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# Hypoferritinemia and erythrocyte degeneration are laboratory features of childhood iron deficiency Anaemia in Lokoja, Nigeria

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## Abstract

Iron deficiency anaemia is caused by a lack of iron. In this paper, we have described the serum ferritin value, serum iron, total iron-binding capacity (TIBC), platelet count and the peripheral blood smear of patients with childhood iron deficiency anaemia detected and confirmed at the Primary Health Care Centre, Lokoja, Nigeria. The patients were referred to the centre for the first time within 1 month. Exclusion criteria were iron therapy before and during the study period, a history of chronic illness or failure by parents to give consent. After informed consent and pretest counselling, blood sample was obtained in each case by venipuncture. Haematological investigations were done by standard methods. The children with anaemia had lower levels of PCV (28.99±2.26), serum ferritin (33.92±5.34), serum iron (29.52±3.83) than the age and sex-matched controls, $p < 0.05$. The red cell morphological picture of the children with anaemia showed significant degrees of degenerative changes of hypochromia, microcytosis, poikilocytosis and anisocytosis. A mild thrombocytosis was observed in the patients. The blood pictures of the controls were essentially normal. The need for monitoring of children in the area for the detection of Iron Deficiency Anaemia (IDA) is very obvious by the results of this study.

**Keywords:** Hypoferritinemia, erythrocyte degeneration, iron deficiency, anaemia.

## Introduction

Iron deficiency is still frequently observed in infancy, school age and adolescence. This is particularly so in developing countries (1,2). The first change that occurs during the development of iron deficiency is a depletion of iron stores in the liver, spleen and bone marrow (3). Iron deficiency anaemia is confirmed by tests that include serum ferritin, serum iron level, serum transferrin and total iron binding capacity. A low serum ferritin is most commonly found although it can be elevated by any type of chronic inflammation (4). A low serum ferritin level may therefore be considered the hallmark in the diagnosis of iron deficiency. Serum ferritin levels are directly proportional to the level of body iron stores and appear to reflect reticuloendothelial storage iron accurately (3,5). There are a number of disorders such as chronic infection, inflammation (e.g. rheumatoid arthritis) and malignancy (Hodgkin's disease) in which there is a low serum iron, a high concentration of serum ferritin and an increased amount of stainable iron in the bone marrow cells (6).

The blood smear of a person with iron deficiency anaemia shows hypochromia, poikilocytosis and anisicytosis (7, 8). We describe our findings in this paper.

## Materials and Methods

Sick children between the ages of 2 and 13 years who were referred to the Primary Health Care Centre, Lokoja, Nigeria for the first time during 1 month were enrolled in the study prospectively and consecutively.

Informed consent was obtained from the parents and the Ethics Committee of the Local Government Council who also approved the study protocol. Exclusion criteria were iron deficiency treatment before or during the study period and any history of chronic illness. Acute phase reactants such as Erythrocyte Sedimentation Rate (ESR) and C-reactive protein levels were measured in all cases suggestive of infectious disease.

Blood samples were obtained from the patients and the age-and-sex matched controls by venipuncture and the hospital charts were evaluated. Samples of patients with any illness known to interact with iron status were discarded. All laboratory tests were done by standard methods (9) and manufacturer's protocol.

For statistical evaluations, $X^2$and student's t-test were performed on the data using a software (SPSS 23.0). $P < 0.05$ was inferred to be statistically significant.

## Results

**Table 1** shows the age and sex distribution of the patients and controls studied. Considering the normal limits for Packed Cell Volume (PCV) and Haemoglobin in children, the males and females were merged (10). However, for the patients, there were 141 males (51%) and 135 females (49%). For the controls, there were 185 males (67%) and 91 females (33%).

**Table 1:** Age and sex distribution of the subjects studied.

| | GENDER | |
|---|---|---|
| | TEST | CONTROL |
| | M F | M F |
| Age Group (Yrs) | 141 135 | 185 91 |
| | 276 | 276 |
| **0 – 2** | 108 (39.13%) | 93 (33.69%) |
| **3 – 5** | 52 (18.84%) | 60 (21.74%) |
| **6 – 8** | 46 (16.67%) | 68 (24.65%) |
| **9 – 11** | 49 (17.75%) | 41 (14.85%) |
| **12 – 14** | 21 (7.61%) | 14 (5.07%) |
| **Total** | **276*** | **276*** |

* Considering the normal limits for Haemoglobin and PCV levels in children, the males and females were merged (10).

**Table 2** shows comparison between the haematological results for the two groups. It shows significant lowering of the values of serum ferritin (33.92±5.34), RBC (3.74±0.32), PCV (28.99±2.26) and serum iron (29.52±3.83). The value of Mean Cell Volume (MCV) (77.61±3.85) was lower and that of Total Iron Binding Capacity (TIBC) (474.48±16.02) was higher in the patients than in controls, but were both statistically insignificant, $p > 0.05$.

Table 2: Haematological & Iron parameters results of the patients and control subjects

| Parameter | Anaemic (n = 276) | Control (n = 276) | P value |
|---|---|---|---|
| Ferritin (ng/ml) | 33.92 ± 5.34 | 71.75 ± 14.84 | <0.04* |
| RBC Count (x $10^{12}$/L) | 3.74 ± 0.32 | 4.23 ± 0.24 | <0.001* |
| PCV (%) | 28.99 ± 2.26 | 33.63 ± 1.89 | <0.001* |
| Retics Count (%) | 0.84 ± 0.27 | 0.88 ± 0.51 | 0.742 |
| Platelet count (x $10^9$/L) | 387.51 ± 66.92 | 261.89 ± 70.92 | <0.026* |
| Serum Iron (ug/dl) | 29.52 ± 3.83 | 40.27 ± 3.09 | <0.030* |
| MCV (Fl) | 77.61 ± 3.85 | 78.85 ± 8.8 | 0.257 |
| TIBC (ug/dl) | 474.48 ± 16.02 | 431.84 ± 22.61 | 0.110 |
| Blood Picture | Hypochromia ++<br>Microcytosis ++<br>Poikolocytosis +<br>Anisocytosis +<br>Thrombocytosis + | Normocytic Normochromic | |

+ - ++ = degree of change.

The blood picture of the patients showed significant degeneration, pictured as hypochromia ++, microcytosis +, poikilocytosis +, anisocytosis + and mild thrombocytosis.

## Discussion

Our results confirmed subjective lowering of serum ferritin level, red blood cell based blood parameters and degenerative changes in the red cell pictures of the patients whereas the results of the control group were essentially normal.

Serum ferritin levels are directly proportional to the level of body iron stores and appear to reflect reticuloendothelial storage iron accurately (3). Our results agree with previous reports that anaemia is a serious global public health problem that particularly affects young children and pregnant women (11, 12, 13).

This report also confirms the lowering of red blood cell based parameters in which the number of red blood cells and packed cell volume were lower than normal (14). Hypoferritinemia means low iron storage in the ferritin form which could manifest as general weakness, easy fatigability, depressed mood, palpitation and hair loss (15). Ferritin is a globular protein complex consisting of 24 protein subunits forming a hollow nanocage with multiple metal-protein interactions (16).

As confirmed by our study, the degenerative changes that occurred in the red blood cells of the patients included; hypochromia, microcytosis, poikilocytosis and anisocytosis. This is in agreement with previous reports (17, 18).

We conclude by recommending that in developing countries, whenever a child presents with pre-anaemia signs and symptoms, the child should be subjected to biochemical and red cell morphological investigation of iron status.

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