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Iron Status of Children with and without Sickle-cell Anaemia

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Summary

Usanga EA and Oluboyede OA. Iron Status of Children with and without Sickle-cell Anaemia. *Nigerian Journal of Paediatrics* **1983; 10:7.** Iron studies were carried out on 63 Nigerian children, aged between three and 13 years, consisting of 41 apparently normal school children who served as controls and 21 children with sickle-cell anaemia. The mean haemoglobin concentration of 12.1±0.3g/dl in the controls, was higher ($p < 0.05$) than one of 8.0±0.3g/dl in children with sickle-cell anaemia. Similarly, the mean serum iron value of 18.1umol/L in the controls was higher ($p < 0.05$) than that of 12.25umol/L in children with sickle-cell anaemia. Values for transferrin saturation, 29.8±1.3% for the controls and 31.3±2.5% for children with sickle-cell anaemia, were not significantly different ($p > 0.2$). The mean serum ferritin of 250±98.8ug/L, in children with sickle-cell anaemia, was higher ($p < 0.05$) than 58±5ug/L in the controls.

Introduction

There is scarcity of information on the iron status of normal Nigerian children. The few documented reports are haemoglobin and haematocrit determinations in neonates[1] and on children, aged six months to five years.[2] From other parts of the world, reports of mean haemoglobin values and packed cell volume in children, aged beween 5 and 9 years, include those of Bruce-Tagoe,[3] Untario *et al* [4] and Hethirat *et al*.[5] Reports on serum ferritin values in children with sickle-cell anaemia are much rarer. Hussain *et al*[6] have reported on haematological parameters including serum ferritin in children with sickle-cell anaemia, aged between one and 15 years. Also, Leyland *et al*[7] have reported on serum ferritin values in 18 northern Nigerian children with homozygous sickle-cell disease, aged two to 16 years.

The aim of the present study was to determine the haematological values including serum iron, total iron binding capacity (TIBC), transferrin saturation and serum ferritin in normal children as well as in those with sickle-cell anaemia (SCA).

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Subjects and Methods

The subjects comprised 63 children, aged between three and 13 years.

(*i*) *Children without sickle-cell anaemia*

This group consisted of 41 children (15 males and 26 females). They were all attending primary schools in Ibadan. Haemoglobin electrophoresis revealed AA in 30 and AS in 11. They were not receiving any haematinics or antimalarial drugs.

(*ii*) *Children with sickle-cell anaemia (Hb SS)*

There were 22 patients (10 males and 12 females) in this group. The patients were attending the Paediatric and Haematology Clinics, University College Hospital (UCH), Ibadan. Each patient had maintained a constant packed cell volume (PCV), determined monthly, for 3 consecutive months prior to the study. They were therefore, in a clinical "steady' state. Those over the age of five years were on daily folic acid (5mg) and proguanil (100mg), while the younger children were taking folic acid 5mg and proguanil, 50mg daily.

The diagnosis of haemoglobin SS was made by standard methods which included haemoglobin electrophoresis on cellulose acetate membrane using tris buffer at pH 8.9.[8] Blood samples for all quantitative tests were collected between the hours of 8.00 a.m. and 11.00 a.m. Serum iron and total iron binding capacity (TIBC) were measured by the method of Williams and Conrad.[9] Serum ferritin concentration was determined by the radioimmuno-assay method (Radiochemical Centre, Amersham, England). Other haemoglobin tests were performed by standard methods. [10] Liver function tests (LFT) were carried out on all patients with sickle-cell anaemia using standard methods.[11] Test of significance between the means was carried out using the Student's 't' test.

Results

The results of the haematological data for both the controls and the children with SCA are shown in the Table. The data for both male and female children were combined and analysed together since earlier comparisons have shown no significant difference in the values for the two sexes.[12]

Children without sickle-cell anaemia (SCA)

In this group, the mean haemoglobin value was 12.1 ± 0.3g/dl (12.1 ± 0.3g/100ml) and the mean haematocrit value was 0.37 ± 0.004 (37 ± 0.4%). The serum iron value was 18.08 ± 0.82umol/L (101 ± 4.6ug/100ml) and the mean TIBC value was 60.68 ± 1.34umol/L (339.9 ± 7.5ug/100ml), while the mean transferrin saturation with iron was 29.8 ± 1.3% and the mean serum ferritin value was 58 ± 5ug/L. There was a strong positive correlation between the serum iron and the serum transferrin saturation ($r=0.89$, $p<0.005$). All other paired variables showed no correlation.

Children with sickle-cell anaemia

The mean haemoglobin concentration was 8.0 ± 0.3g/dl and the mean haematocrit value was 0.24 ± 0.009 (24.3 ± 0.9%). These values were significantly lower than those in children without sickle-cell anaemia ($p<0.001$) (Table). The mean serum iron value was 15.2 ± 1.3umol/L (85.2 ± 7.5ug/100ml) and the mean TIBC value was 49.2 ± 1.6 umol/L, (275 ± 9.9ug/100ml). The mean values of the serum iron and the TIBC were lower in children with SCA than in those without sickle-cell anaemia. The mean transferrin saturation value of 31.3 ± 2.5% in children with SCA and 29.8% in children without SCA was similar. The mean serum ferritin value of 250±98.8ug/L in SCA patients were higher ($p<0.05$) than the value of 58.0±5.0ug/L in children without SCA.

The liver function tests revealed no abnormalities.

TABLE

Iron Status of 22 Hb SS Children and 41 Controls

	Hb SS Children	*Controls*	*P Value*
Hb (g/dl)	8.0±0.3 (5.7-12.5)	12.1±0.3* 10-13.8)**	<0.001
Haematocrit	0.24±0.009 (0.19-0.37)	0.37±0.004 (0.27-0.43)	<0.001
MCHC (%)	33.1±0.2 (28-36)	32.7±0.4 (30-38)	>0.10
Serum iron (umol/L)	15.2±1.3 (40-140)	18.08±0.8 (8.06-30.4)	<0.05
TIBC (umol/L)	49.2±1.6 (35.8-60.86)	60.68±1.34 (41.17-77.87)	<0.005
Transferrin saturation (%)	31.3±2.5 (12-52)	29.8±1.3 (15-49)	>0.20
Median serum ferritin (ug/L)	250±98.8 (55-1,705)	58±5.0 (2-135)	<0.05

* All values, except serum ferritin, are given as mean ± standard error.

** Figures in parentheses are 'range' values

TIBC = Total iron binding capacity

Conversion: SI to traditional units
Serum iron, TIBC: 1 umol/l = 5.6 ug/100ml

Discussion

A mean haemoglobin concentration of 13.0g/dl commonly quoted for caucasian children aged, 3–12 years,[13] is higher than a mean of 12.1g/dl for the 41 children without sickle-cell anaemia in the present study. Similarly, the mean haematocrit of 0.37 in normal subjects is lower than the mean value of 0.41 for caucasian children.[13] Haemoglobin and haematocrit values similar to those obtained in the present study have been reported in black children of the same age group from Papua, New Guinea.[14] A lower mean haemoglobin concentration of 11.0g/dl than in the present series has been reported in Ghana.[3] From Ibadan, Akinkugbe[2] has reported a lower haematocrit value of 0.33±6 in Nigerian children, 10 years old. A possible explanation for the lower values of haemoglobin and haematocrit in the present series than in caucasian children is the fact that our subjects were drawn from a cross-section of the population including those with low socio-economic background and a high incidence of parasitic infestations.

The values of serum iron, TIBC and transferrin saturation obtained in the present study were similar to those reported from other parts of the world.[15–19] The mean serum ferritin level of 58ug/L among the control group was higher than other reported values for children of similar age. Dorman *et al*[20] have reported a mean serum ferritin of 45ug/L for randomly selected Johannesburg 'coloured' children, aged 8–12 years, while Cook, Finch and Smith[21] obtained a mean serum ferritin of 21ug/L for children, aged 5–11 years, from low income group families in Washington. A mean serum ferritin of 30ug/L was reported by Siimes, Addiego and Dallman[22] for children from San Francisco. The high serum ferritin concentration of 58.0ug/L in our controls may reflect a true situation of higher total body iron. In our environment, falciparum malaria infection is endemic. Other inflammatory conditions occur commonly. The monocytosis of malaria infection causes raised serum ferritin levels[23] and any inflammatory condition also causes a rise in serum ferritin. Thus, the interpretation of serum ferritin values in areas where malaria and other forms of infections are common, is difficult. Positive correlations have been reported between serum ferritin, haemoglobin, serum iron, TIBC and transferrin saturation in adult men and women.[7 24-26] In the present study, only serum iron correlated strongly with transferrin saturation. The presence of positive correlations between serum ferritin and other variables in adults but not in children, may be due to the fact that increased iron utilization in growing children becomes stabilised in adults.

The data obtained from children with SCA were in agreement with those reported from northern Nigeria as well as from other parts of

the world.[6 7 27 28] In the present series, the mean serum ferritin value was 250ug/L (range 55–1, 705ug/L). Three (14%) of the 22 children had serum ferritin values greater than 1,000ug/L; 16 (76%) had values greater than 120ug/L, while only two patients (9%) had values less than 100ug/L. The mean value in the present study was higher than the mean values of 180ug/ml and 236.5ug/L reported by Hussein[6] and O'Brien[27] respectively and twice the value of 126.16±98ug/L reported in children with homozygous sickle-cell disease from northern Nigeria.[7]

The high values of serum ferritin concentration in children with SCA may be attributed to a number of factors namely: intermittent blood transfusion which is part of management regime of sickle-cell anaemia;[29] increased gastro-intestinal absorption of iron in sickle-cell anaemia; chronic haemolysis which is part of the patho-physiology of sickle-cell anaemia and increased susceptibility of sickle-cell anaemia patients to infection.[31] In the present study, only three patients were previously transfused. One patient received 4 units of blood, while the remaining two patients received 2 units and one unit of blood, respectively. The serum ferritin levels of the three transfused patients were not significantly higher than those among non-transfused group. It is therefore, unlikely that the increased serum ferritin in the sickle-cell anaemia patients in our series was due to blood transfusion. Possible causes therefore, would include increased gastro-intestinal iron absorption, chronic haemolysis and possibly, 'subclinical' infection particularly by plasmodium falciparum.

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