

## Research Article

# Dysentery - a risk factor for zinc deficiency

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## ABSTRACT

**Background:** The study was carried out to determine the prevalence of zinc deficiency among under-five children with dysentery, and to compare the prevalence of zinc deficiency in children with dysentery with those who have acute non-bloody diarrhoea.

**Methods:** Serum zinc levels were determined using Atomic absorption spectrometry in under-five children with dysentery as well as those with non-bloody diarrhoea. A total of 250 children with diarrhoea were studied at the Wesley Guild Hospital, Ilesa, Nigeria.

**Results:** Twenty seven (10.8%) of the 250 children had dysentery, while the remaining 223 children had non-bloody watery stools. Children with dysentery had a significantly lower mean serum (SD) zinc level of 65.1 (25.0) µg/dl, compared with a mean (SD) of 80.5 (36.3) µg/dl among those without visible blood in their stools ( $p = 0.034$ ). Zinc deficiency (serum zinc <65 µg/dl) was also more prevalent among the dysentery group than those without visible blood in their stools (48.1% versus 28.3%;  $p = 0.034$ ).

**Conclusions:** Presence of visible blood in stools is a risk factor for zinc deficiency among children with diarrhoea.

**Keywords:** Zinc deficiency, Dysentery, Children

## INTRODUCTION

Diarrhoea remains a significant contributor to global childhood morbidity and mortality as it is a leading cause of illness and death among children in developing countries.<sup>1</sup> Diarrhoea with visible blood in the stools is referred to as dysentery and occurs in about 10 percent of diarrhoeal episodes in under-five children.<sup>1,2</sup>

Dysentery is considered to be a severe form of diarrhoea as it is usually a sign of invasive enteric infection and carries a substantial risk of serious morbidity and death.<sup>2</sup> It generally lasts longer and is more commonly associated with complications than watery diarrhoea.<sup>2</sup>

Zinc is an essential micronutrient that is important for growth and development as well as immune function.<sup>3</sup>

Zinc deficiency adversely affects the course of diarrhoeal illnesses in children, resulting in increased severity and prolongation of the duration of the illness.<sup>4</sup>

Thus, the World Health Organization recommends zinc supplementation for the treatment of diarrhoea in children.<sup>5</sup> There are few published data on the relationship between the presence of blood in diarrhoeal stools and the serum zinc levels of affected children.

This study was therefore conducted to determine the prevalence of zinc deficiency among under-five children with dysentery, and to compare the prevalence of zinc deficiency in children with dysentery with those who have acute non-bloody diarrhoea.

## METHODS

The study was a cross-sectional observational study which was conducted at the under-five welfare clinic and the children's emergency ward of the Wesley Guild Hospital (WGH), Ilesa, Osun State, Nigeria. The WGH is one of the units of the Obafemi Awolowo University Teaching Hospitals' complex (OAUTHC), Ile-Ife, Osun state, Nigeria. Ethical clearance was obtained for the study from the Ethics and research committee of the OAUTHC.

Children between the ages of six to 59 months with acute diarrhoea were recruited consecutively into the study. For each child recruited, a written informed consent was obtained from the parent (s) or the accompanying guardian. History about the nature and duration of diarrhoea as well as socio-economic background were obtained and all the patients were examined. Anthropometric measurements including weight and height/length were obtained for the assessment of nutritional status, and axillary temperature was measured for each child. The WHO child growth standards in form of z-scores were used to classify the nutritional status of the children. Signs of dehydration were noted and documented when present. Blood samples were collected for zinc assay at presentation, and the serum was separated by centrifugation at 3000 revolutions per minute using a clinical macro-centrifuge. Serum zinc levels were determined using atomic absorption spectrophotometry (AAS) at the Central science laboratory, Obafemi Awolowo University, Ile-Ife, Nigeria. The AAS machine used was analyst 400 model by PerkinElmer. Zinc deficiency was defined as serum zinc level less than 65.0 µg/dl.<sup>6</sup> Infants less than six months of age were excluded from the study. Children who had recently ingested zinc supplements or zinc-containing drugs, as well as those with severe under nutrition, sepsis, sickle cell anaemia and HIV infection were also excluded.

Other laboratory investigations were carried out as indicated for individual patients, particularly those admitted. These included serum electrolytes, urea and creatinine, blood film for malaria parasites, random blood sugar, stool microscopy, culture and sensitivity. Fluid replacement and other treatment modalities were instituted for the patients as appropriate and the caregivers were counselled on the prevention of diarrhoea.

Data analysis was done using the statistical programme for social sciences (SPSS) version 16.0. Means and standard deviations (SD) were computed for continuous variables while proportions were calculated for discrete variables. Means were compared using the independent samples t-test (t), while proportions were compared using the Pearson's chi-square test ( $\chi^2$ ). Probability values (p) <0.05 were accepted as statistically significant.

## RESULTS

**Table 1: Characteristics of the children who participated in the study.**

Characteristic	Children with dysentery (n = 27)	Children with non-bloody stools (n = 223)	Statistical significance (p)
Mean age (months)	21.52 ± 12.06	16.00 ± 8.88	0.004
Sex	13 (48.1%)	134 (60.1%)	0.234
Male	14 (51.9%)	89 (39.9%)	
Female			
Duration of diarrhoea (days)	4.11 ± 3.55	3.31 ± 2.31	0.112
Episodes per day	5.81 ± 2.60	4.83 ± 2.08	0.025
Presence of signs of dehydration	8 (29.6%)	60 (26.9%)	0.764
Presence of fever	27 (100%)	155 (69.5%)	0.001
Still breastfeeding	6 (22.2%)	129 (57.8%)	<0.001
Socio-economic status	2 (7.4%)	44 (19.7%)	*0.186
High	25 (92.6%)	179 (80.3%)	
Low			
Underweight	2 (7.4%)	43 (19.3%)	*0.184
Stunting	1 (3.7%)	35 (15.7%)	*0.143
Wasting	4 (14.8%)	40 (17.9%)	*1.000
Mean serum zinc level (µg/dl)	65.11 ± 25.01	80.47 ± 36.33	0.034
Zinc-deficient	13 (48.1%)	63 (28.3%)	0.034

\* Fisher's exact test applied

A total of 250 children with diarrhoea were studied. Twenty seven (10.8%) of them had visible blood in their stools, while 223 children had non-bloody diarrhoea. Table 1 shows the comparison of the characteristics of the children in the two groups. Of the 27 children with dysentery, 13 (48.1%) were males, while 14 (51.9%) were females. The mean age of children with dysentery was significantly higher than that of children with non-bloody diarrhoea (21.52 ± 12.06 months versus 16.00 ± 8.88 months; p = 0.004). There were no statistically significant differences in the prevalence of underweight (p = 0.184), stunting (p = 0.143) and wasting (p = 1.000).

between the two groups of children. Similarly, there was no significant difference in their socio-economic status ( $p = 0.186$ ). Six (22.2%) of the 27 children with dysentery were still breastfeeding at the outset of the illness, whereas 129 (57.8%) of those with non-bloody diarrhoea were breastfeeding. The difference was statistically significant ( $p = 0.001$ ).

The mean duration of diarrhoea among children with dysentery was not significantly different from that of children with non-bloody diarrhoea ( $4.11 \pm 3.55$  versus  $3.31 \pm 2.31$ ;  $p = 0.112$ ). On the other hand, the average number of episodes of watery stool per day was significantly higher among children with dysentery ( $5.81 \pm 2.60$  versus  $4.83 \pm 2.08$ ;  $p = 0.025$ ). However, a similar proportion of children in the two groups had signs of dehydration (29.6% and 26.9% respectively;  $p = 0.764$ ). Fever was present in all the 27 children who had dysentery, whereas history of fever was obtained in 155 (69.5%) of those with non-bloody diarrhoea. The difference was statistically significant ( $p < 0.001$ ).

The mean serum zinc level among those with dysentery ( $65.11 \pm 25.01$ ) was significantly lower than those with non-bloody diarrhoea ( $80.47 \pm 36.33$ ;  $t = -2.134$ ;  $p = 0.034$ ). Furthermore, zinc deficiency was more prevalent among the children with dysentery as 13 (48.1%) of them were zinc-deficient, compared with 63 (28.3%) of those who had non-bloody diarrhoea. The difference was statistically significant [ $\chi^2 = 4.506$ ,  $p = 0.034$ , OR (95% CI) = 2.36 (1.06 - 5.23)]. The only stunted child and the two underweight ones among those children with dysentery were zinc-deficient, whereas two of the four who had wasting were zinc-deficient.

Signs of dehydration were present in a similar proportion of the two groups of patients; eight (29.6%) of the 27 children with dysenteric stools had signs of dehydration, while 60 (26.9%) of those with non-bloody diarrhoea had signs of dehydration. A higher proportion (22.2%;  $n = 6$ ) of the children with dysentery required hospital admission, compared with 17.5% ( $n = 39$ ) of those with non-bloody diarrhoea, but the difference was not statistically significant ( $p = 0.555$ ). There was one mortality among the children with dysentery, and two mortalities among those with non-bloody diarrhoea ( $p = 0.291$ ). Zinc deficiency, severe dehydration and multiple electrolyte derangements were common to all the children that died.

## DISCUSSION

Greater severity of diarrhoeal diseases have been reported in zinc-deficient children when compared with children who have normal zinc levels.<sup>4,7</sup> The current study shows that zinc deficiency is more prevalent among children with dysentery, compared with those who have acute non-bloody diarrhoea. The lower serum zinc levels observed among children with dysenteric stools may be related to the loss of significant amounts of zinc through

the red blood cells that are passed in the stools in dysentery. This is because zinc is present in red blood cells, where it is bound to metalloproteins.<sup>8</sup> Increased loss of zinc through the damaged intestinal mucosa in children with dysentery may also be a contributory factor to the low zinc levels observed in these children.

The increased prevalence of zinc deficiency among children with dysentery is an indication that they have a higher risk of mortality from their diarrhoeal illness, considering the fact that zinc deficiency was common to the children who died during the course of the study. Thus, zinc supplementation, in addition to oral rehydration and appropriate antibiotic therapy, may help in reducing the morbidity and mortality associated with childhood dysentery. Zinc therapy improves the immunity of such children, thereby reducing their susceptibility to the aetiological infectious pathogens.

Children with dysenteric stools were observed to have more frequent episodes of watery stool per day in the current study. This is in keeping with the expectation of greater severity of diarrhoea in children who have bloody stools. The increased frequency of bowel movement in children with dysentery may predispose them to a higher risk of dehydration and electrolyte derangements, which further increase the overall risk of death. In addition, fever was more prevalent among those children with dysentery. The presence of fever may increase parental anxiety during childhood diarrhoeal diseases. It also causes discomfort for the ill child and may sometimes be complicated with febrile convulsion.<sup>1</sup>

The difference observed in the mean ages of children with dysentery and their counterparts suggests that dysentery is more common in older children. This may be related to the protective effects of breastfeeding among the younger children, since breastfeeding is known to be protective against diarrhoea and its complications and breast milk also serves as a good source of zinc.<sup>9-12</sup>

Zinc deficiency is often associated with malnutrition and zinc levels have been found to be lower in malnourished children when compared with well-nourished children.<sup>13-16</sup> Among the children with dysentery, the two who were underweight were both zinc-deficient. Similarly, the only stunted child among those with dysentery was zinc-deficient. The underlying malnutrition in these children may be related to their low zinc levels, which in turn probably influenced greater severity of their diarrhoeal illness. Thus, good nutrition with adequate content of all the essential micro-nutrients cannot be over-emphasized for growing children. However, achieving dietary adequacy of zinc is difficult amongst poor populations because zinc-rich foods, such as meat and fish, are usually expensive and unaffordable to many households, who therefore rely mainly on cheaper, plant-based diets. These are not only poor in zinc content, but may also hinder the bioavailability of zinc as a result of their high phytate content.<sup>3,17</sup>

## CONCLUSION

Dysentery is a risk factor for zinc deficiency among children with diarrhoea. Zinc supplementation will therefore be beneficial as part of the treatment for childhood dysentery in developing countries.

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