmol/l) in the controls ($p<0.02$). Furthermore, although 17 (34 percent) of the malnourished children had hypomagnesaemia (serum magnesium <0.8mmol/l), none of the controls had such low levels. Analysis of the inorganic phophorus levels showed that although hypophosphataemia was present in eight percent and two percent respectively, of the malnourished and control groups, there was no significant difference in the mean serum levels of the element in the two groups. No significant relationship existed between the mean levels of serum calcium, inorganic phosphorus or magnesium in the three types of malnutrition (Table II). Similarly, the levels of these elements in the malnourished and controls were not sex-dependent (Table III). Although there was a trend towards higher serum levels of the three elements in children over the age of three years compared with those under three years, this did not reach significant level.

Discussion

The presence of hypocalcaemia in most of the

TABLE I

Serum Concentrations of Calcium, inorganic Phosphorus and Magnesium in Malnourished Children and Controls

Elements	Malnourished means ±SD (mmol/l) (n = 50)	Controls mean ±SD (mmol/l) (n = 50)	P Value
Calcium	1.66 ± 0.31 (0.9 - 2.2)*	2.17 ± 0.29 (1.8 - 2.5)*	<0.02
Phosphorus	1.38 ± 0.45 (0.7 - 2.5)*	1.27 ± 0.29 (0.7 - 1.9)*	>0.05
Magnesium	1.03 ± 0.30 (0.6 - 1.9)*	1.31 ± 0.21 (0.9 - 1.8)*	<0.02

* Values in parentheses represent the range.

TABLE II

Serum Concentrations of Calcium, Inorganic Phosphorus and Magnesium in different Types of Malnutrition

Elements	*Type of Malnutrition*		
	Marasmus (mean ± SD) (n = 24)	*Kwashiorkor (mean ± SD) (n = 24)*	*Marasmic-Kwashiorkor (mean ± SD) (n = 24)*
Calcium	1.63 ± 034*	1.61 ± 0.29	1.78 ± 0.20
Phosphorus	1.37 ± 0.46	1.45 ± 0.40	1.32 ± 0.50
Magnesium	1.05 ± 0.34	1.07 ± 0.22	0.96 ± 0.26

*mmol/l

TABLE III

Serum Concentrations of Calcium, Inorganic Phosphorus and Magnesium in Male and Female Malnourished Patients

Element	*Sex*		*P Value*
	Males (Mean ± SD) (n = 24)	*Females (Mean ± SD) (n = 26)*	
Calcium	1.68 ± 0.25*	1.59 ± 0.37	NS
Phosphorus	1.38 ± 0.41	1.37 ± 0.49	NS
Magnesium	0.98 ± 0.30	1.07 ± 0.28	NS

*mmol/l

children with PEM in the present study was in keeping with published reports elsewhere.[2-4] Its presence in 12 percent of the controls seems to be an indication that calcium deficiency is an important problem among the children in Jos This is probably related to faulty dietary practices, since most weaning foods offered to children in the community are gruels prepared from cereals[10] and these contain phytates which inhibit calcium absorption. de Vizia[11] has reported that diets made from products containing phytates (whole grain cereals) which depress calcium availability can lead to calcium deficiency. In the light of the present findings, it is recommended that therapeutic diets for the rehabilitation of children with PEM should not only be protein-rich, but also calcium-rich. The calcium-rich diet should be provided for a long period of time and always beyond the period of normalization of body weight and lean mass as indicated by balanced studies.[2,12] This will help not only to maintain a balance between calcium and phosphorus, but also between phosphorus and nitrogen. In addition, there should be education of parents to feed their children on locally available calcium-rich diets, such as green leafy vegetables and salmon fish. The relatively small number of malnourished children with phosphorus deficiency in the present study was in keeping with the finding that phosphorus deficiency is uncommon in children with PEM because of its widespread distribution in foodstuffs.[3,11] The low mean serum calcium level observed with slightly raised mean serum phosphorus in the malnourished children was probably due to the alteration of the balance of calcium-phosphorus ratio leading to an accumulation of phosphorus which if uncontrolled, may result in hyperphosphataemia.

Our results are in keeping with reports that plasma magnesium concentration in PEM is usually normal or slightly decreased although there is usually body magnesium depletion.[2,4] It has been recommended that large amounts of magnesium should be administered to children with PEM dur-

ing recovery both for tissue repletion and to sustain new growth.[2,13] This could be given in amounts of 0.50 to 0.75mmol/kg per day orally in the form of magnesium chloride or in combination with magnesium citrate.[13] The trend towards higher serum levels of calcium, phosphorus and magnesium in children above the age of three years may be the result of the children's ability to eat bone meal and vegetables. In contrast to the findings by Adegbejo and Yakubu,[14] the levels of these macro-elements were not sex dependent. We conclude that children with PEM commonly have low serum levels of calcium and magnesium. In order to achieve effective management of these children, it is recommended that calcium and magnesium supplementation be incorporated into their management. Moreover, the community should be educated on the use of locally available rich sources of calcium and magnesium.

References

1 Whitehead RG, Paul AA. Nutritional needs of healthy infants. In: Stanfied P, Chan M, Brueton M, Parkin M, Waterston T, eds. Diseases of Children in the Subtropics and Tropics. London: Edward Arnold (Publishers) Ltd. 1991: 324-35.

2 Rodriguez-Soriano J. Malnutrition and electrolyte metabolism. In: Suskind RM, Lewinter-Suskind L, eds. The Malnourished Child. Nestle Nutrition Workshop Series, Vol 19. New York: Vevey/Raven Press Ltd. 1990: 141-54.

3 Hansen JDL, Pettifor JM. Protein energy malnutrition. In: Mclaren DS, Burman D, Belton NR, Williams AF, eds. Textbook of Paediatric Nutrition. Edinburgh: Churchill Livingstone, 1991: 357-90.

4 Barness LA. Nutrition and nutritional disorders. In: Behrman RE, Kliegman RM, Nelson WE, Vaughan VC, eds. Nelson Textbook of Pediatrics. London: WB Saunders, 1992:130-3.

5 Wellcome Trust Working Party. Classification of infantile malnutrition. *Lancet* 1970; 2: 302-3.

6 Jelliffe DB. The assessment of the nutrition status of the community. WHO Monograph 53, Geneva. 1966: 221-41.

7 Baginski ES, Clark ML, Marie SS, Zak B. Determination of serum calcium. *Microchemical Journal* 1975; 20:22-32.

8 Gamori. Phosphorus determination. In: Tietz NW, ed. Fundamentals of Clinical Chemistry. London: WB Saunders (Publishers) Company, 1976: 636-50.

9 Tietz NW. Magnesium determination. In: Tietz NW, ed. Fundamentals of Clinical Chemistry. London: WB Saunders (Publishers) Company, 1976: 652-3.

10 Ighogboja SI. Some factors contributing to protein-energy malnutrition in the middle belt of Nigeria. *E Afr Med J* 1992; 69: 566-71.

11 de Vizia B. Calcium and phosphorus metabolism in infant and growing child. In: Annales Nestle. Switzerland: Vevey/Raven Press Ltd. 1987, 45/1:36-44.

12 Caballero B, Solomons NW, Torun B, Pineda O. Calcium metabolism in children recovering from severe protein-energy malnutrition. *J Pediatr Gastroenterol Nutr* 1986; 5: 740-5.

13 Caddel JL. Magnesium in the nutrition of the child. *Clin Pediatr* 1974; 13: 263-72.

14 Adegbejo JO, Yakubu AM. Protein-energy malnutrition: a ten-year retrospective study (1980-90). *Nig Med Pract* 1993; 25: 29-32.