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ASSESSMENT OF THE IRON STATUS OF SCHOOL CHILDREN AGED 7-12 YEARS IN SELECTED SCHOOLS IN OGUN STATE

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ABSTRACT
Background: Iron deficiency as a public health problem is based on the seriousness of its consequences on human health and there may be need for certain measures to curb the menace of such deficiency.
Objectives: This study assessed the iron status of rural and urban school age children in selected Local Government Areas in Ogun State.
Methods: A structured pre-tested questionnaire was used to obtain information on the socio economic characteristics and blood samples of the selected children were analysed for biochemical parameters (heamoglobin (Hb), White blood cells and differentials, Serum ferittin (SF), C-reactive protein (CRP), and Reticulocyte count) using standard procedures. Data were analysed using frequency counts, percentages, means, standard deviation, correlation, and T-test with SPSS software.
Result: Results showed that 36.3% of the respondents' families earned less than two hundred thousand naira annually. Also 40.1% (rural) and 59.4.0% (urban) of the mothers had secondary and tertiary education, respectively. The study further revealed that the prevalence of iron deficiency was 23.7%, anaemia was 16.3% while 13.1% of the anaemic children were due to iron deficiency with significant sector (p=0.003) and gender (p-0.032) differences. The range of Neutrophills, Lymphocytes, Monocytes, Basophils and Eosinophils were 3.31 to 3.88, 3.03 to 4.38, 0.53 to 0.59, 0.03 to 0.04, 0.33 to 0.38, respectively while that of heamoglobin, CRP and reticulocyte range from 11.73 to 12.14 (p=0.000), 3.92 to 3.32(p=0.002) and 0.83 to 0.89 respectively. Correlation revealed a significant relationship between annual income and hemoglobin (r= 0.132), mothers education and PCV (r=0.180), mothers age and serum ferritin (r=0.159), also childs age and heamoglobin(r=0.144).
Conclusion: The study concluded that a significant relationship exist between socio economic status and the markers of iron status in the children. Hence, the study recommended a policy to improve school feeding programmes coupled with better access to basic social services including education and health care.

Key words: *Iron deficiency, iron status, anaemia, Reticulocyte*

INTRODUCTION

Iron deficiency is the most common nutritional deficiency in the world and brings with it negative consequences on growth and health (1,2). When iron deficiency is sufficiently severe, red blood cell synthesis becomes impaired, and anaemia results. In developing countries such as Nigeria, iron deficiency is generally the major cause of anaemia (3). Finding of Zaccheaus *et al.* (3) showed that iron-deficiency anaemia was high (13.6%) among the asymptomatic Nigerian children and the consequences of iron deficiency and anaemia include decreased work capacity, maternal mortality, child mortality and impaired neuro-cognitive function in children (4).

Based on estimates of iron-deficiency anaemia as a risk factor for death, iron deficiency has been estimated to cause 726,000 deaths in the perinatal and childhood periods globally, with the greatest toll in South-East Asia and Africa (5,6). Experimental and observational studies have linked iron deficiency with several adverse consequences of child development, including impairments in cognitive functions and motor development (7,8,9), growth (10), immune function, and increased risk of infection (11,12). Iron requirements are particularly high during periods of rapid growth such as childhood, resulting in stages of high risk for iron deficiency (13).

Iron deficiency anaemia is one of the most widespread public health problems, especially in developing countries, and a major cause of morbidity and mortality in Africa (14). It is a worldwide problem that is highly prevalent in developing countries of the world with the highest incidence reported in Asia and Africa (15). Anaemia prevalence is high in children and its cause is frequently multifactorial. It has been estimated that about 40% of the world's population (more than 2 billion individuals) suffer from anaemia with a prevalence of 48% in school-aged children (16,17). The key nutrient deficiency observed among school-aged children is iron deficiency anaemia (18,19).

The Standing Committee on Nutrition (SCN) reported that the prevalence of iron deficiency anaemia among schoolchildren in Africa stood at 49.8% (18). Iron deficiency with or without anemia is associated with increased susceptibility to infection owing to impaired immune function (20). Anaemia is one of the most widespread public health problems, especially in developing countries, and has important health and welfare, social, and economic consequences. These include impaired cognitive development, reduced physical work capacity, and in severe cases increased risk of mortality.Thus, this study determined the iron status of the children.

The impact of iron deficiency on economic cost (21) and human health (2) is massive, An increase of the burden on health systems, reduced adult productivity and school performance are some of the consequences of iron deficiency (21).

Iron deficiency and anaemia are associated with poor growth and cognitive development, lowered immunity with increased risk to infectious diseases, and reduced work productivity. An unhealthy schoolchild is unlikely to have regular school attendance, good academic performance, and involvement in extracurricular activities (22).

It is apparent that more interventions are neccessary so that the iron intake of Nigerian children can be addressed. This is of great importance because of the impact that poor iron status could have on health as well as the immune functions of children. This study provided data necessary for the planning and implementation of positive strategies for the resolution of nutrition and health problems among schoolchildren, particularly those in the rural areas, where most (about 70%) Nigerians live (23) and which are devoid of infrastructure and quality educational opportunities (22);.It will keep people informed and will serve as reference material to the stakeholders.

MATERIALS AND METHODS

Study Area

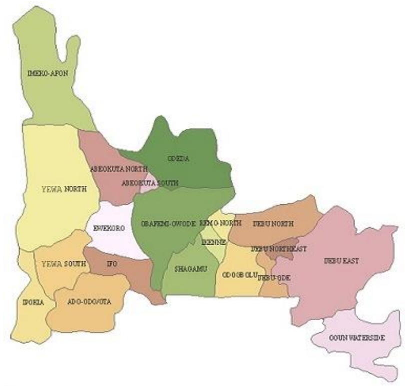

Figure 1: Map of Ogun State

Study Population

The study population consisted of primary school children (7-12 years old) in selected schools in both urban and rural local governments in Ogun states.

Inclusion criteria

- School age children between 7-12 years attending the schools selected for the study.
- School children from primary two to six
- Children whose parents give permission for them to participate in the study.
- Children giving consent participated in the study.
- Children who are present on the day of data collection
- Children not on medication that can affect the iron status.
- Children with no known case of infection or inflammation

The sampling frame consists of school age children (7-12years) from twenty four selected schools in Ogun state. All the three senatorial districts in Ogun State were considered for the study, so that it can be a representation of the iron status of the children in the state. Two (one rural and one urban) local governments were randomly selected from each senatorial district. In each local government four schools are selected. The pupils were stratified according to their class.

Table 1: Schools Selected in each Local Government Area

Ogun West	Ogun Central	Ogun East
1.Ado-odo/Ota LGA	**1.Abeokuta south LGA**	**Ijebu Ode LGA**
i.St James Anglican School, Ota	i.St Paul's School, Igbore	i.St Peters RCM Pry Sch, Imepe
ii. Local Government sch I, Ota	ii.U.A.M.C. Eleja, Ijemo	ii. AUD School I, Ijebu-Ode
iii.NUD School, Iju	iii.First Baptist Primary School, Ijaye	iii.Wesley Pry School, Molipa
iv. Local Government School, Ijako	iv.Mrs F. Kuti Primary school, Isabo	iv. Christ Church Pry School, Sabo
2. Ipokia LGA	**2. Obafemi Owode LGA**	**2. Ijebu North/East LGA**
i.IPLG School, Ipokia	i.OOLG School, Agboke, Oba	i.Moslem Pry School, Ilese
ii.IPLG School, Ago-sasa	ii.OOLG School,Igbo Meku	ii.St John Pry School, Odosimadegun
iii.Methodist School, Idopetu	iii.Saint Patrick's School, Ajegunle	iii.Christ Church Pry school, Odosenlu
iv.Baptist School, Alaari	iv.All Saint School I, Owode	iv.Holy Apostle Pry School, Atan

LGA- Local government area

Procedure for data collection
Prior to the commencement of the research, submission of the research proposal was made to the State Hospital Ijaye, Abeokuta and selected local governments in the three senatorial districts and also to the headmaster of each school. Ethical consent was sought from the State hospital, Ijaye, Abeokuta and also meeting with parents with the assistance of the school management for their verbal consent. Trained fieldworkers with the principal investigator engaged in data collection and Medical laboratory scientist assisted in blood sample collection and analysis.

Method of Data Collection
A structured pre-tested interviewer administered questionnaire was used to collect information from the respondents. The questionnaire was used to collect information on the respondent's bio-data and socio-economic characteristics.

Blood collection (including analytical procedures)
Venous blood samples (10ml) were collected and delivered in two containers as follows: (i) 4ml blood collected in EDTA- containing tube for hemoglobin (Hb) and full blood count; (ii) 6ml blood collected in coagulant free tubes and centrifuged for the estimation of serum ferritin (SF) and C-reative protein (CRP). Parked cell volume (PCV), CD4 count, Reticulocyte count were also measured.

Iron status indices
Iron status was determined by measurement of hemoglobin, PCV and serum ferritin. Since serum ferritin may be altered in the presence of infection, C-reactive protein (CRP) was used to interprete the serum ferritinvalues correctly.
Heamoglobin: measured *in situ* by means of the direct cyanmethemoglobin method (Ames Mini-Pak Hb test pack &Ames™ Minilab), using Drabkins solution and a standard photometer.
White blood cell count and differentials were determined (neutrophil, lymphocyte, monocytes, eosiniphil and basophil) using the method of Ghai (24).
Reticulocyte count was performed on the blood samples according to Lewis *et al.* (25).
Serum ferritin (indication of iron stores): Was determined using ELISA (Randox kits, UK)
C-reactive protein: an acute phase protein, and an indicator of acute infection, was spectrophotometrically measured with a Technicon RA-1000 automated system.

Statistical analysis
Changes in biochemical indicators were calculated. Children were defined as: (i) iron deficient if serum ferritin< 15 µg L^{-1}; (ii) anaemic if haemoglobin is (Hb) < 11.5 g dL^{-1}; and (iii) Iron deficient anaemic if serum ferritin< 15 µg L^{-1} and Hb< 11.5 g dL^{-1}. Significance was set for all analyses at $P < 0.05$. The mean value for White blood cell count and differentials, PCV, serum ferritin,C-reactive protein, Reticulocyte count were calculated and significance was set at $P < 0.05$. The cut off values for heamoglobin, serum ferritin, C-reactive protein, and white blood cell count and differentials were stated below:
Hb: 11-13.0 **SF**: 12-150 **CRP**: 3-10
WBC:4.0-11.0 **NEUT**: 2.0-7.5 **LYMP**: 1.5-4.0
MONO:0.1-1.5 **EOSINO:**0.04-0.4 **BASO**: 0.0-0.1

RESULTS

Table 2 shows the socio-demographic characteristics of the children and family sampled. The age of the children ranged between 7-8years (27.7%), 9-10years (34.4%) and 11-12years (37.4%) in urban LGAs but 22.3%, 25.5% and 52.5% respectively in rural LGAs. The mothers of age less than 20years were 1.9% and 21.9% were between 21-30years of age while 44.5% were within 31-40, and 31.6% were above 40years of age in urban LGAs but as for the rural LGAs, it shows that 6.4% of the mothers were within 0-20years while 45.9% were within 21-30years of age, and 22.9% were within 31-40years while the remaining 24.9% were above 40years of age. The result showed 14.6% and 3.2% of the mothers in rural and urban did not have any formal education while 59.4% and 28.0% had tertiary education respectively. The average annual income of the household heads that are less than one hundred thousands were 3.2% and 14.6% in rural and urban LGAs while 2.0% and 5.8% made above five hundred thousand naira in rural and urban LGAs respectively Majority of the household heads engaged in business (44.6%) in rural LGAs while more of them are civil servants (29.0%) in urban LGAs. Also, artisans were 14.8% in urban but 9.6% of them in rural LGAs. The total percentage of farmers among the household head were 3.3% in urban while a good number, which totaled 44(28.0%) of the household heads were farmer in rural LGAs.

Table 2: Socio demographic characteristics of the children and their family

Characteristics	**Sector**			
	Urban		**Rural**	
	Frequency	**%**	**Frequency**	**%**
Age (yrs)				
7-8	43	27.7	35	22.3
9-10	54	34.4	40	25.5
11-12	58	37.4	82	52.2
Total	155	100.0	157	100.0
Mothers Age(yrs)				
Less than 20	3	1.9	10	6.4
21-30	34	21.9	72	45.9
31-40	69	44.5	36	22.9
Above 40	49	31.6	39	24.9
Total	155	100.0	157	100.0
Mothers' Educational Level				
No formal education	7	4.5	19	12.1
Primary education	22	14.0	31	19.7
Secondary education	34	21.9	63	40.1
Tertiary education	92	59.4	44	28.0
Total	155	100.0	157	100.0
Primary occupation of household head				
Trading	45	29.0	70	44.6
Civil servant	82	52.9	28	17.8
Artisan	23	14.8	15	9.6
Farming	5	3.3	44	28.0
Total	155	100	157	100.0
Average annual income of the household (Naira)				
<100, 000	5	3.2	23	14.6
100,000-199,000	36	23.2	57	36.3
200,000-299,000	28	18.1	54	34.4
300,000-399,000	57	36.8	11	7.0
400,000-499,000	20	13.0	9	5.7
500,000 above	9	5.8	3	2.0
Total	155	100	157	100

Biochemical assessment of Children

Table 3 shows the mean biochemical assessment of the children. The mean values were: Haemoglobin concentration for boys (12.14±1.39 g/dl), serum ferritin (21.52±20.38µg/l), C-reactive protein (3.32±5.06 mg/l), PCV (36.73±3.60), reticulocyte (0.83±0.37), WBC(7.02±2.21(100/µl) and neutrophils, lymphocytes, monocytes, Eosinophils, Basophils were (3.51±1.63), (3.85±4.45), (0.57±0.15), (0.36±0.31), and (0.04±0.05) respectively. The mean values for girls were: haemoglobin level (11.73±0.97 g/dl), serum ferritin (19.64±16.50µg/l), C-reactive protein (3.92±5.62 mg/l), PCV (36.10±3.92), reticulocyte (0.89±0.41), WBC (7.49±2.99 (100/µl) and neutrophils, lymphocytes, monocytes, Eosinophils, Basophils were (3.69±3.29), (3.51±1.52), (0.55±0.19), (0.34±0.35), and (0.04±0.03) respectively.

Table 3: Biochemical Indices of Respondents according to gender (N=312)

Variable	Male (n=155)	Female (n=157)	Total (N=312)	Cut-off Range	p-Value
Hb(mg/dl)	12.14±1.39	11.73±0.97	11.93±1.20	11.5-13.0	0.000*
SF (µg/l)	21.52±20.38	19.64±16.50	20.57±18.52	12-150	NS
CRP(mg/l)	3.32±5.06	3.92±5.62	3.62±5.34	3-10	0.002*
PCV(%)	36.73±3.60	36.10±3.92	36.42±3.76	>34	NS
Reticulocyte	0.89±0.41	0.83±0.37	0.86±0.39	0.5-1.5	NS
WBC(100/ µl)	7.02±2.21	7.49±2.99	7.26±2.64	4.0-11.0	NS
Neutrophils (1000/µl)	3.51±1.63	3.69±3.29	3.60±2.59	2.0-7.5	NS
Lymphocytes (1000/µl)	3.85±4.45	3.51±1.52	3.68±3.32	1.5-4.0	0.003*
Monocytes (1000/µl)	0.57±0.15	0.55±0.19	0.56±0.17	0.1-1.5	0.04*
Eosinophils (1000/µl)	0.36±0.31	0.34±0.35	0.35±0.33	0.04-0.4	NS
Basophils (1000/µl)	0.04±0.05	0.04±0.03	0.04±0.04	0.0-0.1	NS

Hb- Haemoglobin, SF- Serum Ferritin, CRP- C-reactive protein, PCV – Packed cell volume, WBC- White blood cells

Table 4 shows the mean biochemical indices of the children in accordance to the sector: Haemoglobin concentration for urban were (12.15±1.23 g/dl), serum ferritin (20.51±20.59µg/l), C-reactive protein (3.24±5.09 mg/l), PCV (36.65±3.50), reticulocyte (0.87±0.38),WBC (7.28± 2.19(100/µl) andneutrophils, lymphocytes, monocytes, Eosinophils,Basophils were (3.88±2.94), (3.03±0.97), (0.59±0.15), (0.33±0.25), and (0.04±0.03) respectively. The mean values for rural were: haemoglobin level (11.71±1.15 g/dl), serum ferritin (20.63±16.08µg/l), C-reactive protein (4.05±5.71 mg/l), PCV (36.04±3.86), reticulocyte (0.85±0.41), WBC (7.24±3.05 (100/µl) and neutrophils, lymphocytes, monocytes, Eosinophils, Basophils were (3.31±2.14), (4.38±4.57), (0.53±0.18), (0.38±0.39), and (0.04±0.05) respectively.

Table 4: Biochemical Indices of Respondents according to sector(N=312)

Variable	Urban(n=155)	Rural (n=157)	Total (n=312)	Cut-off Range	p-Value
Hb(mg/dl)	12.15±1.23	11.71±1.15	11.93±1.21	11.5-13.0	0.004*
SF (µg/l)	20.51±20.59	20.63±16.08	20.57±18.52	12-150	NS
CRP(mg/l)	3.24±5.09	4.05±5.71	3.63±5.40	3-10	0.001*
PCV(%)	36.65±3.50	36.04±3.86	36.36±3.68	>34	NS
Reticulocyte	0.87±0.38	0.85±0.41	0.86±0.39	0.5-1.5	NS
WBC(100/µl)	7.28±2.19	7.24±3.05	7.26±2.64	4.0-11.0	NS
Neutrophils (1000/µl)	3.88±2.94	3.31±2.14	3.60±2.59	2.0-7.5	NS
Lymphocytes (1000/µl)	3.03±0.97	4.38±4.57	3.68±3.32	1.5-4.0	0.002*
Monocytes (1000/µl)	0.59±0.15	0.53±0.18	0.56±0.17	0.1-1.5	NS
Eosinophils (1000/µl)	0.33±0.25	0.38±0.39	0.35±0.33	0.04-0.4	NS
Basophils (1000/µl)	0.04±0.03	0.04±0.05	0.04±0.04	0.0-0.1	NS

Hb- Haemoglobin, SF- Serum Ferritin, CD4 – Cluster of differentiation 4, CRP- C-reactive protein, PCV – Packed cell volume, WBC- White blood cells

Iron status of the children

Figure 2 showed the Iron status of the respondents, it shows that 23.7 were iron deficient, 16.3% were anaemic while 13.1% had iron deficiency anaemia and the remaning 46.7% are iron sufficient.

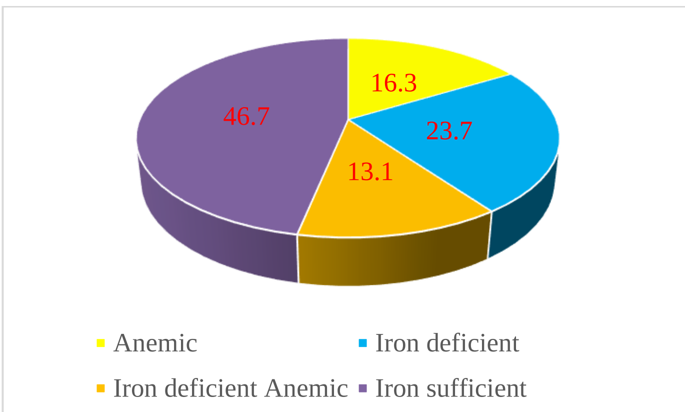

Figure 2: Iron status of the children

Iron status of the respondents is classified based on their sector and gender in Table 5,it shows that 20.6% of the male were iron deficient and 12.9% of iron deficient respondents were anaemic while 11.0% of the anaemia among the male is as a result of iron deficiency (IDA). Females that are iron deficient were 26.8%, while 19.7% of them were anaemic and 15.3% of the anaemia among the female is as a result of iron deficiency (IDA). In urban LGAs, 18.6% of the children were iron deficient and 7.5% of iron deficient respondents were anaemic while 13.7% of the anaemia among the children is as a result of iron deficiency (IDA). In rural LGAs, the percentages of children that are iron deficient were 29.1%, while 25.8% of them were anaemic and 12.6% of the anaemia among the rural children is as a result of iron deficiency (IDA). The overall iron status of the respondents shows that 74(23.7%) of the respondents were deficient in iron and 51(16.3%) were anaemic while iron deficiency anaemia was noticed in 41(13.1%) of them. One hundred and forty six (46.7%) are sufficient in iron.

Table 5: Classification of school children according to iron status(N=312).

Variables	Sector			p-value	Gender			p-value
	Urban	Rural	**Total**		Male	Female	**Total**	
Anaemia (Hb<11.5g/dl)	12(7.5)	39(25.8)	**51(16.3)**	0.003*	20(12.9)	31(19.7)	**51(16.3)**	0.032*
Iron Deficient (Hb≥11.5g/dl & SF <12µg/l)	30(18.6)	44(29.1)	**74(23.7)**	0.022*	32(20.6)	42(26.8)	**74(23.7)**	0.041*
Iron Deficiency Anaemia (Hb<11.5g/dl & SF <12µg/l)	22(13.7)	19(12.6)	**41(13.1)**	0.013*	17(11.0)	24(15.3)	**41(13.1)**	0.022*
Iron Sufficient (Hb≥ 11.5g/dl & SF≥12µg/l)	97(60.2)	49(32.5)	**146(46.7)**	0.012*	85(55.5)	60(38.2)	**146(46.7)**	0.013*
Total	**161**	**151**	**312**		**155**	**157**	**312**	

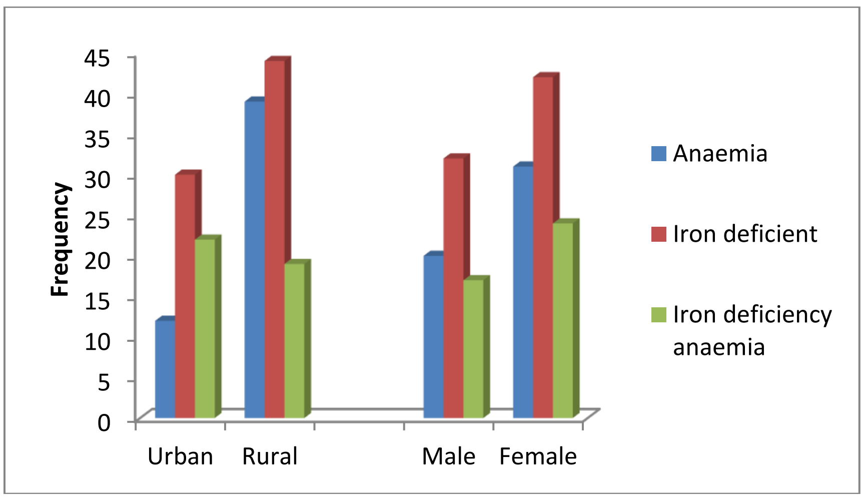

Figure3: Iron status of the Children by gender and sector

Severity of some biochemical indices among the children

Table 6 shows the level of some of the indicators of iron in both urban and rural LGAs and this classification is necessary to show the actual status of the indicators. It shows that 80.0% of the male had a normal haemoglobin level and 12.3% are mildly deficient while 5.8% and 1.9% are moderately and severely deficient in haemoglobin respectively. As for the females, 71.3% had normal level of haemoglobin and 19.1% are mildly deficient while 5.7% and 3.8% are moderately and severely deficient in haemoglobin respectively. In urban LGAs, 83.2% had a normal haemoglobin level and 10.6% are mildly deficient while 4.3% and 1.9% are moderately and severely deficient in haemoglobin respectively. As for the rural LGAs, 67.5% had normal level of haemoglobin and 21.2% are mildly deficient while 7.3% and 4.0% are moderately and severely deficient in haemoglobin respectively. The overall haemoglobin status shows that75.6% had a normal level and 15.7% are mildly deficient while 5.8% and 2.9% are moderately and severely deficient in haemoglobin respectively. There is a significant difference in heamoglobin status across the sector (p=0.032) and gender (p=0.040). Parked cell volume (PCV) was at low level in 19.4% of the males and 34.4% females while 21.1% and 33.1% had a low level of PCV in urban and rural LGAs respectively, with a significant difference in both the sector (0.024) and gender (0.032).Serum ferittin was deficient in 25.2% of the males and 34.4% females while in the LGAs, deficiency of ferittin was noticed in 22.4% of the children in urban and 37.7% in rural LGAs.Reticulocyte which is an immature red blood cell was low in 18.7% and 24.2% of male and female respondents and noticed to be high in 14.2% and 17.2% of male and female respondents respectively. It also shows that 16.1% and 27.2% have a low level of Reticulocyte while it was high in 14.3% and 17.2% in urban and rural LGAs

Table 6: Severity of some biochemical indices among the children

Variables	Sector			p-value	Gender			p-value
	Urban	Rural	**Total**		Male	Female	**Total**	
Heamoglobin (mg/dl)	Urban	Rural	**Total**	0.032*	Male	Female	**Total**	0.040*
Seve31re	3(1.9)	6(4.0)	**9(2.9)**		3(1.9)	6(3.8)	**9(2.9)**	
Moderate	7(4.3)	11(7.3)	**18(5.8)**		9(5.8)	9(5.7)	**18(5.8)**	
Mild	17(10.6)	32(21.2)	**49(15.7)**		19(12.3)	30(19.1)	**49(15.7)**	
Normal	134(83.2)	102(67.5)	**236(75.6)**		124(80.0)	112(71.3)	**236(75.6)**	
PCV(%)				0.024*				0.032*
Low	34(21.1)	50(33.1)	**84(26.9)**		30(19.4)	54(34.4)	**84(26.9)**	
Normal	127(78.9)	101(66.9)	**228(73.1)**		123(80.6)	103(65.6)	**228(73.1)**	
	161	151	**312**		155	157	**312**	
Ferittin(ng/ml)				0.021*				0.051
Deficient	36(22.4)	57(37.7)	**93(29.8)**		39(25.2)	54(34.4)	**93(29.8)**	
Normal	125(77.6)	94(62.3)	**219(70.2)**		116(74.8)	103(65.6)	**219(70.2)**	
Reticulocyte				0.001*				0.122
Low	26(16.1)	41(27.2)	**67(21.5)**		29(18.7)	38(24.2)	**67(21.5)**	
Normal	112(69.6)	84(55.6)	**196(62.8)**		104(67.1)	92(58.6)	**196(62.8)**	
High	23(14.3)	26(17.2)	**49(15.7)**		22(14.2)	27(17.2)	**49(15.7)**	
	161	151	**312**		155	157	**312**	

[a] WHO, 2001; [b] Tatala et al, 2004; [C] Thurnham et al, 2010 and [d]Thurnham et al, 2010

Table 7 shows the correlations between socio economic status and markers of iron status. Haemoglobin correlated positively with childs age (r= 0.144, p= 0.05) and average annual income of the family(r=0.132, p=0.05), serum ferritin correlated positively with mothers age (r= 0.159, p= 0.05). CRP positively correlated with annual income(r= 0.155, p= 0.05), PCV correlated positively with mothers education (r= 0.180, p= 0.05). White blood cell positively correlated with childs age, mothers education and annual income (r= 0.127, p= 0.05; r= 0.110, p= 0.05, r= 0.163, p= 0.05). Neutrophills correlated positively with childs age (r= 0.101, p= 0.05) and mothers education (r= 0.175, p= 0.01) and Lymphocytes correlated positively with mothers age (r= 0.202, p= 0.01) and fathers occupation (r= 0.011, p= 0.01). There was no significant correlation between reticulocyte counts, monocytes, eosinophills basophills and socio demographic parameters.

Table 7: Pearson's Correlations between socio economic status and markers of iron status

Variable	Childs age	Mothers age	Mothers Education	Fathers Occupation	Annual Income
Hb	0.144*	-0.059	0.055	-0.167	0.132*
SF	-0.120	0.159*	-0.110	0.215	0.062
CRP	0.107	0.105	0.070	-0.040	0.155*
PCV	-0.068	-0.005	0.180*	-0.041	0.001
RETICS	0.012	-0.156	0.027	0.116	0.103
WBC	0.127*	0.030	0.110*	0.109	0.163*
NEUT	0.101*	-0.011	0.175**	-0.014	0.173
LYMP	-0.078	0.202**	-0.043	0.011**	-0.049
MONO	-0.026	0.071	0.002	-0.020	0.008
EOSINO	0.171	0.080	-0.027	-0.007	0.101
BASO	-0.008	0.080	0.030	-0.007	0.048

DISCUSSION

According toWorld Health Organization (WHO) (2), it has been reported that anaemia is a global public health problem, with one in four people being affected. Iron deficiency was the commonest cause of anaemia and contributed further to the anaemias of sickle cell disease and protein-energy malnutrition (26). Irondeficiency has been reported to be the most prevalent nutritional deficiency in the world (27). A considerable number of children are anaemic in this study but it is not surprising to also note that more than one third is as a result of iron deficiency (Of all the children in the study, 16.3% were anaemic (Hb < 11.5 g/dL), 23.7% iron deficient (Hb ≥ 11.5 g/dL and SF < 12 μg/L) and 13.1% had iron deficiency anaemia (Hb < 11.5 g/dL and SF < 12 μg/L)). This high rate of anaemia and iron deficiency anaemia in the present study may be indicative of the fact that the diet of the school age most especially in the rural LGAs are not adequate for their iron needs. Observations and brief interviews of the people living in this rural areas during the data collection revealed that "garri" (cassava flakes) is their most common staple food with no form of animal protein. Farming is the major occupation and only crops that are likely to yield some income are planted. The level of income of family breadwinners is also low, judging by their houses and the yield from their farms. Their financial access to meat and other good animal sources of iron is therefore very limited. Considering other biochemical parameters under study, it can be easily concluded that though anaemia affect both urban and rural LGAs but the majority of those affected in urban may likely not be as a result of diet but other factor like parasitic infections and all these factors come into play in the rural LGAs, that is both diet and infections contributed to the level of anaemia in rural LGAs. It is worthy to note that the public health effects of iron deficiency and anemia include reduced work capacity and mental performance, poor growth development, impaired regulation of body temperature, impairments in behavior and intellectual performance, and decreased resistance to infections (28). The values reported in this study are higher than the report of Taljaard (29) which reported iron deficiency anaemia among black African school children aged 6-11 years in the Klerksdorp area of North West, South Africa. The prevalence of anemia and ID by Sana *et al.* (30) in the study conducted in Mexico, US and Colombia shows that 12% and 18% of children in Mexico were anaemic and iron deficient respectively. However, the values of aneamia and iron deficiency in this study arecloser to that reported by Achouri *et al.* (31). Other studies (32,20), have reported higher prevalence of anemia and iron deficiency among children. another study by Ughasoro *et al.* (33) report the prevalence of anaemia and iron deficiency anaemia (IDA) to be 49.2% and42.3%. Also, Onyemaobi *et al*. (34) reported 48.8% iron deficiency among school age while Anumdu *et al.* (35) reported 63% aneamia among children.Other studies across African and Asian countries have reportedlowiron status and iron deficiency anaemia to be prevalent. Astudy of 8 African and Asian countries found that 40%-60% of school aged childrenin Mali, Tanzania, Mozambique, Ghana, Malawi and Kenya and 12% and 30% ofthose in Vietnam and Indonesia suffered anaemia (36). Poor nutrition especially irondeficiency in school-aged children is associated with retardation of growth and poorcognitive development (37). According to other study, school age children are at risk of iron because of an expanding red cell and muscle mass (38). Although the prevalence of anemia was more in girls than boys,and significantly higher in rural than in the urban LGAs in this study.Various studies have established the fact that girls are more likely to be anaemic than boys and an example of such is the study of Izolda et al (39) of which the same trend was also observed in the present study. In contrast, some other studies found anaemia prevalence to be more in boys than girls and a good example is the study of Barduagni *et al.* (40). Onimawo reported 82.6% anaemia among school age children in Abia state butsex specific anaemia rates were not significantly different for boys and girls (19). In other to show the severity of the iron deficiency in the subjects, the heamoglobin concentration was further classified into severe, moderate, mild and normal according to World Health Organization classification (21). The result indicated that a good number of the children were severely and moderately anaemic with more in rural areas and female gender. The value reported in this study was lower than what was reported on the severity of anaemia among schoolchildren (6–15 years) in rural Nigeria by Rufina *et al.*(41) but consistence with the study of Onimawo and colleagues where the overall prevalence of anaemia was 82.6% with rates of mild, moderate and severe anaemia being 9.6%, 71.6% and 1.4%, respectively and all the subjects that had severe anaemia were females while none of the males had severe anaemia (19). Thando *et al.* (42) also reported 51.2% and 41.9% for mild and moderate forms of anaemia respectively, while severe anaemia was 2.3%. A jointly sponsored study in 2001 by WHO/UNICEF/UNN reported varying degrees of anaemia with 38.0% mild anaemia, 31.8% were moderately anaemic and 0.8% was severely anaemic (21). Another study on 15450 children attending the

Korle Bu Teaching Hospital, Accra showed that 71.1% of the children had haemoglobin (HB) levels below 11.0 Gm/dl while 27.7% of anaemic patients had Hb levels below 7.0 gm/dl (26). Indeed, 71.1% of children with severe anaemia had Hb levels below 5.0 gm/dl, thus requiring urgent blood transfusion (26). Alongside, is the study of Ahumareze et al, in which the prevalence of anaemia in the study was 54.2%; where severe anaemia, mild and moderate anaemia was 1.2% and 53.0% respectively (43). However, low haemoglobin may not be totally a specific indicator for anaemia because it is also influenced by blood depleting parasites, chronic infections and haematological conditions (44,45) and that is the reason for considering other parameter like PCV. It is however, interesting to note that majority of the children that are severely anaemic were females. This suggests that anaemia may not only have occurred as a result of low haemoglobin but may have been influenced by other factors like monthly menstrual period.

Serum ferritin (SF) concentration has been identified as the most specific biochemical test that correlates with relative total body iron store, hence is a precondition for iron deficiency in the absence of infection (17). Low levels of SF were used to indicate iron depletion (46). The result of the study shows that almost one third of the children had a low level of ferittin indicative of low iron stores in the body. There was significant difference in serum ferritin values in rural LGAs and urban LGAs but more female as compared to male were anemic. This results obtained in this study is at variance with the studies of Thando *et al*.(42) and that of Onabanjo *et al*. (47) that assessed the anthropometric and iron status of Adolescents in Ogun State. The serum ferritin values reported by Onimawo *et al*. (19) are lower than the present study. In the study, serum ferritin correlate with malaria parasites (r=0.109, p=0.05), indicative of infections in the study population. This conclusion is confirmed by a study conducted in Lagos, which showed that ferritin levels were significantly higher in subjects with high densities of malaria parasites (48).

C-reactive protein (CRP) is a marker of infection or inflammation in the body. It is released into the blood by the liver shortly after the start of an infection or inflammations as an early indicator of these problems and its levels can rise quickly. CRP and Serum ferritin when used in combination showed the best agreement with body iron stores (42). In the present study, result shows that CRP was elevated in a very close number of the subjects both in urbanand rural LGAswhich could be due to inflammation or infectionand also more female gender than the males were affected. Elevated level of CRP (above 20mg/l) in this study is a pointer to the fact that malaria is still endermic in most of the areas featured in the study and other parasites like hookworm still affects good number of subjects in both urban and rural settlements.

The overall percentage of the subjects with elevated CRP in this study is close to the value reported by John et al. (49) in which raised CRP levels was identified in 16% of the children. The results obtained in this study is similar to works of others studies, (50,51,52) that found CRP to be higher in girls than in boys. Conversely, Rodoo *et al*. (53) and Colantonio *et al.* (54) reported no gender differences in CRP values of children.

Reticulocyte are young, anucleate erythrocytes, which are released from bone marrow into the blood in increased numbers as a response to anemia caused by hemolysis (destruction) or loss (hemorrhage) of erythrocytes. Detection and identification of immature anucleate RBCs verifies whether the bone marrow is responding to the anemia by increasing RBC production in a regenerative response. Reticulocyte hemoglobin content is a reliable and early indicator of bone marrow iron status and may detect functional iron deficiency with more sensitivity than biochemical parameters (55). Low values indicate a low production of red cells possibly due to nutrient deficiency, whereas high values indicate a high production of reticulocytes to replace lost blood and healthy hematopoiesis. The result shows that more subjects in the rural LGAs have low level of Reticulocyte as compared to urban subjects and this may likely be as a result of nutrient deficiency and this result is in line with the study of Foy*et al*. (56) that reported reticulocyte hemoglobin content to be significantly lower in the blood donor group in their study, but it is not surprising that there are also subjects from urban LGAs that are anaemic because it reflected from the result that good number of subjects from both urban and rural LGAs had higher number of Reticulocyte than normal range which is very likely to be a result of other factors like infections apart from diet. The result of Reticulocyte heamoglobin content is a pointer to the fact that the rate of anaemia recorded in this study is not solely as a result of inadequate diet but other factors also come into play, more subjects had a low level of Reticulocyte in rural which is suggestive of inadequate diet but also an increase in the level of Reticulocyte was noticed in almost the same number of children in both urban and rural LGAs which is indicative of other parasitic infections and this is supported by the result of CRP in this study that reflects almost the same number of children in both urban and rural with elevated level of CRP. The implication of this is that the high level of anaemia in this study is not only as a result of diet but also infection plays a major role. Comparatively, the majorities of the mothers of the urban children had

Bachelors degree and above, thus were more educated and earned more income, and as such are in a better position to provide the basic nutrient needs of their children to achieve desirable nutrition as compared to their rural counterpact.

CONCLUSION

The following can be concluded from this study:

- The socio-economic status was very poor among the children who participated in the study, particularly in rural areas.
- The study revealed high prevalence of iron deficiency (23.7%) and aneamia (16.3%) with 13.1% of the prevalence of aneamia caused by iron deficiency among the children. This is significant ($p<0.05$) for gender and sector differences in the iron status.

The study revealed significant relationship between socio economic status and markers of iron status in the children that participated in the study.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made;

- More efforts should be geared towards improving the nutritional status of school children through the effective implementation of the school lunch feeding programme in the country.
- Nutrition education should also enable mothers and caregivers understand the basic needs and nutrient requirements of children for optimal growth and development, as well as sources of these nutrients.
- Appropriate investigations for iron status and inflammation/infection screening, need to be integral in the evaluation of anaemia and its causes before anaemia control interventions are implemented. Interventions that target the multifactorial nature of anaemia in school-aged children need to be strengthened. Additionally, regular screening of anaemia in school-aged children from disadvantaged communities is recommended.

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