DOI: https://doi.org/10.53350/pjmhs2023171410

ORIGINAL ARTICLE

Serum Magnesium Level in Protein-Energy Malnourished Children

WARISHA IKHLAQ[1], ADEEL KHALID[2], AMBER KAMRAN[3], MUHAMMAD RAFIQUE[4], SHARMEEN NASIR[5], RUMANA SANGI[6]
[1]*FCPS Paediatrics*
[2]*Assistant Professor of Paediatric Cardiology, Ziauddin medical university*
[3]*FCPS Paediatrics, Fellowship in Paediatric Cardiology, Assistant Professor Paediatrics, Paediatric Unit II, DUHS & CHK*
[4]*FCPS Paediatrics, Assistant Professor Paediatrics, Paediatric Unit II, DUHS & CHK*
[5]*FCPS Paediatrics, Senior Registrar, Paediatric Unit II, DUHS & CHK*
[6]*FCPS Paediatrics, Senior Registrar, Paediatric Cardiology, NICVD Karachi*
Corresponding author: Amber Kamran, Email: dramberkamran@gmail.com

ABSTRACT

Background: Protein energy malnutrition (PEM) is mainly due to inadequate intake of food both in quantity and quality. Serum magnesium level can be detected to identify magnesium deficiency in malnourished children. Low magnesium level in these children is associated with illness and death.

Objective: To determine the serum magnesium level in protein energy malnourished children who are under the age of 5 years.

Study Design: Prospective Cross Sectional study.

Setting: The Pediatric department, civil hospital, Karachi.

Study period: From July to December 2021.

Material and Methods: Total 245 patients of both genders with moderate and severe malnutrition were included. Venous samples were sent to laboratory and a centrifuge machine was used to separate the serum, which was maintained at a temperature of 20°C for serum magnesium test. Atomic Absorption Spectrophotometer was used to measure serum magnesium levels. Descriptive statistics were applied. Frequency and percentage was calculated. Stratification was done using chi square test and p-value ≤0.05 was considered as significant.

Results: Total 156 male and 89 female patients were included in the study. Mean age was 26.63±15.17 months. Mean duration of malnutrition was 11.74±4.86 months. Mean mid upper arm circumference (MUAC) was 11.66±0.76 cm. Serum magnesium level was 1.78±0.22 mg/dl. Overall 180 (73.5%) have moderate PEM.

Conclusion: Study showed low serum concentration of magnesium in children with PEM.

Keywords: Serum Magnesium Level, Protein Energy Malnutrition, Children Under 5 Years.

INTRODUCTION

PEM is a global health problem and a major cause of illness and death of children in developing countries. PEM is mainly due to inadequate intake of food both in quantity and quality. Despite hospitalization, the mortality rate for PEM is alarming which is documented 28.4%.[1] It nearly affects 150 million children across the world who are under 5 years of age.[2]

The three South Asian countries, Pakistan, Bangladesh and India account for half of world's underweight children.[3] PEM is not only an important cause of illness and death in children but also impairs cognitive as well as physical development.[4,5]

Worldwide, malnutrition is a co-factor in over 50 % of children under 5 year of age who die each year due to preventable causes like diarrhea, pneumonia, measles and malaria. [6-10]

Magnesium deficiency has been reported to occur in PEM which is evidenced by reduced concentration of magnesium in serum and tissues. Diet in malnourished children is frequently deficient both in macronutrients and micronutrients.[5] Magnesium is important for nerve conduction as well as stabilization of cell membranes. It acts as a co-enzyme in various bio energetic reactions.[11] Magnesium deficiency may cause cardiac arrthymias which are only controlled by adding magnesium to treatment regime as well as various neurological complaints such as convulsions, twitching and tremors.[13]

Regular intake of legumes, nuts, bananas and whole grains can prevent magnesium deficiency.[14] A wide variety of clinical conditions such as PEM, malabsorption, hypoalbuminaemia, sepsis, hypothermia, etc which are very common among children in developing countries are also a cause of low magnesium level.[14]

Magnesium acts as a bronchodilator and also has anti-inflammatory properties.[15] It not only impedes the contractility of smooth muscle but also the release of histamine and acetyl choline thus depressing the excitability of smooth muscle fibers by reducing uptake of calcium by the cells. Thus the vasomotor tone, peripheral blood flow and blood pressure are all modulated by this micronutrient magnesium.[16,17]

All the age groups can suffer from micronutrient deficiencies but more vulnerable among them are young children and pregnant women specially in the developing world.[18] According to a study by Karakelleoglu et al. the mortality in the malnourished children with hypomagnesaemia was 7.5 times higher than in the malnourished children without hypomagnesemia.[9]

Dietary deficiency of magnesium is more frequent than presumed[19] especially in malnourished children who are under five years of age.[3] Low magnesium level in the malnourished children is associated with high morbidity and mortality.

Although studies have documented the status of other micronutrients among children[12, 13] little information is available on magnesium status in the malnourished children. As there is very scarce information available regarding magnesium levels in malnourished children. Moreover the previous studies were done on a very small sample size. Therefore a better understanding of the magnesium deficiency in our targeted population may improve the use of magnesium, and simultaneously, may help reduce morbidity and mortality.

Objective: To determine the serum magnesium level in protein energy malnourished children under 5 years of age.

MATERIAL & METHODS

This study is done at Department of Pediatrics, Civil Hospital, Karachi for a duration of six months after the approval from the institutional ethical review board. The sample size was 245 which was calculated using WHO sample size calculator by taking the mean magnesium level 1.63±0.26, relative precision 2% and 95% confidence interval. It is a prospective, observational cross sectional study. Sampling was done by non-probability consecutive technique. The patients of both genders admitted at pediatric unit who were between 6 months to 5 years of age having malnutrition for at least 3 months were included in the study. Patients were categorized for the severity of malnutrition according to the WHO criteria. Moderate malnutrition was classified if their height for length was between -2 SD and -3 SD and severe malnutrition if their weight was <-3SD or mid upper arm circumference <11.5 cm or if there were signs of severe wasting and bilateral edema. The children are whose weight for length was > -2 SD and whose stay at hospital was less than 24 hours were excluded from the study. All children who were less than 6 months or more than 5 years of age or had some chronic illness such as malabsorption syndrome,

chronic liver disease, nephrotic syndrome, chronic renal failure and congenital heart disease were excluded from the study.

After admission to the pediatric ward, a detailed history of the patients was taken including age, gender, socioeconomic and educational status of parents on a pre-designed structured questionnaire after taking informed consent from the guardians. Venous samples of all patients were collected in disposable syringes under aseptic technique and sent for serum electrolytes (magnesium, potassium, calcium, phosphate and sodium), along with other baseline investigations such as complete blood picture (CBC) and renal function test (RFT), serum albumin levels. The treatment of all these admitted patients was started according to WHO guidelines for PCM children. The length of hospital stay, time of discharge and death of patients was recorded. The serum was centrifuged and kept at 20°C for serum magnesium test, which was measured by Atomic Absorption Spectrophotometer at Central laboratory, Civil hospital Karachi. Serum magnesium concentration of 1.5-2.5 mg/dL was taken as normal, < 1.5 m g/d L was taken as hypomagnesaemia and >2.5mg/dL was taken as hypermagnesemia.

Data Analysis: Analysis of data was done by Statistical Package for Social Sciences Version 21 (SPSS-21). The quantitative variables i.e. age, height, weight, MUAC, duration of malnutrition and magnesium levels were computed to find the mean and standard deviation. The qualitative variables i.e. gender, residency, socioeconomic status, PEM classification i.e. moderate or severe and education status of parents were computed to find the frequency and percentage. Effect of modifiers was controlled by stratification of gender, age, socioeconomic status, residency, duration of malnutrition and parent's education status. The independent t-test and ANOVA was applied to observe the effect of modifiers on magnesium levels.

P-value ≤0.05 was considered as significant.

RESULT

Total 245 patients were enrolled in the study. Among which 156 (63.7%) were male and 89 (36.3%) were female. The mean age of study subjects was 26.63±15.17 months. They were stratified into two groups. 121(49.4%) patients were up till or below 24 months of age and 124 (50.6%) were above 24 months of age. The mean duration of malnutrition was less than 12 months in 153 (62.4%) and it was more than 12 months in 92 (37.6%) patients. The mean weight was 8.13±2.21 Kg. The mean height of was 79.32±11.11 cm. The mean MUAC of was 11.66±0.77 cm. The details are given in table 1.

The serum magnesium levels of patients was 1.78±0.22 meq/dl. 102(41.6%) patients belonged to urban areas while 143(58.4%) patients were from rural areas.

Out of 245 patients 180(73.5%) had moderate PEM and 65(25.5%) had severe PEM. In our study, education level of mothers was primary in 152(62.0%) cases, secondary in 58(23.7%) cases, intermediate in 26(10.6%) cases, and graduation in 9 (3.7%) study subjects. Educational level of fathers in our study was primary in 72 (29.4%) subjects, secondary in 107 (43.7%) cases, intermediate in 45(18.3%) cases, and graduate for 21 (8.6%) study subjects. 157 (64.1%) had monthly income less than 15,000 rupees. It was between 15,000 to 30,000 rupees per months in 81 (33.1%) subjects and more than 30,000 rupees per month was observed in 7 (2.9%) cases.

Stratification with respect to gender, age, socio economic status, residence, duration of malnutrition, education of mother and education of father was done to compare mean serum magnesium by applying students t-test and ANOVA. P-value ≤0.05 was considered as significant.

The results showed that there was significant difference in serum magnesium levels for age (p=0.040), duration of malnutrition (p=0.002), education of mother (p=0.007), and education of father (p=0.017). The detailed results are presented in Table 1 and Table 2.

Table: 1 Demographic data od participants

	Summary
Total (N)	245
Gender	
Male	63.7% (156)
Female	36.3% (89)
Median Age (months)	25 [14 - 38]
≤24 months	49.4% (121)
>24 months	50.6% (124)
Mean duration of malnutrition (months)	11.73 ± 4.87
≤12 months	62.4% (153)
>12 months	37.6% (92)
Residence	
Urban	41.6% (102)
Rural	58.4% (143)
Weight (gm)	8.13 ± 2.21
Height (cm)	79.32 ± 11.11
MUAC (cm)	11.66 ± 0.77
Protein Energy Malnutrition	
Moderate	73.5% (180)
Severe	26.5% (65)
Education of Mother	
Primary	62% (152)
Secondary	23.7% (58)
Intermediate	10.6% (26)
Graduate	3.7% (9)
Education of Father	
Primary	29.4% (72)
Secondary	43.7% (107)
Intermediate	18.4% (45)
Graduate	8.6% (21)
Socio Economic Status	
<15,000	64.1% (157)
15,000-30,000	33.1% (81)
>30,000	2.9% (7)
Mean Serum Magnesium	1.78 ± 0.22

Table 2: Association of hypomagnesemia with various factors

	Total	Hypomagnesemia		Serum Magnesium	
	N	n (%)	P-value	Mean ± SD	P-value
Gender					
Male	156	36 (23.1%)	0.604	1.78 ± 0.22	0.857
Female	89	18 (20.2%)		1.77 ± 0.24	
Age					
≤24 months	121	20 (16.5%)	0.040	1.81 ± 0.2	0.041
>24 months	124	34 (27.4%)		1.75 ± 0.24	
Duration of malnutrition					
≤12 months	153	24 (15.7%)	0.002	1.81 ± 0.19	0.002
>12 months	92	30 (32.6%)		1.71 ± 0.26	
Residency					
Urban	102	18 (17.6%)	0.161	1.79 ± 0.22	0.397
Rural	143	36 (25.2%)		1.77 ± 0.22	
Protein Energy Malnutrition					
Moderate	180	37 (20.6%)	0.351	1.78 ± 0.23	0.833
Severe	65	17 (26.2%)		1.77 ± 0.22	
Education of Mother					
Primary	152	44 (28.9%)	0.007	1.75 ± 0.24	0.909
Secondary	58	8 (13.8%)		1.81 ± 0.2	
Intermediate	26	2 (7.7%)		1.84 ± 0.16	
Graduate	9	0 (0%)		1.88 ± 0.04	
Education of Father					
Primary	72	22 (30.6%)	0.017	1.73 ± 0.26	0.429
Secondary	107	25 (23.4%)		1.77 ± 0.21	
Intermediate	45	7 (15.6%)		1.8 ± 0.22	
Graduate	21	0 (0%)		1.9 ± 0.04	
Socio economic Status					
<15,000	157	41 (26.1%)	0.121	1.76 ± 0.23	0.458
15,000-30,000	81	12 (14.8%)		1.8 ± 0.21	
>30,000	7	1 (14.3%)		1.81 ± 0.22	

DISCUSSION

The deficiency of micronutrients such as iron, zinc, potassium, calcium etc is very common in children with severe malnutrition especially who are under five years of age. Apart from these the deficiency of magnesium is highly prevalent in malnourished children who are admitted and it is associated with high mortality.[19] Mean age of children in our study was 26.63±15.17 months whereas the mean age of children in the study by Khan S. et al.[20] was 18.4±2.8. In our study we found hypomagnesaemia was more prevalent in male patients i.e. 63.7% with male to female ratio of 1.75:1. In the study conducted by Dandinavar et al.[14] there were 56.6% males whereas there were 62% males in the study conducted by Fatima et al.[16] These results were similar to ours

possibly because more male children were brought for management.

The result of our study showed that 60.8% of enrolled children were stunted. This figure is not only alarming but also much higher as compared to a previous study conducted by Amare B. et al in Gumbrit in Ethiopia[21] in which 50% children were stunted.

We observed that hypomagnesemia was more in age group <12 months (53.4%). Dandinavar et al[14] reported similar results while other studies reported hypomagnesemia was more prevalent in patients >12 months of age.[15,19,20]

The mean serum magnesium in our study was 1.78 ± 0.22, as compared to another study in which mean serum magnesium levels were 1.46 and 1.56 respectively. [22,23] In our study prevalence of hypomagnesemia was 53.4% which is remarkedly high as compared to the other studies. In the study by Raza et al[24] prevalence of hypomagnesemia was 13.6% in malnourished children where as Chisti et al reported a prevalence of 3.3%.[8]

In our study, 62% of mothers of PEM children had only primary level education whereas 43.7 % of fathers were educated upto secondary level. Monthly income of most of the parents i.e. 64.1% of PEM children was less than 15000 rupees which indicates poverty and un availability of food is a major cause of malnutrition as well as hypomagnesemia.

Limitation of the Study: Our study lacks a detailed information on dietary intake of the patients which can provide useful information to explain the cause of magnesium deficiency in the population studied.

Recommendation: A multicentre study would be beneficial owing to various traditional food practices prevailing in different areas which can affect the nutritional status of the child as well as the micronutrient content in their diet. The results of a large scale study would help chalk out a strategy at national level to prevent the deficiency of such micronutrients.

CONCLUSION

The serum magnesium level in malnourished children is low and it increases further with the severity of malnutrition. Therefore, magnesium should be added early in the management of PEM children to improve their response to general management and decreasing hospital stay.

REFERENCES

1. Amsalu S, Asnakew G. The outcome of severe malnutrition in northwest Ethiopia: retrospective analysis of admissions. Ethiop Med J. 2006;44: 151–7.
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M,et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet. 2008; 371(9608):243–60.
3. Rosalind SG, Yewelsew A, Hambidge KM, Isabel A, Aklilu T, Barbara JS. Inadequate feeding practices and impaired growth among children from subsistence farming households in Sidama, Southern Ethiopia. Matern Child Nutr 2009, 5:260-75.
4. Abuye C. Nutrition Baseline Survey Report for the National Nutrition Program of Ethiopia. Addis Ababa, Ethiopia: Ethiopian Health and Nutrition Research Institute; 2009/10. p. 98.
5. World Health Organization. Management of severe malnutrition: a manual for physicians and other senior health workers. Geneva: World Health Organization; 1999.
6. Collins S, Dent N, Binns P, Bahwere P, Sadler K, Hallam A. Management of severe acute malnutrition in children. Lancet. 2006;368(9551):1992–2000.
7. Teferi E, Lera M, Sita S, Bogale Z, Datiko DG, Yassin MA. Treatment outcome of children with severe acute malnutrition admitted to therapeutic feeding centers in Southern Region of Ethiopia. Ethiop J Health Dev. 2010;24(3).
8 Chisti MJ, Salam MA, Ashraf H, et al: Prevalence, clinical predictors, and outcome of hypocalcaemia in severely-malnourished under-five children admitted to an urban hospital in Bangladesh: a case-control study. J Health Popul Nutr. 2014, 32:270-275.
9. Karakelleoglu C, Orbak Z, Ozturk CF, Kosan C: Hypomagnesaemia As a Mortality Risk Factor in Protein-energy Malnutrition. Journal of Health, Population and Nutrition, 29(2), 181–182. https://doi.org/10.3329/jhpn.v29i2.7863
9 Javali NS, Shashikala P, Banu N, Ramya R: Hypomagnesaemia in protein energy malnutrition. J Evid Based Med Healthc. 2015, 2:81-88
10. Caulfield LE, de Onis M, Blössner M, Black RE. Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. Am J Clin Nutr. 2004;80(1):193–8. 11.
11 Gupte S. Pediatric nutritional requirements. Short Textbook of paediatrics, 9th millennium edition. New Delhi; Jaypee Bros; 2002, pp 99-103.
12. Shivakumar K, Model of cardiovascular injury in magnesium deficiency. Med hypotheses. 2001;56(1):110-3.
13. Rude RK. Magnesium disorders. In Fluids and Electrolytes. 3rd edition. Edited by Kokko JP, Tannen RL. Philadelphia: WB Saunders; 1996:421–4515.
14. Dandinavar SF, Suma D, Ratageri VH, Wari PK. Prevalence of hypomagnesemia in children admitted to pediatric intensive care unit and 15. Elizabeth KE, Vitamins, minerals and micronutrients. In: Elizabeth KE (Ed). Nutrition and Child Development, 2nd ed. Hyderabad: Paras Publishing; 2002, pp.86-114. its correlation with patient outcome. Int J Contemp Pediatr 2019;6:462-7.
16 Fatima B, Sheikh MA, Naeem MM: The serum sodium, potassium and calcium levels in children 6-59 months of age with severe acute malnutrition. Pak J Med Health Sci. 2017, 11:292-294.
17 Bilal A, Sadiq MA, Haider N: Frequency of hyponatraemia and hypokalaemia in malnourished children with acute diarrhoea. J Pak Med Assoc. 2016, 66:1077-1080.
18 Zulqarnain A, Jaffar Z, Iqbal I: Malnourished children with diarrhea; to assess the frequency of serum electrolytes (Na+, K+ & Ca+) disturbances. Professional Med J. 2015, 22:610-614
19 Saleem AF, Haque A. On admission hypomagnesemia in critically ill children: Risk factors and outcome. Indian J Pediatr 2009;76:1227-30
20. Khan S, Ali H, Ali I, Abbas A, Nazir F, Ajmal A. Prevalence of hypomagnesaemia in children with severe acute malnutrition aged 6-60 months. Rawal Med J 202;46:163-166
21. Amare B, Moges B, Fantahun B, Tafess K, Woldeyohannes D, Yismaw G.et al. Micronutrient levels and nutritional status of school children living in Northwest Ethiopia. Nutrition journal. 2012;11(1):1.
22 Khalil M. Baki AA, Akhtar N, Azad M, Zafreen F, Wahab MA. Magnesium supplementation on children with severe protein energy malnutrition. Journal of Armed Forces Medical College, Bangladesh. 2008; 4(2):10-3.
23 Singla PN, Chandj P, Kumar A, Kanchhwaha JS. Serum magnesium levels in protein energy malnutrition. J Trop Paed. 1998; 44:117-9.
24 Raza M, Kumar S, Ejaz M, et al. Electrolyte Imbalance in Children With Severe Acute Malnutrition at a Tertiary Care Hospital in Pakistan: A Cross-Sectional Study. Cureus Sept 2020;12(9): e10541. doi:10.7759/cureus.10541