Assessment of Calcium, Phosphate and Magnesium Levels among Sudanese Children with Malnutrition

Ibrahim Malik Hospital, Khartoum, Sudan

Khansa Hassan Bushra[1], SalihAbdelgadirElmahadi[2], Ismail Mohamed Ismail[3]

1. Department of Clinical Chemistry, Faculty of Medical Laboratory Science Alneelain University-Sudan
2. Department of Clinical Chemistry, Faculty of Medical Laboratory Sciences, The National Ribat University, Khartoum, Sudan.

Abstract:

Background: Malnutrition is currently the most widespread and serious health problem of children in the world.

Objective: This study aimed to assess calcium, phosphate and magnesium levels among Sudanese Children with Malnutrition.

Materials and Methods: This is a hospital based case control study, which was conducted in the period from 2014 to 2015.A total of 120 samples were collected (60 patients and 60 apparently healthy individuals served as control.Quantitative method by mindary BS200 was used to estimate calcium, phosphorus and magnesium levels in Sudanese children with malnutrition and control group. Data was analyzed using SPSS version 25.

Results: The results showed that 31 (52%) of patients were males and 29 (48%) were females. Thirty seven 37(62%) of malnourished children had Marasmus, 15(25%) of them had Kwash and 8(13%) had marasmic kwash. Forty four 44(73%) of the malnourished children were less than 12 month while 16(27%) were more than 12 month.Mean of BMI, calcium, phosphate and magnesium in patients and control groups when compared showed a significantly decreased in malnourished children as BMI (12.25±0.91 versus 14.71±0.76) calcium (5.59±0.98 versus 9.19±0.62) phosphorus (2.81±0.45 versus 5.26±2.3) magnesium (1.01±0.24 versus 1.91±0.18) P-values 0.006, 0.000, 0.000 and 0.000 respectively. Plasma calcium and magnesium levels in males did not reveal significant change versus female group whereas phosphate element significantly decreased among females, p.value 0.038. There was positive correlation between BMI,Calcium and Phosphorous levels (R=0.269, P=0.038 and (R=0.258, P=0.044) while there was no correlation between BMI and magnesium level (R=0.074, P=0.572).

Conclusion: This study concluded that, calcium, phosphorous and magnesium levels were reduced in malnutrition children patients, and phosphate element decreased among female group rather than male.

Key words: Calcium, phosphorous, magnesium,malnutrition children

Introduction:

Malnutrition is a complex problem which results from a long chain of interrelated events. It continues to be a major health burden in developing countries and affects mostly infants, young children and lactating mothers [(1)]. Protein-energy malnutrition (PEM) previously referred to as protein-calorie malnutrition (PCM) describes the severe form of malnutrition seen in childhood (kwashiorkor, Marasmic-kwashiorkor, Marasmus and underweight) is the most common nutritional disorder affecting children in developing countries and the third most common disease of childhood in such countries. It manifests primarily by inadequate dietary intake of protein and energy and always accompanied by deficiencies of other nutrients [(2)].Undernutrition,is still one of the major public health problems especially in Sub-Saharan Africa [(3)]. Undernutritioned children may develop severe infection secondary to compromised immune responses as well as influences many immune aspects, as cell-mediated immunity [(4, 5)]. Undernutrition contributed with bacterial, parasitic infections revealed in a high prevalence in poor countries [(6)]. The most vulnerable to undernutrition group are children and that is due to inadequacy of dietary intake, inaccessibility to food,inequitable distribution of food within the household, improper food preparation and storage, dietary taboos and infectious diseases [(6)]. Especially, micronutrient deficiencies are a result of inadequate intake or inefficient utilization of available micronutrients due to infections and parasitic infestations[(7)]. Malnutrition plays an important role in more than half of all child deaths worldwide and has adverse effects on the health status of children aged 0 to 5 years [(8)].Calcium element serves a major role in muscle contraction and regulation of water balance intracellularly, its plasma imbalance disturbance fluctuates the blood pressure. Magnesium element modulates various tasks in the body, serves with a group of enzymes as co-factor, neurochemical transmitter and in peripheral vasodilation [(9)]. Magnesium deficiency is often developed in a wide variety of clinical conditions. These clinical conditions may be protein-energy malnutrition, malabsorption, hypoalbuminemia, sepsis, conditions that are commonly seen in children in developing countries [(10)]. Eighty-five percent of the body phosphorus is located in the mineral phase of bone. In ECF, phosphate is mostly inorganic. Intracellular phosphate has vital functions in macromolecular structure, energy metabolism, enzyme activation by phosphorylation and cell signaling. Intracellular phosphate is largely organic as a component of phospholipid,phosphoprotein, nucleic acid and nucleotides [(11)].In a severe acute malnutrition states (SAM) in children usually accompanied by deficiencies of phosphorus, magnesium and other minerals [(12)].

Materials and Methods:

This is a hospital based case control study, which was conducted in period from 2014 to 2015**.** A total of 120 samples were collected (60 patients and 60 healthy children served as control (age and sex matched with test group)**.** The study included Sudanese children with malnutrition and healthy children served as control. The study excluded any patients with bone disease, renal disease, thyroid disease, other chronic disease and any drug that affect calcium, phosphorus and magnesium measurement.Five 5ml of blood was obtained from each group (patients, control) and then placed in plane tubes. The blood was centrifuged to separate serum and was used for the estimation of calcium, phosphorus and magnesium

levels.Quantitative method by (mindray BS200, China) was used to estimate calcium, phosphorus and magnesium in all of the two groups.The study was approved by the ethical committee in faculty of Medical Laboratory Sciences, Alneelain University, and informed consent was obtained from each participant's mother before sample collection. Data was analyzed using SPSS version 21. The results were expressed as frequencies, percentage, mean and Standard Diviation. Independent t-test was done to compare the mean levels of calcium, phosphorus and magnesium in case and control groups. ANOVA was obtained to compare the mean of calcium, phosphorus and magnesium across the types of malnutrition. Correlation was done to study the relationship between study variables (age and BMI) with study parameters (calcium, phosphorus and magnesium).

Results:

Figure (1) distribution of patients according to gender and type of malnutrition, out of 60 malnourished children, 31 (52%) were males while 29 (48%) were females. 37 (62%) of malnourished children had Marasmus, 15 (25%) of them had Kowash and 8 (13%) had both marasmic kwash.

Table (1) distribution of patients according to age group, the frequency analysis showed that,44 (73%) of the malnourished children were less than 12 month while 16 (27%) were more than 12 month.

Table (2): shows mean of BMI, calcium, phosphate and magnesium levels in patients and control groups. The levels of BMI, calcium, phosphate and magnesium were significantly decreased in malnourished children compared to control group: BMI (12.25±0.91 versus 14.71±0.76) calcium (5.59±0.98 versus 9.19±0.62) phosphorus (2.81±0.45 versus 5.26±2.3) magnesium (1.01±0.24 versus 1.91±0.18) *P-value*(0.006, 0.000, 0.000 and 0.000), respectively.

Table 3: demonstrates comparison of means of the study parameters in the two gender groups. Calcium and magnesium showed no significant changes while phosphorous decreased significantly among females group, p.value = 0.038.

Table (4): shows mean of BMI, calcium, phosphate and magnesium across the types of malnutrition. There was insignificant difference in calcium and magnesium levels in male malnourished children (5.48±0.95 versus 5.71±1.0) and (1.04±0.26 versus 0.96±021) compared to female malnourished children p-value 0.368 and 0.158 respectively. Phosphorus level was significantly different in male malnourished children (2.91±0.45 versus 2.07±0.43) compared to female malnourished children p-value 0.038.

Table (5) shows correlation between age and calcium, phosphorus and magnesium there was no correlation between age and calcium, phosphorus and magnesium

Figure (2)correlation between BMI and calcium, phosphorus and magnesium**,**there was positive correlation between BMI,Calcium and Phosphorous level while there was no correlation between BMI and magnesium level.

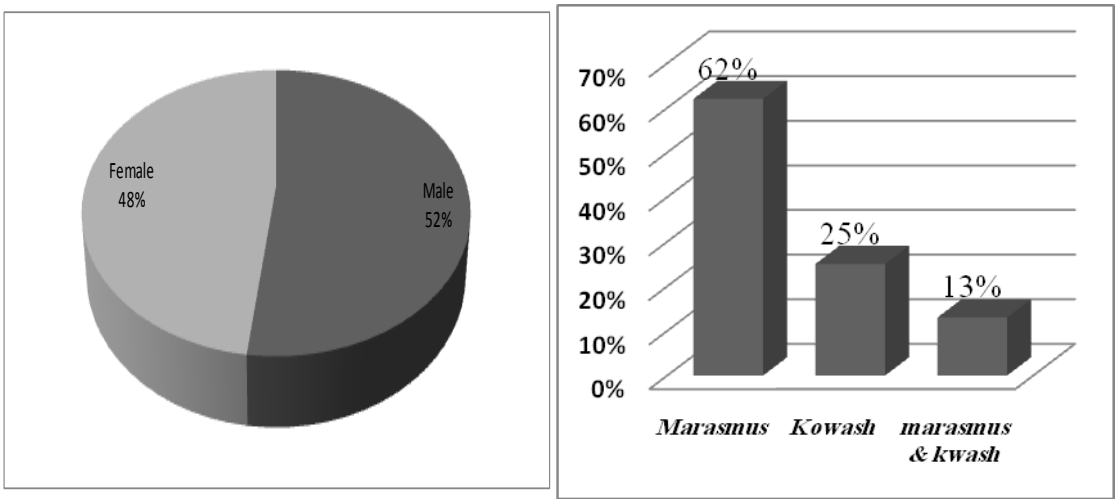

Figure (1): Distribution of patients according to gender and type of malnutrition(N=60)

Table (1):Distribution of patients according to age group (N=60)

Variable	Frequency	Percentage (%)
<12 Month	44	73.0
>12 Month	16	27.0
Total	60	100.0

Table (2): Comparison of means of study parameters in case versus control group(N=60)

Parameters	Case (Mean±SD)	Control (Mean±SD)	*P-value*
BMI	12.25±0.91	14.71±0.76	0.006
Calcium (mg/dl)	5.59±0.98	9.19±0.62	0.000
Phosphorus (mg/dl)	2.81±0.45	5.26±2.3	0.000
Magnesium (mg/dl)	1.01±0.24	1.91±0.18	0.000

Table (3):Showscomparison of means of study parameters(Calcium, phosphorous, magnesium) across gender

Parameters	Male (Mean±SD)	Female (Mean±SD)	*P-value*
Calcium (mg/dl)	5.48±0.95	5.71±1.0	0.368
Phosphorus (mg/dl)	2.91±0.45	2.07±0.43	0.038
Magnesium (mg/dl)	1.04±0.26	0.96±021	0.158

Table (4): Comparison of means of study parameters (BMI, Calcium, phosphorous, magnesium) across malnutrition types(Marasmas, Kwash, Marasmas/kwash). (N=60)

Parameters	Marasmus (Mean±SD)	Kowash (Mean±SD)	marasmus/kwah(Mean±SD)	*P-value*
BMI	12.02±0.87	12.87±0.59	12.21±1.11	0.007
Calcium (mg/dl)	5.68±1.00	5.43±1.01	5.48±0.87	0.655
Phosphorus (mg/dl)	2.76±0.43	2.76±0.44	3.130±0.49	0.106
Magnesium (mg/dl)	0.99±0.25	1.05±0.26	0.98±0.15	0.721

Table (5) correlation betweenageand (calcium, phosphorus and magnesium)

Parameters	*R-value*	*P-value*
Age//Calcium (mg/dl)	-0.222	0.088
Age//Phosphorus (mg/dl)	-0.019	0.884
Age//Magnesium (mg/dl)	0.122	0.355

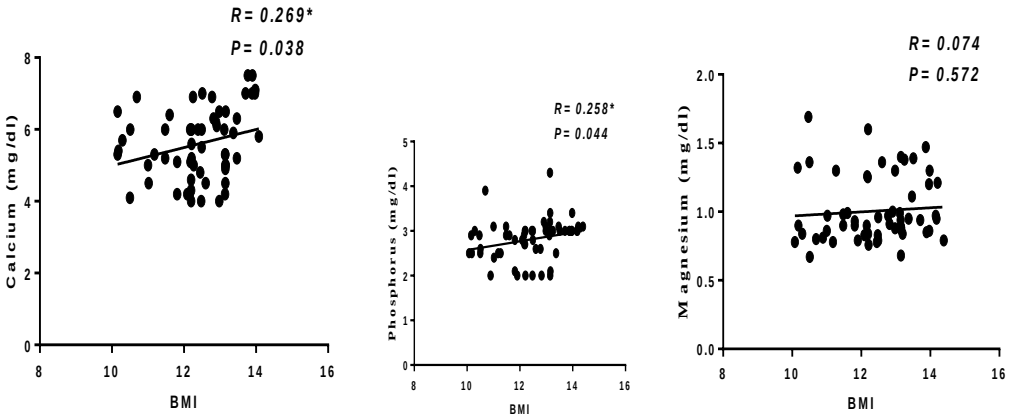

Figure (2): Correlation between BMI and study variables (calcium, phosphorus and magnesium).

Discussion:

Malnutrition continues to be a major problem among children in developing countries[13]. Good nutrition aids to prohibit acute and chronic illnesses and to potentiate physical and mental activities [14].The idea of starting nutritional assessment is an important pre-step of normalizing nutritional status by clinical nutritionist and registered dietician to confirm the existence of malnutrition, to assess its effects and to formulate diets that will maintain the adequacy in nutrition.Poor nourishment results from improper diet or from some metabolic defect that deprives the body to utilize food properly [14].The present study showed that, malnutrition was more common in <12 month old than >12 month old. These findings are in agreement with several previous researches in African (Malawi, Zambia and Nigeria)

countries who reported that malnutrition tendency to develop in lower aged than older age [15, 16,17].In this study malnutrition frequency was found slightly higher among males 52% than females 48%. In fact this result findings was similar too old and recent study done by (kaneta, et al, 2000,Ahmed et al, 2016, Shazia F et al, 2017), who mentioned that malnutrition most abundant in males than females [18, 19, 20].The present study results revealed that, calcium, phosphorous and magnesium levels were significantly decreased in malnourished patients compared to control group, as previously, (Mahaman.et al 2017) had reported. Usually the occurrence of reduced levels of these nutrients among malnourished children due to dietary deficiency or infection owing to increased metabolic losses. The dietary deficiency of calcium could be as a result of intake of calcium-free diet such as gruel which is often prepared from phytates-containing cereals [20].Also the results showed, there was significantly decreasein the mean of BMI in patients compared to control group.The result findings concerning mean levels of calcium and magnesium in malnourished males and females children were the same, while phosphorous revealed a significant reduction in females, (p.value = 0.03), this may be attributed to volemia of the normal distribution of human body-fluids, accordingly the female gender body-water content of high percent than males or may be due to extension of period stay with malnutrition in which the patients presented with hypophosphatemia [19].

Concerning ANOVA analysis for comparison between the three types of malnutrition, there was no significantly changes in the parameters (calcium, phosphorous, magnesium),except BMI, p.value = 0.007..Regarding the correlation study, there was no correlation between calcium, phosphorus and magnesium levels with age of malnourished children. This result was agreed with another finding reported by Ahmad, et al 2016, which indicated that, there was no correlation between electrolytes (calcium and phosphorous) levels and age of malnourished children [20].Also the correlation showed that, there was positive correlation between BMI and (Calcium and Phosphorous) levels while there was no correlation between BMI and magnesium level. This result agreed with another result carried by Freedman, et al, 2009 which showed positive correlation between BMI and calcium and phosphorous [21].

Conclusion:

This study concluded that, calcium, phosphorous and magnesium levels were reduced in malnutrition children patients. BMI was positively correlated with calcium and Phosphorous levels.

References:

1. Muller, O., Krawinkel, M.Malnutrition and health in developing. countries.*Can Med Ass J,2005*;171:279-293.
2. Nassar, M.F., Dina, A .A.,Salwa , R.E and Soad ,M.G**.** Markersof bone metabolism in Protein Energy Malnutrition. Intern *J FoodNutrPublicHealth*(2010).; 3:59-70
3. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J: Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008, 371(9608):243–260.
4. Rayhan I, Khan SH: Factors causing malnutrition among under five children in Bangladesh, Asian Network for Scientific Information. Pak J Nutr 2006, 5(6):558–562.
5. 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, 5:260–275.
6. Chandra RK: Nutrition and the immune system: an introduction. Am J Clin
7. Nutr 1997, 66:460S–463S.
8. Girma W, Genebo T: Determinants of Nutritional Status of Women and Children in Ethiopia. Calverton, Maryland, USA: ORC Macro; 2002:38–143.
9. Grimble RF: Malnutrition and the immune response 2. Impact of nutrients on cytokine biology in infection. Trans Royal Soc Trop Med Hyg 1994, 88:615–619.
10. BemnetAmare, BeyeneMoges, BereketFantahun, KetemaTafess, DesalegnWoldeyohannes, GizachewYismaw, et al. Micronutrient levels and nutritional status of school children living in Northwest Ethiopia. Nutrition Journal 2012;11(108):1-8.
11. Ake-Tano O, Ekou FK, Tetchi EO, Koffi KB, Oussou KR, Kpebo DOD, CoulibalyTiembre I et Koffi K (2011). Détermination de la malnutrition chez les enfants de moins de 5 anssuivis à l'institut national de santé publique Côte d'Ivoire. Med. Afri. Noir. 58(2):93-99.
12. Rude RK: Magnesium disorders. In Fluids and Electrolytes.3rd edition.
13. Edited by Kokko JP, Tannen RL. Philadelphia: WB Saunders; 1996:421–445.
14. Nicolas PolicarpeNolla, Marie Modestine Kana Sop, Mariyne Josephine Mananga, TetanyeAkoe, InocentGouado. (2014) Assessment of nutritional status of preschool children in the Bangang rural community, Cameroon. International Journal of Biotech and food Science;2(2):44-52.
15. Geoffery,B.,Simon,W.,Peter,R and Peter,A. Clinical Biochemistry. 7thedition..(2005). USA:Blackwell Publishing Ltd:72-89.
16. Anne-Louise Hother*, TsinuelGirma, Maren J. H. Rytter, AlemsegedAbdissa, Christian Ritz, Christian Mølgaard,Kim F. Michaelsen, André Briend, HenrikFriis , PernilleKæstel.Serum phosphate and magnesium in children recovering from severe acute undernutrition in Ethiopia: an observational study. BMC Pediatrics (2016) 16:178; 1-9.
17. Angelina OpokuDanquah, *, AdwoaNyantakyiwaa Amoah2, Clara Opare-Obisaw.Nutritional status of upper primary school pupils in a rural setting in Ghana.International Journal of Nutrition and Food Sciences.2013; 2(6): 320-326.
18. FarougBakheit Mohamed Ahmed1, Esam-EddinBakheit Mohamed Ahmed. Malnutrition Among Basic Schools' Children of Elshagalwa Village, Shendi Locality, Sudan. International Journal of Nutrition and Food Sciences2016; 5(2): 134-138.
19. Jobiba, C., Andrew, T., Theresa, B., Catherine, M.P.F.(2008). The impact of HIV on mortality during in-patient rehabilitation of severely malnourished children in Malawi.*Trans R SocTrope Med Hyg*; 102: 639-644.
20. Irena, A.H.,Mwambazi, M., Mulenga,V.(Diarrhea is a major killer of children with severe acute malnutrition admitted to inpatient set-up in Lusaka, Zambia. *NutrJ*, 2011, 10(1):110.
21. Chukwuma, B., Uche, R., Oluoha.,Kelechi, A., Uwakwe1., Kelvin, C., Diwe., Irene, A., Merenu., Ifeadike, O.,Chigozie, A., Anthony, C and Iwu.(Prevalence and Sociodemographic Determinants of Malnutrition among Under-Five Children in Rural Communities in Imo State, Nigeria.*Amer JPH R*; 2015. 3(6):199-206
22. kaneta, k . , Choudhury , M . , Hanifi , S and Abbas , A . gender inequality and severe

malnutrition among children in a Remote Rural Area of Bangladesh .*J health population*, center For Health and population Research; (2000).; 18(3):123-130.

23. Ahmad ,M.S..Prevalence of Electrolyte Disorders Among Cases of Diarrhea with Severe Dehydration and Correlation of Electrolyte Levels with Age of the Patients ,*Journal of the College of Physicians and SurgeonsPakistan.*2016,26 (5): 394-398.
24. Shazia F, Abbas K, Falak Z, Saleem K, Mahpara S, et al. (2017) Nutritional Status Assessment of Children with Nutritional Rickets Under Five Years at District Headquarter Hospital, Upper Dir- Pakistan. J Nutr Health Sci 4(2): 1-7.
25. Freedman, D., Wang, J., Thornton, J., Mei, Z., Sopher, A and Pierson,R. (Classification of body fatness by Body Mass Index-for-Age among children. Archives of Pediatric & Adolescent Medicine, 2009, 163(9), 805-811.