

Association between intestinal helminthiasis and serum ferritin levels among school children

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ABSTRACT

Background: significant iron deficiency anaemia is a major concern in children with helminthiasis, because it may eventually contribute to the growing health challenges of severe anaemia. This descriptive cross sectional study was carried out to determine the association between serum ferritin levels and intestinal helminthiasis among school children. **Methods:** a structured questionnaire was used to collect the study population data. Stool specimens were obtained and examined on the same day using the sedimentation method for identification of the parasite. Blood samples were also obtained for full blood count and serum ferritin measurement. **Results:** a total of 246 school children were studied with a response rate of 82%. The prevalence of intestinal helminthiasis was 29.7%. The different helminthes identified included *Ascaris lumbricoides*, *Necator americanus*, *Trichuris trichiura*, *Strongyloides stercoralis*. Of the population studied, 36.2% were anaemic, 15.9% had microcytosis, and 47.6% had hypochromia. The prevalence of exhausted iron stores was 3.7%. Serum ferritin levels were significantly lower in children with intestinal helminthiasis compared with controls. **Conclusions:** The findings in this study demonstrate an inverse relationship between intestinal helminthiasis and serum ferritin levels and this is more marked in pupils with hookworm infections. The control of intestinal helminthiasis and prevention of iron deficiency anaemia should be given high priority in the implementation of the school health programme.

Keywords: Intestinal Helminthiasis; Serum Ferritin; School Children

1. INTRODUCTION

Children are generally at risk of iron deficiency since the

iron requirements for growth are high and the intake of iron is likely to be less than their requirements. Thus, any condition that increases the need for iron, decreases its intake or increases its loss will precipitate its deficiency [1].

Several factors contribute to iron deficiency such as insufficient dietary intake, malabsorption and infections [2]. Helminthic infections may influence iron status by reducing nutrient intake and by interfering directly or indirectly with iron metabolism and transport [2]. In school-aged children, both infections and iron deficiency can lead to anorexia. Infections inhibit the absorption of iron from the gastro-intestinal tract and iron deficiency lowers resistance to infections. This process creates a vicious circle of inadequate nutrition [2,3].

Iron deficiency is very common in Nigeria, occurring in approximately 36% of children younger than 5 years of age [4]. Helminthiasis is also a common problem among Nigerian school children and has a negative impact in their physical and mental development by many mechanisms including malabsorption [6] blood and protein loss [7], anorexia, vomiting and diarrhoea. These effects can lead to aggravation of protein energy malnutrition [8], anemia and other nutrient deficiencies [8] (iodine, vitamin A, iron deficiency) [9] which indirectly affect cognitive development and performance. Iron deficiency impairs children's cognitive abilities, and interventions to prevent and correct iron deficiency may enhance children's learning potential in school [5,6]. Improving the iron status of school children will also ameliorate their fitness and work capacity [11], and improvements in girls' iron status during the school age may help prevent anemia during their reproductive years.

The school setting is ideal for public health interventions, such as health education, iron supplementation and treatment or prevention of parasitic infestations [12] The aim of this study was to study the association of helminthic infections and serum ferritin among school children.

2. MATERIALS AND METHODS

The study was a descriptive cross sectional study conducted over a four month period in Ilorin metropolis, a typical urban city in the middle belt of Nigeria. The town has pipe-borne water that is supplied erratically on some days of the week with augmentation from other sources such as well, streams and bore-holes. Most of the homes have pit latrines and water closets used by both the adults and children [13]. There are 98 public schools and 71 private schools within Ilorin metropolis; a few have school clinics managed by nurses or trained teachers that can offer first aid treatment [13].

The study population consisted of primary school children aged between 5 and 12 years from 3 private and 3 public schools. Children who had taken anti-helminthic drugs within 6 months of study or those who received a blood transfusion or iron containing medicines within 3 months preceding the study or those who were febrile were excluded.

Multistage sampling technique was employed in selecting subjects for this study. Selection of schools was done by a simple random sampling technique. Selection of classes in each school was done by a proportionate sampling technique. Selection of pupils was done by a systematic random sampling. Controls of the study were age and sex matched children without helminthiasis.

A structured questionnaire was used to collect socio-demographic characteristics such as age, sex, level of education of the parents and socioeconomic status. Anthropometric measurements (*i.e.*, weights and heights) were performed.

Fresh stool sample was collected using precoded specimen bottles. Samples were analyzed within an hour of collection or preserved using 10% formol saline when immediate analysis was not possible. However, all analysis was done within 24 hours. Each stool sample was microscopically examined using saline and iodine preparations and formyl ether for the identification of the parasite species [14,15].

Under strict aseptic conditions a 5 ml specimen of venous blood was withdrawn. 3 ml of the blood was decanted into a sample bottle containing ethylene diamine tetra acetate (EDTA) and gently mixed to prevent clotting while the remaining 2 ml was decanted into a heparinized bottle which was to stand for 2 hours and the serum was separated into another bottle and stored frozen at -20°C .

Hemoglobin concentration was determined using a Sysmex 18 parameter autoanalyser. Anaemia was defined as a hemoglobin of less than 11 g/dl and severe anaemia was defined as a haemoglobin of less than 5 g/dl [16]. Serum ferritin concentration was analyzed by enzyme-linked immunosorbent assay using the CLI-

NOTECH[®] human ferritin enzyme immunoassay test kit. [17] Exhaustion of iron stores was defined as a serum ferritin of less than 20 $\mu\text{g/L}$.

Data entry and analysis were carried out with the Epi info version 6.0 software for epidemiology developed by Centers for Disease Control and Prevention [18]. A *p*-value of less than 0.05 was considered as significant.

3. RESULTS

A total of 300 primary school children from 6 selected schools were recruited into the study but 246 (82%) returned with suitable stool and blood specimens. The characteristics of these children are presented in **Table 1**. The overall prevalence rate of intestinal helminthic infections was 29.7%. In addition, 26.5% of the males and 31.9% of females had parasitic infections (**Table 1**). The mean age, weight and height according to sex are summarized in **Table 2**.

Anaemia was recorded in 36.2% of the pupils studied. No pupil had severe anaemia. Serum ferritin in the total population studied was $77.6 \pm 32.6 \mu\text{g/L}$. Serum ferritin of less than 20 $\mu\text{g/L}$ (iron stores exhaustion) was observed in 3.7% of the studied population. Serum ferritin in males was $72.0 \pm 29.9 \mu\text{g/L}$ compared to $83.2 \pm 35.4 \mu\text{g/L}$ in females ($p = 0.01$). Serum ferritin, did not differ significantly in pupils in the various age-groups (**Table 3**). Serum ferritin levels were significantly lower in children with intestinal helminthiasis compared with controls. However there was no significant difference in total protein and serum albumin levels between the groups (**Table 4**).

Table 1. The sex distribution of pupils according to age in the total population studied.

Age (years)	Total <i>n</i> (%)	Male <i>n</i> (%)	Female <i>n</i> (%)	Odd Ratio	<i>p</i>
5 - 7	67 (27.2)	22 (21.6)	45 (31.3)	1.65	NS
8 - 10	116(47.2)	49 (48.0)	67 (46.5)	0.94	NS
11 - 12	63 (25.6)	31 (30.4)	32 (22.2)	0.65	NS
Total	246	102 (41.5)	144 (58.5)		NS

Table 2. The mean age, weight and height according to sex.

	Male <i>n</i> = 102	Female <i>n</i> = 144	T	<i>p</i>
Age (yrs)	9.2 ± 2.07	8.7 ± 2.18	1.7	NS
Weight (kg)	23.4 ± 5.7	23.2 ± 6.4	0.3	NS
Height (cm)	121.5 ± 11.23	120.07 ± 12.85	0.87	NS

NS: no significant

Table 3. Ferritin levels amongst the different age-groups in the population of the study.

Age-group (years)	Serum ferritin ($\mu\text{g/L}$)	
	Mean	Range
5 - 7	74.12 ± 34.13	15 - 140
8 - 10	75.78 ± 33.66	5 - 150
11 - 12	83.69 ± 32.96	20 - 150

$F = 1.02$; $p = \text{NS}$; NS: no significant

Table 4. Comparison of serum ferritin, serum protein and serum albumin levels in the infected and non-infected groups.

	N	Serum Ferritin ($\mu\text{g/L}$)	Total Protein (g/L)	Serum albumin (g/L)
Non-infected	173	83.6 \pm 36.56	66.3 \pm 0.92	35.17 \pm 0.52
Infected	73	72.4 \pm 25.26	65.8 \pm 0.90	35.63 \pm 0.52

$F = 5.7$; $p = 0.01$; $p = \text{NS}$; $p = \text{NS}$; $p = \text{NS}$; NS: no significant

Table 5. Comparison of the serum ferritin levels of the non infected group with the levels of children with different intestinal helminthes.

	Serum ferritin levels		
	Mean \pm SD	F	p
Non-infected:	83.6 \pm 36.56		
Helminth detected:			
Ascaris lumbricoides	81.9 \pm 30.91	0.1	NS
Hookworm species	50.9 \pm 27.91	8.47	NS
Trichuris trichiura	66.7 \pm 14.43	0.64	NS
Polyparasites	72.5 \pm 53.03	0.35	NS
Strongyloides stercoralis	90.00 \pm 0.00	2.43	0.04

NS: no significant

In **Table 5** the results of the serum ferritin levels with different intestinal helminthes are presented and are compared with those of the control group. It is of interest that 4 of 11 patients (36%) of patients with hookworm infection had exhausted iron stores.

4. Discussion

This study showed an overall prevalence of 29.7% of the common intestinal helminthic infections among primary school children in Ilorin. This value is comparable to the findings of similar studies in other parts of Nigeria [19-22] and Africa [23]. While higher prevalence rates of between 50% and 97% [24-30] as well as lower prevalence rates of less than 20% [23,31-34] have been reported. These differences in the prevalence rates could be attributable to the locations of the studies, the season of the year the study was carried out and the method of stool analysis. The high prevalence rate in this study therefore confirms that intestinal helminthic infection is a common problem in the school aged children.

In this study, the female children had a higher prevalence of intestinal helminthic infections prevalence than the males. This is in consonance with studies previously documented [34,35]. The influence of gender on prevalence of helminthic infection may or may not play a role depending on the regional and environmental factors.

The overall prevalence rate of anaemia among the school children studied was high. More than a third of the pupils had their haemoglobin levels less than 11 g/dl. It is noteworthy to state that no pupil had severe anaemia. This is in consonance with previous publications [16]. The mean haemoglobin value is higher than values obtained in previous studies [36-39]. Childhood anaemia

appears to be increasing in the country due to the declining nutritional status secondary to a dwindling national economy.

In this study, a comparison of the haematological status between the intestinal helminthic-infected and non-infected children showed that the mean haemoglobin indices of the latter were higher.

The iron store of the population in this study was adequate with only 3.7% having exhausted iron stores. This is at variance with studies done in other parts of Africa [2,3] where the degree of exhausted iron stores were high. This could be attributed to the low prevalence of hookworm infection observed. The serum ferritin level was higher in females than males. This has also been documented in a previous study [3]. The reason for this could be attributed to the higher number of boys infected with hookworm species. The serum ferritin level was higher in pupils aged 10 years and above and lower at the age of 8 years. This is in agreement with previously documented studies where it was attributed to the high iron demands of early childhood [2,3].

The serum ferritin levels were lower in children with hookworm infection. In addition, 36% of pupils with hookworm had exhausted iron stores. No relationship was found between *Ascaris lumbricoides* and iron status in this study. This is similar to the study done in Western Kenya but not with that done in Zanzibar, where low serum ferritin levels were associated with Ascariasis. Iron is absorbed through the intestinal wall in the duodenum and jejunum and it is believed that iron absorption could be impaired by the presence of *Ascaris lumbricoides* in this part of the intestine [40]. *Trichuris trichiura* infection was not related to any of the iron status indicators. This is because *Trichuris trichiura* lives in the luminal epithelium, mainly the large intestine, and trichuriasis has a specific association with anaemia which is mediated through erythrocyte loss from the gut [41].

The high prevalence of intestinal helminthic infection and anaemia observed in this study calls for a comprehensive public health intervention. The most important application of the findings is to guide the development of appropriate interventions to minimize the predisposing factors to parasitic infections and prevent iron deficiency anaemia in school children. There is a strong basis for helminthics control as a strategy to control iron deficiency in the population group. Anthelmintic drugs are safe and cheap and periodic delivery of these drugs through the school system is a highly feasible public health intervention [42].

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