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SERUM MAGNESIUM LEVEL;
COMPARISON BETWEEN HEALTHY AND MALNOURISHED CHILDREN

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ABSTRACT... Objectives: To evaluate serum magnesium level in children with 3rd degree malnutrition and to compare these values with healthy children. **Study Design:** Cross sectional comparative study. **Setting and Duration:** Pediatric Department of Allied Hospital Faisalabad from Oct. 2003 to Nov. 2004. **Subjects:** Cases: 60 children of age six month to five year having weight < 60% of that for age. Control: 60 healthy children of age six month to five year having weight > 80% of that for age. **Methods:** Both cases & controls were selected from indoor & outdoor through simple random sampling. Detailed history & examination was done and S/Mg level were measured by atomic absorption spectrophotometer. Data was analyzed with the help of SPSS by applying T test and was presented by frequency tables. **Results:** The cases showed decreased S/Mg level (1.11+/- 0.24 mg/dl) as compared to controls (2.01+/- 0.78mg/dl).S/Mg levels were also decreased in cases with height < 80 % of that for age (0.98+/-0.5mg/dl) as compared to controls having height > 90 % of that for age. S/Mg levels were markedly low in cases who had low albumin level (0.98+/- 0.05 mg/dl) and those children who presented with persistent diarrhea (0.96+/-0.12mg/dl) Conclusion: S/Mg levels were decreased in children with PEM as compared to those with age and sex matched control. This decrease in S/Mg levels was marked in those cases who had decrease serum albumin level and persistent diarrhea.

Key words: Serum Magnesium, Malnutrition, chronic diarrhea

INTRODUCTION

Magnesium (Mg) is the fourth most abundant mineral in the body and the most abundant intracellular divalent cation, with essential roles in many physiological functions[1]. Magnesium regulates hundreds of enzyme systems[2].

Magnesium is critical cofactor in many metabolic reactions[3]. The normal level of serum magnesium ranges between 1.5 - 2.3 mg/dl(1.2-1.9 mEq/L;0.62-0.94 mmol/L) and is maintained at a fairly constant level[4]. The level of serum magnesium to label Hypomagnesemia is below (1.56 mg/dl)[5].

Hypomagnesaemia is a common occurrence in pediatric intensive care unit[6]. Magnesium has been directly implicated in hypokalemia, hypocalcemia, tetany, and dysrhythmia. Moreover, Mg may play a role in acute coronary syndromes, acute cerebral ischemia, and asthma[2].

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Lot of work has been done on magnesium in protein energy malnutrition in various countries of the world including Jamaica, South Africa, Nigeria and India. Pakistan is a developing country and protein energy malnutrition is a major problem in children. According to the National Nutrition Survey 2001-2002, 38% of Pakistani children (6-59 months old) are under weight, 37% are stunted and 13% are wasted[7]. Work on magnesium deficiency especially in protein energy malnutrition is lacking in our community and also our dietary habits are different from other countries. The present study was done to estimate serum magnesium in malnourished children and its comparison with healthy children in order to get an idea about the magnesium status of malnourished children and its association with the degree of weight loss, stunting and persistent diarrhea.

AIMS AND OBJECTIVES

- To evaluate the serum magnesium level in children with third degree malnutrition.
- To compare these values with healthy children having weight more than 80 % of that normal for age.

MATERIAL AND METHODS

Setting

This study was conducted in the Department of Pediatrics in Allied Hospital, Faisalabad which is an 1100 bed teaching hospital and pediatric ward comprising of 72 beds.

Duration

This study was completed during a period of one year and twenty seven days (Nov, 2003 to Sep, 2004).

Sample Size

Serum magnesium levels of 120 children were studied comprising of 60 malnourished children and 60 healthy children.

Sampling Technique

Simple random sampling.

INCLUSION CRITERIA

For Cases

60 children of age 6 month to 5 year with third degree malnutrition having weight less than 60% of that expected for age according to NCHS studies (Modified Gomez Classification of protein energy malnutrition).

For Controls

60 healthy children aged 6 month to 5 year having weight more than 80% of that expected for age (according to Modified Gomez Classification of protein energy malnutrition).

EXCLUSION CRITERIA

- Children less than 6 month and more than 5 years of age.
- Children with first and second degree of malnutrition.
- Children suffering from liver, kidney, cardiac and chronic lung disease.

Study Design

It was a Cross – sectional comparative study.

Data Collection Procedure

Both cases & controls were selected from the indoor and outdoor through simple random sampling. In this study, 60 hospitalized children of age six month to five year with third degree malnutrition having weight less than 60 % of that expected for age (according to Modified Gomez Classification of protein energy malnutrition) were taken as case group. These malnourished children were hospitalized due to the complaints of persistent diarrhea, acute diarrhea, acute respiratory infections and ten malnourished children without associated illness were admitted for nutritional rehabilitation.60 healthy children of age six month to five year having weight more than 80 % of that expected for age (according to Modified Gomez Classification of protein energy malnutrition) were taken from outdoor who came for vaccination and also from indoor who came along with other siblings and parents.

Children having liver, kidney, cardiac and chronic lung disease were excluded from both cases and controls.

Among controls 34 were females and 26 were males. Among cases 42 were females and 18 were males.

Among cases 20 children were between six month to one year of age, 15 were 1-2 years old, 12 were 2-3 years old & 13 were 3-5 years old. While in controls 15 children were between six month to one year of age, 18 were 1-2 years old, 15 were 2-3 years old & 12 were 3-5 years old.

Persistent diarrhea was defined as diarrhea lasting for 14 days or longer. Distinction between marasmus (n=48) and marasmic kwashiorkor (n=12) was done according to Welcome's classification of protein energy malnutrition.

A detailed history regarding age, sex, feeding and family history including socioeconomic status was recorded on the proforma. Special inquiries were made regarding history of acute diarrhea, persistent diarrhea & fits. Thorough physical examination was performed especially looking for pallor, jaundice and edema. Detailed systemic examination was done and recorded on proforma. Nutritional status was determined by measuring weight, height and length. Venous samples were taken by the doctor herself. 5cc of venous blood samples were collected in disposable syringes under aseptic techniques and serum was separated by centrifuge machine and was stored at – 20 C^{o} until analysis. Serum magnesium levels were measured by Atomic Absorption Spectrophotometer at Hi-tech Laboratory Agriculture University Faisalabad. At the same time serum proteins and serum calcium levels were also measured.

The results obtained were compared with normal values[4]. Data was analyzed with the help of SPSS (Statistical Package of Social Science) by applying T test. Data was presented through frequency table.

Data Analysis

Results were analyzed with the help of SPSS (Statistical package of social science computer program) by applying T. Test.

Test of Significance

T. Test.

Data Presentation

Through frequency table.

RESULTS

The results of the study showed that in cases mean serum magnesium level was (1.11+/- 0.24) mg/dl, which is in hypomagnesemic range (below 1.56 mg/dl). While in controls, the mean serum magnesium level was (2.01+/- 0.78) mg/dl. (P value < 0.000) as shown in Table-I.
Among controls 40 children having heights > 90 % of that for age showed higher serum magnesium level (2.06+/- 0.29) mg /dl as compared to 20 children having height between 85 – 90 % of that for age, in which serum magnesium level was (1.92+/- 0.20) mg/dl (p value < 0.034).

Table-I. Serum Magnesium in relation to weight for age

Weight for age (%)	n	S/Mg (Mean ± SD) mg/dl
> 80%	60	2.01±0.78
< 60%	60	1.11±0.24
P Value= 0.000		

Among cases 12 children having height < 80 % of that for age showed significantly decreased serum magnesium level of (0.97+/- 0.06) mg/dl as compared to 48 children having height between 80 - 85 % of that for age, in which serum magnesium level was (1.14+/- 0.26) mg/dl (p value<0.000).

Table II described the S/mg-level among cases who presented with persistent diarrhea (38) acute diarrhea (7), acute respiratory infections (5) and children with 3rd degree malnutrition without associated illness (10).

Among cases 48 were marasmic with serum magnesium level (1.14+/- 0.25) mg/dl while 12 were marasmic - kwashiorkor who had serum magnesium level of (0.98+/- 0.05) mg/dl (p value < 0.031).

The age wise distribution of S/mg among both cases and controls is shown in figures-1a and b.

Table-II. Serum magnesium levels.

	n	%age	S/Mg (mean ±SD)mg/dl
Persistent diarrhea	38	63	0.96[a]±0.12
Acute Diarrhea	07	12	1.44[b]±0.29
Acute Respiratory infections	05	08	1.41[c]±0.16
3rd Degree Malnutritions with out associated illness	10	17	1.25[d]±0.05

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.3	03	0.766	37.856***	0.000
Within Groups	1.13	56	2.022 E-02		
Total	3.43	59			

***P value < 0.01*

Fig-1a. Serum Magnesium Age wise distribution in cases.

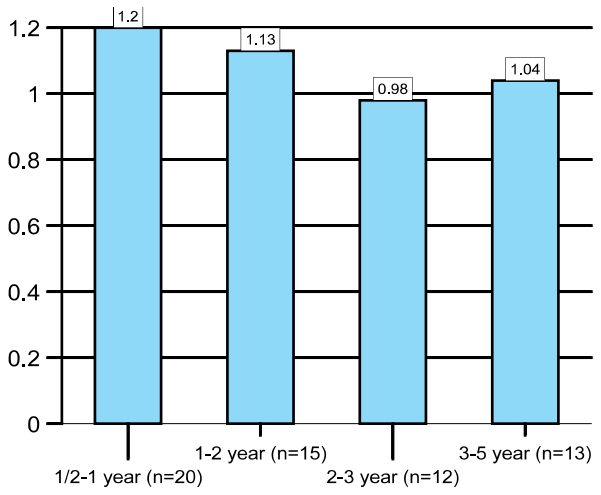
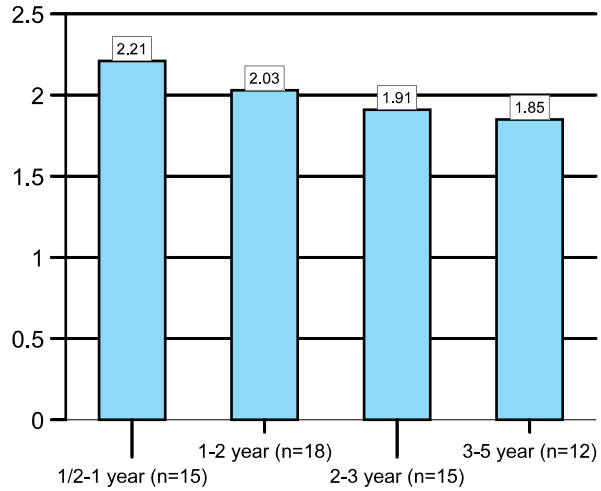


Fig-1b. Serum Magnesium Age wise distribution in controls.



The 12 cases, with the marasmic kwashiorkor who showed decreased albumin level of (2.26+/- 0.32) mg/dl also showed significant decrease in serum magnesium level as compared to 48 marasmic cases who showed serum albumin level of (4.1+/- 0.59) mg/dl as shown in figure-2.

In cases serum calcium level was (8.2 +/- 0.49) mg/dl.
Among cases there was a significant positive relationship between serum magnesium and serum calcium as shown in figure 3.
Among cases hypomagnesemia was clearly documented but they did not show any sign of neuromuscular irritability.

DISCUSSION

The problem of malnutrition has been recognized in Pakistan for several decades and underlies much of its high infant and under five morbidity and mortality[8]. Lot of work has been done on Zinc and copper in children with malnutrition but work on magnesium especially in PEM had not been given much attention.

According to Durlach (2002), evaluation of total Mg in plasma or serum appears as a better marker than ionized

Fig-2. Relationship between Serum magnesium & serum albumin in cases.

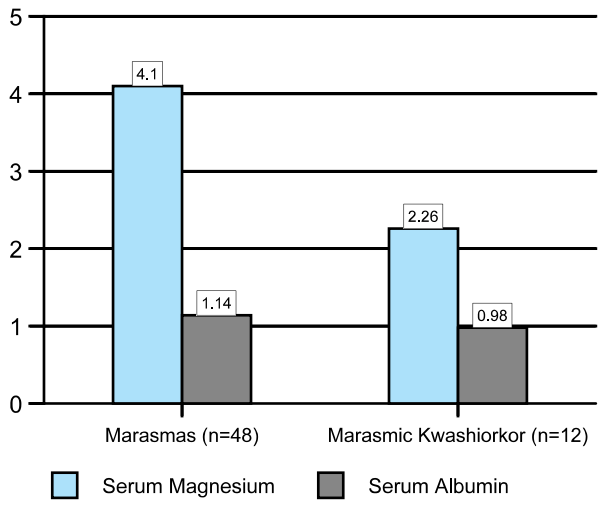
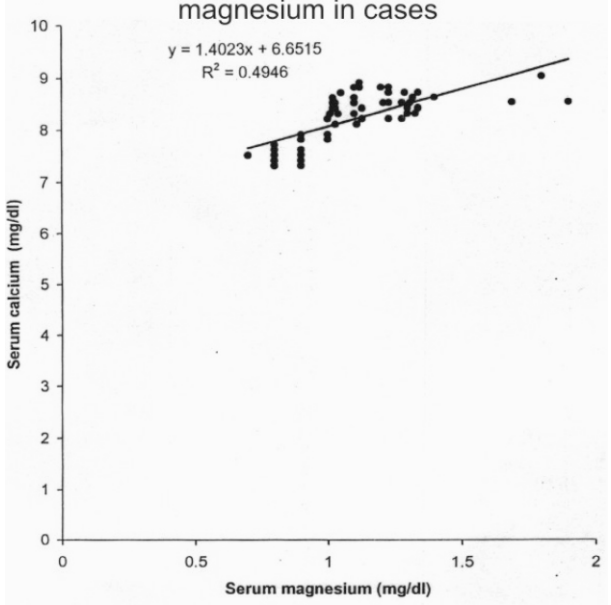


Fig-3. Relationship between serum calcium and magnesium in cases



Mg in Mg imbalance, because it is easily available and inexpensive[9]. In our study we used serum magnesium levels to asses the magnesium status of children.

Lanizinger (2003) also showed that changes in ionized Mg and total serum Mg concentration are closely correlated. Total serum Mg assay, while over estimating the prevalence at ionized hypomagnesaemia, is sufficient to screen hypomagnesaemia[10].

In our study healthy children showed serum Mg level (2.01+/-0.78mg/dl), which was almost similar to previously, published data. Males showed high serum Mg level (2.15+/-0.28) mg/dl than females (1.91+/-0.21)mg/dl. In contrast to this De Lucas (2000) showed that serum Mg was 0.83 +/- 0.1 mmol/L (range 0.66-1.36 mmol / L), with no difference between sexes[11].

In our study infants showed higher serum Mg levels in both cases & controls (1.20+/-0.32mg/dl) , (2.21+/-0.27mg/dl) respectively, as shown in figure 1a & 1b. Similar results were shown by Munoz (2000) in a study conducted at Children's Hospital Boston in which infants also exhibited the highest Ionized Mg concentration[12]. But De Lucas (2000) showed that children under 2 years had higher serum mg levels (0.92+/- 0-13 mmol/L) than children over 2 years (0.81 +/- 0.08 mmol/L P<0.01)[11].

The results obtained from our study revealed that serum magnesium levels were markedly decreased in children with PEM as compared to those who were having normal weight (P<0.000), supporting the hypothesis which was made at the start of study. The serum magnesium levels were significantly related to the degree of linear growth retardation (P<0.000).These findings are comparable to the study done by PN Singula (1998) on 46 malnourished children showing that serum magnesium levels were significantly low in children with moderate (weight for age 61-70%) and severe (weight < 60%) malnutrition and in children with marked linear growth retardation (weight for age < 85%). Nearly half of the marasmic children had serum magnesium levels in the hypomagnesaemic range (below 1.56 mg/dl)[5].

Said (1997) in his study on electrolytes pattern in Plasma and erythrocyte of children with protein energy malnutrition also showed that Mg level was lower than normal in both plasma and RBC's in all-malnourished subject[13].

In our study the serum magnesium levels were more decreased in cases with hypoalbuminemia and there is statistically significant relation between low serum magnesium and albumin (P value <0.031). Comparable to this PN Singula (1998) also showed that Serum magnesium levels had significant relation with weight for age and serum albumin[5].

In this study malnourished children were complicated by acute diarrhea, persistent diarrhea and acute respiratory tract infection and ten malnourished children were without any associated illness. But profound magnesium deficiency was found in malnourished children with persistent tdiarrhea and S/ Mg levels were found to be significantly related to persistent diarrhea in malnourished children (P<0.000). Work done by Caddlle (1973) also showed that decrease serum magnesium in PEM was the result of decrease intake and increase loss from gastrointestinal tract in children with persistent diarrhea (P<0.001)[14].

In our study it was observed that magnesium deficiency in malnourished children was probably due to inadequate intake during the development of PEM and presence of diarrhea worsens magnesium deficiency.

According to Bhutta (2002), in addition to the role of diarrhea, the major contributory factor of micronutrient deficiency in early childhood is poor dietary intake[15].

In this study it was observed that there was a significant relationship between serum magnesium and serum calcium in children with 3rd degree malnutrition as shown in figure 3.

In our study we clearly documented hypomagnesaemia in children with PEM but were not able to find any correlation between signs of neuromuscular irritability and hypomagnesaemia, as most of the patients with hypomagnesaemia were asymptomatic. In contras to this Caddlle and coworkers in 1967 showed that decrease magnesium levels were associated with signs of neuromuscular irritability[16].

Pakistan is a developing country where incidence of malnutrition is high. Work on Magnesium especially in PEM is lacking in our community so this study could be helpful in children with PEM. However it is a hospital based study which can not be applied to community. So further studies are required to define the role of magnesium in PEM, its causes & management.

CONCLUSION

Serum magnesium levels were decreased in children with protein energy malnutrition as compared to the children with normal weight. Serum magnesium levels had relation with weight for age and to linear growth retardation in malnourished children. The decrease in S/Mg levels was marked in those malnourished children who had persistent diarrhea and hypoalbuminemia.

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