

Original Research Article

PREVALENCE OF ANAEMIA AMONG CHILDREN ATTENDING PAEDIATRICS

DEPARTMENT OF UDUTH, SOKOTO, NORTH-WESTERN NIGERIA

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ABSTRACT

Introduction: Anaemia is a global public health problem. It affects more than 56 million people globally, two thirds of them being from developing countries. This study was designed to investigate the prevalence and types of anaemia among the children attending the Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto North Western Nigeria.

Method: Four hundred children between the ages of newborn to 15years were recruited for this study. Haematological parameters tested include red cell indices, white cell total and differential, platelet counts and morphologies were studied with a MythicTM 5-part autoanalyzer and manual techniques while morphological features were examined on blood film stained with leishman's stain. Other investigations include serum iron, serum ferritin, serum transferrin, total iron binding capacity and haemoglobin electrophoresis using an alkaline pH 8.4

Result: Out of the four hundred children tested, 139 (34.8%) were anaemic, revealing five aetiological types of anaemia among the children; iron deficiency 62(44.6%), sickle cell 43(31.0%), normocytic normochromic 19(13.7%), anaemia of chronic diseases 10(7.1%), and megaloblastic 5(3.6%) and three morphologic classification (i.e., normocytic anaemia 48(34.5%), macrocytic anaemia 18(13.0%) and microcytic anaemia 73(52.5%)).

Conclusion: This cross-sectional non-interventional study found approximately one-third of a child cohort with anaemia in a single hospital in a North-Western Nigeria. These findings lead to the potential for the targeted provision of iron and other micro nutrients supplementation for anaemic children.

Key Words: Anaemia, prevalence, Paediatrics, Sokoto, Nigeria.

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INTRODUCTION

Anaemia is a global public health problem affecting more than 56 million people, two thirds of them being from developing countries [1]. It is associated with a decrease in the haemoglobin concentration with a consequent decrease in the haematocrit (PCV) level. Anaemia is defined by the World Health Organization (WHO) as haemoglobin (Hb) <12g/dL in adult non-pregnant female, Hb < 11g/dL in pregnant females, Hb <13g/dL in adult men, Hb <12g/dL in male children, Hb <11g/dL in female children and Hb < 13g/dL in newborn [2].

The aetiological factors of anaemia are multi-factorial and include iron deficiency, other micronutrient deficiency, excessive blood loss, inheritance of the disorders of haemoglobin synthesis, malaria and other parasitic infections (i.e., hookworm and schistosomiasis infestations), HIV- infection and drug treatment-related complications [3]. Among the numerous factors, both nutritional and non-nutritional those contribute to the onset of anaemia, iron deficiency and malaria play the most critical role [4].

Anaemia is a common clinical problem encountered among the under-fives in everyday paediatric practice. A study done in the Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital Sokoto, North-Western Nigeria revealed a high prevalence of anaemia (50%) was due to severe malaria [8].

Anaemia is typically diagnosed on a complete blood count. Apart from reporting the number of red blood cells Hb, the automatic counters also measure the size of the red blood cells by flow cytometry, which is an important tool in distinguishing between the causes of anaemia. Examination of a stained blood smear using a microscope can also be helpful, and it is sometimes a necessity in regions of the world where automated analysis is less accessible. In modern coulter counters, four parameters: red blood cells (RBC) count, Hb concentration, packed cells volume (PCV) and red cell distribution width (RDW) are measured, allowing others (mean corpuscular volume (MCV) , Mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) to be calculated, and compared to values adjusted for age and gender. Other tests for proper differential diagnosis of anaemia include malaria testing, haemoglobinopathies

(using electrophoresis at alkaline pH), serum transferrin, serum iron and total iron binding capacity [5].

Anaemia is a common blood disorder in children and imposes an economic burden on the parents/caregivers and the country as a whole. The majority of anaemic children (76.2%) are under the age of 5 years, the most frequently affected age is 2 years (23.8%) with a male to female ratio was 2:1 [6]. In various African settings about 12 to 29% of hospitalized children have severe anaemia with hospital case fatality rate ranging between 8 and 17% [7]. Severe anaemia is a major paediatric problem in Nigeria. It is associated with many untoward effects such as, congestive cardiac failure, chest pain, jaundice, splenomegaly, joints pain, fever, and swelling of the limbs [8]. Severe anaemia which is a life threatening condition is a common occurrence in paediatrics emergency units in hospitals in developing countries [7]. Conventional methods for the diagnosis of anaemia do not completely differentiate between some types of anaemia (i.e., iron deficiency anaemia from anaemia of chronic diseases) especially in children leading to inappropriate treatment. Although, many researchers have sought out the causes, types, prevention and controls of anaemia, in low income regions (Agi, 1997), this research work is the first to use enzyme-linked immunosorbent assay (ELISA) for serum ferritin estimation in the differential diagnosis of anaemia among the children in Sokoto, North-Western, Nigeria. Serum ferritin is the most reliable marker for easy diagnosis of iron deficiency anaemia while differentiating it from any other types of anaemia [5]. The need to carry out this study was informed by the paucity of literature on the aetiological factors, types and prevalence of anaemia among children in the vulnerable age groups of newborn to 15 years. This study would be helpful to health care practitioners and health policy makers in curbing this preventable but potentially fatal disorder particularly among children, the youngest members of the society.

MATERIAL AND METHODS

2.1 STUDY AREA

This study was carried out in the Paediatrics Department of Usmanu Danfodiyo University Teaching (UDUTH) Sokoto, North-Western Nigeria. Sokoto State is located in the extreme North- West of Nigeria, near to the confluence of the Sokoto River and the Rima River. The State is located between longitude 11°30', 13°50' East and latitude 4° to 6°0' North. It is bordered to the North by Niger Republic, Zamfara State to the East while Kebbi State borders most of the South and Western parts [9]. The State falls within the Savannah vegetation zone. Rainfall starts late and ends early with mean annual rainfall ranging from 500 to 1,300 mm, and annual average temperature of 28.3°C (82.9°F) [10]. The major indigenous tribes in the state are the Hausa and Fulani and other groups such as Gobirawa, Zabarmawa, Kabawa, Adarawa, Arawa, Nupes, Yorubas, Ibos and others [10]. Occupation of city inhabitants include trading, commerce, with a reasonable proportion of the population working in private and public sectors. Majority of the Hausas' are farmers while Fulanis are nomadic and are engaged in animal rearing [10]. The population has experienced significant growth going from 3,696,999 in 2006 [11] to 4,806,098 in 2015 based on an annual growth rate of 3% [12].

2.2 STUDY POPULATION

A total of 400 children aged newborn to 15 years, whose parents completed a written informed consent for their wards to participate, were recruited for this cross-sectional study. The subjects were recruited from Paediatrics Department of UDUTH, Sokoto, North- Western Nigeria. The age of 15 years is considered as the upper limit for paediatrics patients in UDUTH, Sokoto [8].

2.3 STUDY DESIGN

This is a cross-sectional study designed to investigate the prevalence and the types of anaemia among 400 children attending Paediatrics Wards of UDUTH, Sokoto, North-Western Nigeria. Whole blood samples from the subjects were tested for full blood

count, blood film reports, and Hb electrophoresis. Serum samples were tested for serum iron, total iron binding capacity, serum transferrin and serum ferritin.

2.3 SAMPLE SIZE ESTIMATION

The sample was calculated using the following formula [13]: $n = Z^2pq/d^2$

Where n = minimum required sample size in population >10,000

Z = standard normal deviate set at 95% (1.96).

p = proportion of success or prevalence

q = proportion of failure (= 1- p)

d = precision, tolerable margin of error, expected difference set at 5%.

Attrition rate of 10% was added.

Prevalence of 50% of severe anaemia among children with malaria was recorded in Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital Sokoto, North-Western Nigeria [14].

$$n = Z^2pq/d^2$$

$$z = 95\% (1.96)$$

$$p = 50\% (0.5)$$

$$q = 1-0.5 = 0.5$$

$$d = 5\% (0.05)$$

$$n = Z^2pq/d^2$$

$$n = (1.96)^2(0.5) (0.5) / (0.05)^2$$

$$n = 384.16$$

$$\text{SAMPLE SIZE} = 385.$$

$$\text{Attrition rate of } 10\% = 38.5 = 39 + 385 = 424$$

$$\text{Therefore, sample size} = 424$$

2.4 SELECTION OF SUBJECTS:

2.4.1 Inclusion Criteria. The inclusion criteria for this study included: children aged (newborn-15.0 years), attendance to the Paediatrics Wards of Usmanu Danfodiyo University Teaching Sokoto, North-Western Nigeria and written informed consent obtained from their parents/guardians.

2.4.2 Exclusion criteria: Individuals who did not meet the inclusion criteria included: individuals above 15 years, and children whose parents/guardians refused to provide a written informed consent for their wards to participate in the study.

2.5 METHODS

Between three to five mL of blood was collected from the subjects (about 2.5mL in K₂EDTA containers). The anti-coagulated samples were used for full blood counts using a MythicTM (22 CT, 2008) 5-part automated haematological analyser; blood films were stained with leishman's stain for blood morphology, and haemoglobin electrophoresis was carried out at pH 8.4 using the procedure described by Helena Biosciences [14]. Samples in coagulated containers were allowed to clot and serum was separated for the investigations of serum iron, serum ferritin, serum transferrin and total iron binding capacity using ELISA techniques.

Ethical Consideration

This study was approved by the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto and written informed consent was obtained from the parents of all participants in this study.

Competing Interests: "Authors have declared that no competing interests exist."

STATISTICAL ANALYSIS

The data collected were entered into the data editor of the Statistical Package for Social Sciences (SPSSTM Version 20) software. Analysis was based on simple percentages, proportions, and values were expressed in a standard form (i.e., mean $\pm$ std). A Chi-square test at a 95% confidence level was used to test for association between aged groups, anaemia, and gender. A p-value of < 0.05 was considered as significant in all statistical analysis.

RESULTS

Four hundred subjects including 224(56.0%) males and 176(44.0%) females aged newborn to 15 years participated in this study. The children included: pre-primary school (newborn to 5.0 years), primary school (5.1- 10.0 years) and post-primary school (10.1- 15.0 years).

The mean values and standard deviation of key haematological variables are reflected in table 1.

Table 1: Mean Values and Standard Deviation of the Haematological Variables, iron and iron-related parameters/biochemical parameters.

Variable	Mean $\pm$ Standard Deviation
Age	5.27 $\pm$ 4.63
Haemoglobin (Hb) (g/dl)	11.12 $\pm$ 2.51
Packed Cells Volume (PCV) (%)	33.30 $\pm$ 7.99
Red Blood Cells (RBC)($\times 10^{12}/l$)	3.81 $\pm$ 0.82
Total Leucocytes Count (TLC) ($\times 10^9/l$)	9.20 $\pm$ 6.89
Platelets count (PLT)($\times 10^9/l$)	310.60 $\pm$ 136.70
Serum Iron (S I)(ug/dL)	82.59 $\pm$ 31.55

Serum Ferritin (S F) (ng/mL)	56.66 ± 27.92
Serum Transferrin (ST) (mg/dL)	253.72 ± 82.81
Total Iron Binding Capacity (TIBC) (mg/dL)	304.30 ± 99.60
Mean Cells Volume (MCV) (fl)	88.28 ± 12.41
Mean Cells Haemoglobin (MCH) (pg)	28.72 ± 4.38
Mean Cells Haemoglobin Concentration (MCHC) (g/dL)	32.39 ± 15.39
Red Cells Distribution Width (RDW) (%)	16.62 ± 7.35

The reference range/values were attached in appendix iii. std = standard deviation, g/dL = gram/decilitre, % = percent, µg = microgram, ml = millilitres, mg = milligrams, fl = fentolitres, pg = picogram, l = litre.

Of the four hundred children tested, 139 (34.8%) children were anaemic while 261 (65.2%) were not anaemic (normal) as shown in table 2 below. Children aged newborn to 5.0 years were more affected with anaemia compared to those above 5.0 years but there was no statistically significance difference.

Table 2: Age Specific Prevalence of Anaemia among the Study Population.

Age (years)	Not anaemic	Anaemic	Total
Newborn to 5.0	154(38.5%)	74(18.5)	228(57.0%)
5.1 – 10.0	59(14.8%)	38(9.5%)	97(24.2%)
10.1 – 15.0	48(12.0%)	27(6.8%)	75(18.8%)
Total	261(65.2%)	139(34.8%)	400(100%)

$\chi^2 = 1.42$; $df = 2$ p -value = 0.500. Linear by linear association ($\chi^2 = 0.684$; $df = 1$, p -value = 0.038, df = degree of freedom).

Children whose Hb ≥ 13g/dl were considered not anaemic, mild anaemic children had Hb of 9.0-10.9g/dl, moderate children had Hb of 7.0-8.9g/dl while severe anaemic children had Hb of < 7.0g/dl as indicated. According to table 3 which reflects the severity of anaemia in the total population indicates that children aged newborn to 5.0 years were more likely to exhibit severe anaemia than those above 5.0 years.

200 **Table 3: Severity of Anaemia among the Study Population.**

Age (years)	Degree of Anaemia				Total
	Not Anaemic	Mild	Moderate	Severe	
Newborn to 5.0	154(38.5%)	32(8.0%)	34(8.5%)	8(2.0%)	228(57.0%)
5.1 – 10.0	59(14.8%)	8(2.0%)	22(5.5%)	8(2.0%)	97(24.3%)
10.1 – 15.0	48(12.0%)	6(1.5%)	17(4.2%)	4(1.0%)	75(18.7%)
Total	261(65.3%)	46(11.5%)	73(18.2%)	20(5.0%)	400(100%)

201 $\chi^2 = 9.7$; $df = 6$, $p\text{-value} = 0.133$, $df = \text{degree of freedom}$. A = Anaemia.

202 **Table 4** shows the age and gender specific distribution of the anaemic children. Male
 203 children were **found to have higher prevalence** than their female counterpart .

204 **Table 4: Age and Gender Specific Distribution of the Anaemic Children.**

Age (Years)	Gender		Total
	Male	Female	
Newborn to 5.0	46(33.1%)	28(20.1%)	74(53.2%)
5.1 – 10.0	27(19.4%)	11(7.9%)	38(27.3%)
10.1 – 15.0	14(10.1%)	13(9.4%)	27(19.5%)
Total	87(62.6%)	52(37.4%)	139(100%)

205 $\chi^2 = 2.49$; $df = 2$, $p\text{-value} = 0.287$.

206 Of the 139 anaemic children recorded, 87(62.6%) were male while 52(37.4%) were
 207 female indicating that male incidence was higher than their female counterparts.

208 **Table 5: Gender Specific Grading of Anaemia among the Anaemic Children.**

Degree of Anaemia				
Gender	Mild A.	Moderate A.	Severe A.	Total
Male	36(25.9%)	36(25.9%)	15(10.8%)	87(62.6%)
Female	19(13.7%)	28(20.1%)	5(3.6%)	52(37.4%)
Total	55(39.6%)	64(46.0%)	20(14.4%)	139(100%)

209 Proportion M/F = 2:1; M = male, F = female, $X^2 = 2.07$; $df = 2$, p -value = 0.27.

210 These results revealed that iron deficiency anaemia is the most common type of
 211 anaemia among the presenting children.

212 **Table 6: Aetiological Classification of Anaemia among the Anaemic Children**
 213 **based on age groups.**

Aetiological Classification of Anaemia						
Age(years)	IDA	SCA	NNA	ACD	MBA	TOTAL
Newborn to 5.0	40(28.8%)	19(13.7%)	8(5.7%)	6(4.3%)	1(0.7%)	74(53.2%)
5.1 – 10.0	11(7.9%)	13(9.4%)	7(5.0%)	3(2.1%)	4(2.9%)	38(27.3%)
10.1 – 15.0	11(7.9%)	11(7.9%)	4(3.0%)	1(0.7%)	0	27(19.5%)

Total	62(44.6%)	43(31.0%)	19(13.7%)	10(7.1%)	5(3.6%)	139(100%)
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214 $\chi^2 = 14.04$; $df = 8$, $p\text{-value} = 0.076$.

215 This table shows that microcytic anaemia is the most common type of anaemia among
216 the anaemic children.

217 **Table 7: Age Specific Morphologic Classification of Anaemia among the Anaemic**
218 **Children.**

Morphologic Classification of Anaemia				
Age(years)	NA	MACA	MICA	TOTAL
Newborn – 5.0	27(19.4%)	6(4.3%)	42(30.2%)	75(54.0%)
5.1 – 10.0	11(7.9%)	11(7.9%)	16(11.5%)	38(27.3%)
10.1 – 15.0	10(7.2%)	1(0.7%)	15(10.8%)	26(18.7%)
Total	48(34.5%)	18(13.0%)	73(52.5%)	139(100%)

219 $\chi^2 = 2.7$; $df = 2$, $p\text{-value} = 0.291$.

220

DISCUSSION

Anaemia in this study was defined based on the WHO criteria of haemoglobin values of less than 11g/dl; mild anaemia (9.0–10.9 g/dl), moderate anaemia (7.0–8.9 g/dl) and < 7.0 g/dl (severe anaemia) [15]. The global prevalence of anaemia in school-age and preschool-age children is 25.4% and 47.4% respectively. It affects 293 million children globally with the highest prevalence found in Africa (67.6%) [15].

Four hundred subjects comprising 224(56.0%) male and 176(44.0%) female were used

in this study. The red cell indices observed in this study is consistent with the average MCV in IDA of 66.81 fl, the mean value of MCH of 23.97 pg, mean value of MCHC of 34.81%, and mean haemoglobin of 10.41 gm/dl in IDA recorded by Abu-syed *et al.*, 2014 [16].

In this study, we recorded an overall prevalence of anaemia of 34.8% among our cohort of children in Sokoto, North Western Nigeria. This finding is consistent with the global prevalence of 33% [17]. The observed prevalence is lower compared to the high prevalence rate of 49.6% anaemia recorded in children in South Eastern Nigeria [18]. Similarly, the observed prevalence among children in Sokoto is also lower compared to the high prevalence of 82%, 62%, 66.7% and 57.1% reported in Abia State [19]; Ibadan [20]; Anambra [21] and Enugu State [22] respectively. The low prevalence observed in our study may be linked to the facts that this present study was carried out in Usmanu Danfodiyo University Teaching Hospital where a significant number of patients seen are in the higher economic class and may have access to better nutrition. They are also more likely to be able to afford insecticide-treated mosquito bed nets and thus are less exposed to malaria and malaria-related anaemia. This may also be linked to the facts that the study was conducted between March to June, 2015(dry session) when there is climatic changes and the environment is not conducive for the breeding of female anopheles mosquitoes (causative agent of malaria). However, our observed prevalence is higher than a 29% prevalence of anaemia reported in Katsina [23]. Several factors may be responsible for the high prevalence of anaemia among children recorded in this study and in other studies from other parts of Nigeria. These include; malaria, poor nutrition, frequent bacterial infections, poor hygiene and high parasitic infections, etc [24].

In this present study, we observed prevalence of severe anaemia, mild anaemia and moderate anaemia of 20(14.4%), (46.0%) and 55(39.6%) respectively among our cohort of children in Sokoto, Nigeria. Our observed prevalence varied significantly from the prevalence of severe anaemia, mild anaemia and moderate anaemia of 16.7-22.2%, 13.9% and 8.3% respectively observed in a previous report in North Western Nigeria [25]. However, our study is consistent with the prevalence level for developing countries recorded to be 42% for pre-school children but inconsistent with 53% of anaemia recorded

previously for school children in developing countries. This may likely be due to poor nutrition, mal-absorption, poor environment or poor socio-economic background.

The results of our findings revealed that out of 139 anaemic children; 74 (53.3%) were in the pre-school age (Newborn to 5.0 years), 38 (27.3%) were school age (5.1-10.0) and 27 (19.4%) were post- primary school children (10.1-15.0). These findings indicate that children under the age of five are more vulnerable to anaemia than those above five years. This finding is consistent with the global findings of 47.4% and 27.4% in pre-school and schooled children respectively [15]. Our study is also consistent with the prevalence level for developing countries recorded to be 42% for pre-school children but inconsistent with 53% of anaemia recorded previously for school children in developing countries [1]. This may be due to poor nutrition, mal-absorption, poor environment or poor socio-economic background.

This study also indicates that, of the 139 anaemic children tested, anaemia was higher among male children 87(62.6%) compared to female children 52(37.4%) representing a male to female ratio of 2:1 approximately. This finding is consistent with the findings of a previous report [7]. In this present study, we observed a low prevalence of severe anaemia of 5% among our cohort of children in Sokoto, Nigeria. Our finding is consistent with the findings of previous studies by other Nigerian workers which indicated prevalence rates ranging from 2.7% to 12.5% [26]. Our observed prevalence for severe anaemia is however lower than a prevalence rate of 9.7% reported in under-5 children in Abakaliki South Eastern Nigeria [27]. Similarly, previous report in various African settings indicated that about 12 to 29% of hospitalized children had severe anaemia [6].

In this study, we observed the prevalence of 44.6% of iron deficiency anaemia among the anaemic children in study population. According to WHO criteria, the accepted cut-off point for iron deficiency anaemia screening in children is set at 11gm/dl, 70fl and 20pg for haemoglobin, MCV and MCH respectively. Following these criteria, the most common type of anaemia recorded among the children in this present study is iron deficiency anaemia, followed by sickle cell anaemia

31.0%, normocytic normochromic anaemia 13.7%, anaemia of chronic diseases 7.1% and macrocytic/megaloblastic anaemia 3.6%. Our finding is also higher compared to the prevalence rate of 34.3% reported in Enugu South East Nigeria by [22]. The higher prevalence recorded in our study, may be linked to the facts that some children in this area are malnourished. Other factors may include; inadequate intake of iron containing food, mal-absorption from the gastro-intestinal tract and excessive loss from the circulation [28]. Also prevalence of iron deficiency anaemia in children was higher in male compared to female. The prevalence of iron deficiency anaemia declined sharply in males after 15 years of age coinciding with the end of a growth spurt while the prevalence among females stated to rise after the age 18 years as they proceed to marriage and childbearing [29].

CONCLUSION

Generally, there is high prevalence of anaemia among the children in Sokoto (34.8%), and iron deficiency anaemia is the highest, follow by sickle cell, normocytic normochromic, anaemia of chronic diseases while megaloblastic anaemia is the least. Serum iron and ferritin levels, as measured by ELISA can be a reliable marker for the differential diagnosis of iron deficiency anaemia (from other anaemia) among children. This findings leads to potential for the targeted provision of iron and other micronutrient supplementation for anaemic children.

AUTHORS CONTRIBUTIONS:

IKK, JNM, MAS and UEU: Designed the topic and provided fund, EO, JML, SM, GA and UA: Data collectors, compiled and analysed the data using SPSS version 22. HL, OFO, BZ, SLS and MSK: Interpreters and concerned with logistics

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APPENDIX I

USMANU DANFODIYO UNIVERSITY TEACHING HOSPITAL, SOKOTO.
PRIVATE MAIL BAG 2370 SOKOTO, NIGERIA

Chairman Board
Rt. Hon. Inusa Simon Dogari

Director of Administration
Alh. Bala Hassan B.Sc (Pol.Sc.)MPA



Chief Medical Director
Dr. Y. Ahmed MBBS, FWACS

Chairman M.A.C
Dr. S. A. Saidu, MBBS, FWACS, FMCR

UDUTH/HREC/2014/292

Our Ref: _____ Your Ref: _____ Date: 25th February, 2015

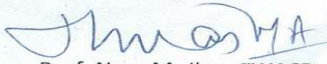
Ibrahim Kalle Kwaifa (PG Adm. No. 12211225007)
Department of Haematology & Blood Transfusion Sciences,
Faculty of Medical Laboratory Sciences,
Usmanu Danfodiyo University, Sokoto.

RE: APPLICATION FOR ETHICAL CLEARANCE

With reference to application on the above subject dated 31st December, 2014 on a research topic titled: ***"Aetiology and types of Anaemia among Children visiting Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital, Sokoto, North-western Nigeria"***, I write to acknowledge its receipt and to convey Ethical Committee's approval to you. The approval is given with the understanding that the data obtained would be used to substantiate the above topic.

Please ensure that the study is guided by the methodology presented in the proposal.

Thank you.



Prof. Nma M. Jiya, **FWACP**
Chairman HREC

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APPENDIX II
RESEARCH QUESTIONNAIRE

STUDY TITLE: Prevalence and Types of Anaemia among Children Attending Paediatric Departments (CLINIC 1, EPU, PSW, PMW, PNSW,SCBU, A&E) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, North-Western, Nigeria.

I give consent for myself/child to be a participant in this study. I have been fully informed what participation will involve and had all my questions answered. I understand that I can withdraw from this study at any time without giving reason and without penalty.

- Age (Years).....**
- Gender: Male [] Female []**
- Occupation of the parent: Farming [] Business [] Civil Servant [] others []
Specify.....**
- Level of educational attainment of the parent: No formal [] Primary [] Secondary []
Tertiary []**
- Area of resident.....**
- Number of children/sibling.....**
- Number of wife(s).....**
- Any medication: Haematinic [] others [] Specify.....**
- Sign and symptoms of disease(s).....**
- Hereditary disease(s) sickle cells anaemia [] others [] Specify.....**

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APPENDIX III

Example of Reference Values (Mythic 22CT, 2008)

Parameter	1st Week	8 Days-3 Months	3 Months to 3 Years	3-6 Years	6-15 Years	Adult
RBC 106/μL (1012/L)	5,0 to 6,0	3,8 to 4,8	3,6 to 5,2	4,1 to 5,3	4,0 to 5,4	M : 4,5 to 5,8 F : 3,8 to 5,4
HGB g/dL	14,5 to 22,5	10 to 16	10,5 to 13,5	10,5 to 13,5	11,5 to 14,5	M : 13,5 to 17,5 F : 12,5 to 15,5
HCT %	44 to 58	38 to 44	36 to 44	36 to 44	37 to 45	M : 40 to 50 F : 37 to 47
MCV fl	100 to 120	85 to 96	70 to 86	73 to 89	77 to 91	82 to 98
MCH pg	34 to 38	24 to 34	23 to 31	24 to 30	24 to 30	> or = 27
MCHC g/dL	32 to 36	32 to 36	32 to 36	32 to 36	32 to 36	32 to 36
PLT 10³/μL (109/L).	150 to 400	150 to 400	150 to 400	150 to 400	150 to 400	150 -400

246 M = male, F = female. OTHER REFERENCES: Serum ferritin: 15-120ng/ml for adolescence and children, 30-300ng/mL for Men and 10-
247 160ng/mL (up to 300ng/mL generally) for women. Serum Transferrin: 170-360mg/dL. Serum Iron: Male = 55-175 μ g/dL, Female = 40-
248 145 μ g/dL. Total Iron Binding Capacity: Newborn = 100-400 μ g/dL, Adult = 250-425 μ g/dL.