ORIGINAL ARTICLE

SERUM COPPER AND ZINC LEVELS IN PRESCHOOL CHILDREN WITH PROTEIN ENERGY MALNUTRITION

Asha Khubchandani*1, Hiren Sanghani2, Gagandeep Sidhu1, Sandip Sendhav2, Paulin Gandhi2, Viral Solanki2

1 Associate professor, 2 Resident, Departments of Biochemistry, B.J.Medical College & Civil Hospital – Ahmedabad, Gujarat,

ABSTRACT

BACKGROUND: Malnutrition is like an iceberg, most people in the developing countries live under the burden of malnutrition. The objective of the study was to determine the serum copper and serum zinc level in preschool children with protein energy malnutrition. MATERIALS AND METHODS: Serum zinc and copper were estimated in thirty (30) malnourished pre-school-age children (age, 6-60 months) and thirty (30) age-and sex-matched apparently healthy well nourished controls to evaluate the effect of protein-energy malnutrition on serum zinc and copper. Along with that serum total protein and serum albumin were also measured. RESULTS: Mean serum zinc and copper were significantly reduced (p<0.05) in malnourished than in well-nourished children. While serum total protein was significantly lower (p<0.05) in malnourished than the controls, and comparable (p>0.05). Among kwashiorkor and marasmus, serum albumin was significantly lower (p<0.05) in kwashiorkor than in marasmus. CONCLUSION: For effective management of protein-energy malnutrition, zinc and copper supplementation should be part of treatment regimen, however, in order to prevent zinc and copper deficiency and its health implications in pre-school age children, food fortification should be promoted.

Keywords: Protein energy malnutrition, Serum albumin, Serum Copper, Serum total protein, Serum Zinc

INTRODUCTION

Malnutrition is like an iceberg, most people in the developing countries live under the burden of malnutrition.1 Malnutrition continues to be a primary cause of ill health and mortality among children in developing countries. Children, especially those less than 5 years old, are among the most susceptible. It is a major public health problem and accounts for about half of all child deaths worldwide.2 Besides poverty, there are other factors that directly or indirectly affect the nutritional status of children. Several studies showed that maternal education emerges as a key element of an overall strategy to address malnutrition.2 The best global indicator of children’s well being is growth. Poor growth is attributable to a range of factors closely linked to overall standards of living and the ability of populations to meet their basic needs, such as access to food, housing and health care. Assessment of growth is the single measurement that best defines the nutritional and health status of children, and provides an indirect measurement of the quality of life of the entire population.5 In addition to deficiencies of energy and proteins, children with protein-energy malnutrition (PEM) have been found to be deficient in micronutrients.3,4 Causes of malnutrition include, inadequate intake as a result of insufficient or inappropriate supply of food, early cessation of breastfeeding, cultural and religious beliefs, poor sanitation, increased armed conflicts and chronic diseases.5,6 Zinc and copper are essential nutrients for human beings as they are required for the functional activity of several enzyme systems. Trace element deficiencies are common in children with protein energy malnutrition and, as a result, they may suffer from various nutrient-specific deficiency disorders.7 The

*Corresponding Author
Dr. Asha S Khubchandani
Associate Professor in Biochemistry
11, Vidhi Bunglows, New C.G. Road, Chandkheda, Ahmedabad-382424, Gujarat.

Email: ashakhub@yahoo.com
clinical features of zinc deficiency like poor appetite, growth failure, skin lesions, diarrhea, poor wound healing and impaired immune response are also observed in children with severe PEM. Inadequate zinc intake may limit the growth of these children during recovery from malnutrition. Both zinc and Copper exert a beneficial influence on host defense mechanisms, a finding that has important implications for the management of malnourished children. Therefore, this study was carried out to evaluate zinc and copper status of the malnourished children by measuring the concentrations of these elements in the serum.

MATERIALS AND METHODS
The cross sectional case control study was conducted in Civil Hospital, Ahmedabad during August 2012 to December 2012. Altogether 60 children (6 – 60 months) were involved in this study. Out of 60, 30 children with protein energy malnutrition based on clinical findings and anthropometric parameters included who were admitted into the paediatric ward of Civil Hospital. Children with liver or kidney disease at the time of study were excluded. The children were classified into marasmic (n=10), kwashiorkor (n=13) and marasmic kwashiorkor (n=7) in accordance with Welcome classification. Thirty (30) age-and sex-matched well nourished and apparently healthy children attending Paediatric out-patient Department of Civil Hospital for regular immunization served as the controls. The parents were interviewed to get the necessary information. About 3 ml of blood samples were collected from these children using disposable syringes. Blood samples were allowed to clot, then were transferred into test tubes and centrifuged to obtain the serum. Serum total protein was determined by Biuret method. The serum albumin was determined by BCG method. The globulin was estimated by subtracting albumin from total protein and results were expressed in gm globulin/100 ml of samples. Serum Zn and Cu determined by colorimetric method. And results were analysed with GraphPad InStat software by using student’s t-test for statistical significance of 0.05.

RESULTS
As shown in table 1 Majority of the subjects were in the age group 6-30 months although the cases and controls were matched for both age and sex. (Table 1) Serum level of copper & zinc in PEM cases shows significant decrease as compared to normal healthy children of control group (p < 0.05). Serum copper level was found significantly low in kwashiorkor children compared to other PEM children. (Table 2) Total protein and serum albumin level in malnourished children shows significant decrease as compared to control (p < 0.05). Serum albumin was significantly lowered in kwashiorkor than in marasmus. (Table 3)

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Case</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (%)</td>
<td>Female (%)</td>
</tr>
<tr>
<td>6 – 30</td>
<td>11 (37)</td>
<td>8 (26)</td>
</tr>
<tr>
<td>31- 60</td>
<td>6 (20)</td>
<td>5 (17)</td>
</tr>
<tr>
<td>Total</td>
<td>16 (54)</td>
<td>14 (46)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Copper (µg/dL)</th>
<th>Zinc (µg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>p value</td>
</tr>
<tr>
<td>Control (n=30)</td>
<td>121.82±14.56</td>
<td>-</td>
</tr>
<tr>
<td>Marasmus (n=10)</td>
<td>105.27±22.31</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Kwashiorkor(n=13)</td>
<td>84.92 ± 19.53</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Marasmic-kwashiorkor(n=7)</td>
<td>96.97 ± 18.21</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
DISCUSSION
The zinc requirement of growing children is high, so they are more vulnerable to zinc depletion. In this study, the children with severe PEM had significantly low levels of serum zinc. Results of present study correlate well with previous studies.7,12 The reasons for zinc deficiency in malnourished children are low dietary intake, poor bioavailability, mal-absorption, or increased losses due to diarrhea.7 Since approximately 65% of plasma zinc is bound to albumin, hypalbuminemia in severe PEM may contribute to low zinc levels. Zinc deficiency impairs growth by interfering with nucleic acid metabolism and protein synthesis.13 Zinc supplementation has been demonstrated to cause improved weight gain in severe PEM.14
Serum copper was also significantly low in children with PEM. Similar observations have been reported earlier.15,16 Copper deficiency has been found in children with diarrhoea, in patients receiving long-term parenteral nutrition, during excess zinc ingestion and in population with high intakes of cereals.17 The reasons for low serum copper in malnourished children could be poor dietary intake, increased losses from gastrointestinal tract, and low ceruloplasmin levels. Long-term therapy with high doses of zinc may also result in low serum copper levels by interfering with copper bioavailability.18 Phytate in cereals, which constitute the most important sources of nutrients of children in our environment, may be responsible for copper and zinc deficiency as a result of poor availability.19
Also malnutrition and infectious diseases may likely interact during this period, thus resulting in compromised nutritional status.20 Numbers of factors induced by infection are known to further impair nutritional status.21 These include increased protein metabolism and negative nitrogen balance, depletion of carbohydrate stores, increased energy consumption, increased gluconeogenesis, relative insulin resistance, altered lipid metabolism and redistribution of minerals between nutrient compartments (including iron, zinc and copper) and these factors further increase the vicious cycle between malnutrition and infections. Infections no matter how mild, have adverse effect on nutritional status and conversely, almost any nutrient deficiency, if sufficiently severe will impair resistance to infection.22 Results of present study show decrease in serum protein and albumin level in PEM children as compared to control group. Although, there was no significant difference in the levels of total protein in the marasmus and kwashiorkor, serum albumin was lower in kwashiorkor in conformity with the findings of previous study.23 This suggests greater losses and inadequate intakes in kwashiorkor than in marasmus and this may in part explain the presence of edema in kwashiorkor.5 To conclude, serum zinc and copper concentrations were significantly low in children with PEM, and there was a progressive decline in serum zinc and copper levels with increasing severity of PEM. In the light of above findings, the practice of supplementing zinc and copper in malnourished children is justified. Supplemental copper and zinc should be part of nutritional rehabilitation of malnourished children in order to achieve optimal results and avoid clinical complications associated with zinc and copper deficiencies. However, fortification of food with zinc and copper remains the best way to prevent deficiencies in those at risk.

REFERENCES

### Table 3: Serum total protein & albumin level (mean ± SD) in case & control groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Protein (gm/dL)</th>
<th>Serum Albumin (gm/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>p value</td>
</tr>
<tr>
<td>Control (n=30)</td>
<td>6.9 ± 0.63</td>
<td>-</td>
</tr>
<tr>
<td>Marasmus (n=10)</td>
<td>6.2 ± 0.79</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Kwashiorkor(n=13)</td>
<td>5.9 ± 0.65</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Marasmic-kwashiorkor(n=7)</td>
<td>6.1 ± 0.58</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>


