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Effect of essential mineral status in growth shunt and metabolic abnormalities of protein energy malnutrition children

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Abstract
Protein-energy malnutrition (PEM) is a major problem in modern children. They effect lot of growth and minerals like Ca+, Zn+, Iron, and Po4. These minerals directly affect growing children along with Protein Energy Malnutrition.
Materials and Methods: The study was conducted on those suffering from malnutrition subjects in Malwanchal University (Index Medical College & Hospital, Department of SPM, and Pediatrics Department. These parameters under assessed by 150 cases and 150 controls.
In this study cases and controls interpret the values of minerals are significantly lowered except phosphate is elevated p=0.01, z=0.01, t=0.01.
Conclusion: The minerals such as serum Ca+, Zn+, Iron, and Po4 are poor in PEM children because the lack of minerals widely affects growth and bone (demineralization) protein synthesis. formation of hemoglobin leads to effects lot of metabolic abnormalities, loss of appetite, impairment of zinc-dependent cholecystokinin hormone leads to effect of bile production lack of vitamin D and cholesterol absorption low calcium effect.
Low transferrin levels and transferrin saturation were seen in this study.

Keywords: Protein energy malnutrition, calcium, zinc phosphorus, social preventive medicine

Introduction
Protein-energy malnutrition is a challenge for WHO for epidemiologically social health effects in children commonly observed edema, anemia, osteoporosis, hyperpigmentation, growth shunt, mental illness metabolic abnormalities effect in PEM children. In the last 15 years, there has been a continuing interest in biochemical indices of nutritional status. The search for these indices has been directed towards two main objectives [1].
World Health Organization (WHO) has defined, "Protein Energy Malnutrition (PEM)" as a range of pathological conditions arising from a coincidental lack in varying proportions of proteins and calories, occurring most frequently in infants & young children & commonly associated with infection [2].
For years nutrition scientists thought that lack of protein and energy were the primary causes of PEM. Today we know that in most cases PEM is caused by a combination of inadequate dietary intake, lack of good care, and the adverse effect of infection [3].
PEM is not an isolated deficiency of protein & energy alone but is usually associated with general undernutrition due to complex biological & social adverse processes.
WHO has described malnutrition as a "global problem", having adverse effects on the survival, health performance & progression of population groups. The growth of the child starts to falter & the process of becoming malnourished tends to start at around 4-6 months of age – the age at which a child needs to have semi-solid foods in addition to breastfeeding. This is the critical period for prevention of malnutrition [4].
This is also the age at which diarrheal incidents tend to rise. Persistent diarrhea is often associated with malnutrition. The illness tends to be of longer duration, increased severity & a substantially higher risk of death.
The National Family Health Survey (NHFS) depicts the most common age of PEM between 6 months – 2 years & around 50- 60% of children are malnourished by 2 years [5].

As per the National Nutrition Monitoring Bureau (NNMB), there is caloric inadequacy in a larger proportion of children (60%) than in adults (45%).

The global percentage (%) of underweight children less than 5 years of age is 27%.

Malnutrition is more common in India (47%) than in Sub-Saharan Africa (29%). 1 out of every 3 malnourished children in the world live in India.

PEM has been recognized as a major health & nutrition problem in India. It is most common in preschool children (incidence in preschool children is 1-2%). 2 out of 3 preschool-age children are severely or moderately malnourished. About 6,600 children under the age of 5 die daily due to malnutrition in India. PEM accounts for death in 7% of cases & is the underlying cause of death in 46% of cases below 5 years. A major cause of death is the potentiation of the infectious diseases by malnutrition [6].

The majority of PEM (60-70%) is mild to a moderate degree, but 2-5% of preschool-age children suffer from severe PEM [6].

In India 46 % of all children under the age of three are too small for their age, 47 % are underweight and 16 % are wasted. Prevalence of severe malnutrition varies across the states with MP recording the highest rate (55%) and Kerala, the lowest (27%). In Madhya Pradesh, it is 37% [7].

PEM is an important cause of childhood morbidity and mortality and leads to permanent impairment of physical and mental health among survivors. It has a long-term effect on cognitive and social development, physical work capacity, productivity, and economic growth [8].

Calcium is the principle mineral for bone formation and regulates the various metabolic and physiological functions. In malnutrition, children effects low calcium levels lead to impaired bone formation and commonly observed calcium resorption from bone. Due to a lack of vitamin D. IAP third-degree protein-energy malnutrition, ultrafilterable or diffusible serum calcium concentrations remain normal, while the protein-bound fraction is low in those with hypoalbuminemia, accounting for overall hypocalcemia [9].

Nutrition is the life-sustaining process by which elements of nature are assimilated and used for 1) growth and development 2) for maintenance of healthy tissue and 3) as mediators of physiological and metabolic processes. When there is a lack of good nutrition, it is not surprising that there is impaired host defense, wound healing, mentation, and muscle strength. These adverse effects have a profound pathological effect on the general body growth and development of children [10].

Malnutrition children have luminal acidity more. The acidity inhibits iron absorption and peptides also promote iron absorption. Due to lack of dietary proteins impairs the absorption of Iron and synthesis of transferrin. This results in transferrin saturation occur.

Transferrin kinetics are altered in children with severe protein-energy malnutrition, reduction in concentration in severe protein-energy malnutrition [11].

Transferrin is the major transport protein for iron and is the second most investigated protein marker in malnutrition. It is synthesized in the liver and has a much smaller pool than albumin, most of it being intravascular. So it is more sensitive than albumin to decrease in synthesis in the liver. It has a shorter half-life of 8-9 days in comparison to albumin which has a half-life of 20 days, thus making it a more sensitive protein-energy balance marker as well as a prognostic indicator [12, 13].

Plasma transferrin concentration of the acutely malnourished children was markedly lower compared with values at recovery and values from normal children (200-360 mg/dl). In normal health, the pool size of a plasma protein could be reduced by one of the two possible mechanisms- either owing to a decrease in synthesis rate unbalanced by a change in the rate of catabolism, or an increase in the catabolic rate relative to the synthesis rate.

The total body protein along with transferrin, the major iron-binding transport protein is reduced in protein energy malnutrition. In normal children, only 30% of the available transferrin is involved in the binding and transport of iron; hence there is an excess of iron binding capacity in malnourished children [14, 15].

Owing to the decreased availability of transferrin in children with severe PEM, plasma transferrin becomes more saturated with iron, thus markedly reducing the iron binding capacity in PEM.

There are very large reductions in serum transferrin concentrations in kwashiorkor, and there are progressive reductions in the concentration of this protein in the serum of monkeys during the development of severe PEM. It would seem worthwhile therefore to study the use of the measurement of serum transferrin concentration as a method for the early detection of undernutrition [16].

Malnutrition is a globally prevalent disease, more so in the developing countries. It includes both macronutrient and micronutrient or trace element deficiency of late, zinc has been recognized as an essential trace element, required for maintaining normal body homeostasis. Zinc deficiency is associated with growth retardation (height and weight), delayed sexual and bond maturation, impaired immune function, recurrent infections, dermatitis, diarrhea, alopecia, anorexia, and mental disturbances, serum zinc levels are low in protein energy malnutrition globally. Zinc supplementation during the rehabilitation phase of malnutrition has been associated with rapid weight gain [17].

Protein Energy Malnutrition subjects altered the phosphate levels during hypocalcemia.

Materials and Methods

The study was conducted over 1 year and 6 months Department of SPM & pediatrics at Malwanchal University, Index Medical College & Hospital both sexes were included and all of them were in the age group of 7 – 13 years children, the children were identified and isolation by both departments as SPM and Paediatrics of North Indian population of Madhya Pradesh in Indore premises villages. First time the n-value sample size represented 150 cases and 75 controls and referred to be central clinical biochemistry laboratory for the assessment of mineral estimation and transferrin protein in Index Medical College & Hospital in Indore were enrolled as controls from the normal individuals such as over not under by divine healthy children in consumption of healthy nutrients history undertaken by a survey of SPM department.

To whom so ever effect in PEM that might affect serum Zn^+, Ca^+, Iron, Phosphorus, and transferrin as inclusion parameters exclusion parameters are Na^+, K^+, Cl^-, and Fluoride. Informed consent was taken for all subject's sample collection.

Sample collection
After isolation from the SPM department and pediatrics ward collection of 3.5 ml blood sample was allowed to clot for serum separation the serum was used for the estimation of Ca+, Zn+, Iron, and Transferrin levels.

Estimation of Calcium
OCPC method (o-cresol phthalein complexone method) measured at 570 nm.

Calculations: Calcium in mg/dl = Absorbance of test/absorbance of standard X 10

Reference value: calcium- 9-11 mg/dl

Estimation of serum phosphorus
Phosphate reacts with molybdate in a strong acidic medium to form a complex.
The absorbance of this complex in the near ultraviolet is directly proportional to the phosphate concentration.
Reference values Phosphorus = 3.5- 5 mg/dl.

Estimation of Zinc
Nitro-PAPS method (Phosphorus Adenosyl Phospho Sulfate)
Zinc in an alkaline medium reacts with nitro-PAPS to form a purple-coloured complex. The intensity of the complex formed is directly proportional to the amount of zinc present in the sample.

Reference values Zinc = 66 – 106 mcg/dL

Estimation of Iron
The serum iron gives a measure of the iron supply to the tissues at the time of sampling.

Chromogenic Method
When serum iron is treated with a mixed acid reagent, the protein-bound iron is detached by the action of conc. HCL and reduced to a ferrous state by thioglycolic acid and proteins are precipitated by the action of TCA

Reference values Iron = 11.5 - 12.8 mg/dL

Estimation of Transferrin
Immunoturbidimetric Method
Diagnostic reagent for quantitative in vitro determination of transferrin (TOF) in serum or plasma on the photometric system.

Reference value Transferrin = 250 – 380 mg/dL

Statistical analysis
The data was analyzed using the statistical software SPSS12. Version. Values are expressed as mean ± SD comparison of continuous variables was done. Using PEM subjects 't' test correlation and in case of Skeweeds Ranle correlation test was used p-value and t value <0.0001 was considered statistically significant.

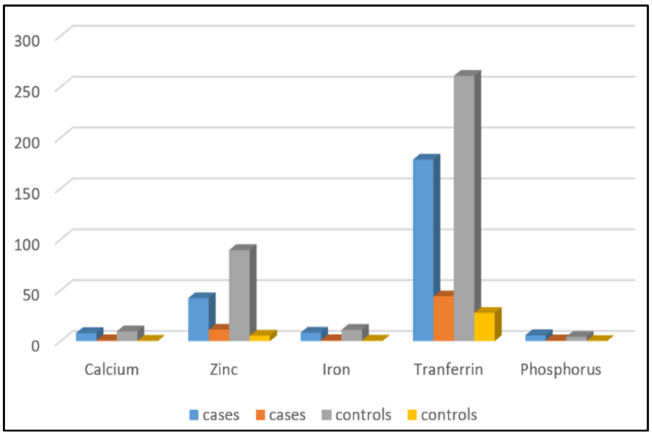
Results

Table 1: Case and control study of mineral status in PEM children

Sl.no	Parameter	Cases		Controls		t value	p value
		Mean	S.D	Mean	S.D		
1	Calcium	7.95	0.82	9.67	0.4	27.56	<0.0001
2	Zinc	42.3	11.3	89.52	5.4	34.25	<0.0001
3	Iron	8.3	0.9	11.15	0.5	24.5	<0.0001
4	Transferrin	178.4	44	260.7	28	14.79	<0.0001
5	Phosphorus	5.8	0.7	4.24	0.3	18.7	<0.0001

Calcium P value and statistical significance: The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval: The mean of PEM subjects minus Controls equals Intermediate values used in calculations: t = 27.56.
Zinc P value and statistical significance: The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of PEM subjects minus Controls equals Intermediate values used in calculations: t = 34.25.
Iron P value and statistical significance: The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of PEM subjects minus Controls equals Intermediate values used in calculations: t = 24.50.
Transferrin P value and statistical significance: The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of PEM subjects minus Controls equals Intermediate values used in calculations: t = 14.71.
Phosphorus P value and statistical significance: The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of PEM subjects minus Controls equals Intermediate values used in calculations: t = 18.70.



Bar diagram chart comparison of cases and controls minerals and transferrin

Discussion

In the Protein Energy Malnutrition children, the mean value of minerals and transferrin protein was found <0.0001 significant except for phosphorus when compared to controls. The levels of abnormal values of Ca+, Zn+, Iron, and transferrin promote the demineralization of bone loss of apatite an anemia observed in lack of essential dietary factors in body fluids of (serum) children. Demineralization of bone is commonly seen in PEM children as recorded by WHO and also this study correlates with the previously recorded values.

The previous study and present publishing study correlation of the values are significantly positive of essential minerals are lowered except phosphate is elevated. This is not my controversy in the result confidently accepting SPM and pediatrics department there was running studies, authors and research scholars strongly announced the PEM children lack essential minerals Ca+, Zn, Iron, and transferrin is most important parameters the transferrin levels are understanding of transferrin saturation in soft tissues due to lack of iron.

Calcium is lower in the PEM because of a lack of vitamin D synthesis lack of calcium-binding protein and lack of dietary calcium these incidences say hypocalcemia is the factor affected by lack of zinc. Zinc influences the transcription factor of CBP in intestinal cells this is the result of lower calcium levels and also loss of the apatite due to lack of zinc. When lack of iron the transferrin is waiting for transportation for the ferric.

Conclusion

Calcium is one of the minerals for bone formation when lack of dietary Ca+ or poor consumption of Zn+ leads to demineralization of bone hypocalcemia seen in this study, impairs the consumption of iron dietary factors lack of protein for the synthesis of transferrin leads to transferrin saturation occur in the PEM children the study indicates the hypercalcemia, Anaemia, Hypoalbuminemia, Edema, observed due to lack of this essential minerals and impairs the metabolic function of phosphorus is elevated in this condition.

This study examines the role of zinc malnutrition in PEM children. Zinc is a primary mineral for the regulation and enhancement of hunger (appetite) prevention of loss of appetite improves the absorption of essential dietary factors for the synthesis of Na+-dependent carrier protein for the absorption of amino acids.

Regulation of taste sensation for the Gustine protein, the protein energy malnutrition (PEM) children commonly lack of absorption of zinc leads to loss of taste this facto impair the appetite, impair the synthesis of amino acids absorption from the intestine, zinc also influences the synthesis of proteins like albumin when lowers the zinc levels in the PEM children leads to hypoalbuminemia.

Transferrin is a glycoprotein that is important for ferric transportation from the lumen to the liver, blood, and spleen when a lack of consumption of dietary iron leads to transferrin saturation. It is commonly seen in iron deficiency anemia in PEM children.

Zinc is also one of the transcription factors for the synthesis of calcium-binding protein (CBP) in intestinal cells, CBP can promote the absorption of calcium, and lack of zinc impairs the dietary calcium from the intestine.

Protein-energy malnutrition is a challenge for WHO for epidemiologically social health effects in children commonly offer edema, anemia, osteoporosis, growth shunt, mental illness, and metabolic abnormalities are major health risks in protein malnutrition energy children. It can be prevented by the administration of essential dietary factors which we are suggesting in this study.

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