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MAJOR TYPES OF ANAEMIA AMONG THE CHILDREN ATTENDING PAEDIATRIC DEPARTMENT OF UDUTH, SOKOTO, NORTH-WESTERN NIGERIA

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ABSTRACT

The World Health Organization (WHO) defined anaemia as HB <12g/dl in adult non-pregnant female, Hb < 11g/dl in pregnant females, Hb <13g/dl in adult men, Hb <12g/dl and Hb <11g/dl in male & female children respectively. The major causes of anaemia include; iron deficiency, macro and micronutrient deficiencies, excessive blood loss, inheritance disorders of haemoglobin, malaria and other parasitic infections, HIV- infection and drug-related complications. This study is aimed to investigate the major types of anaemia among the children attending Usmanu Danfodiyo University Sokoto, North-Western, Nigeria. Four hundred children aged 0-15years were recruited for this study. Haematological parameters tested include red cell indices, white cell total and differential, platelet counts and morphologies were studied with mythic 5-part autoanalyzer and manual techniques. Malaria testing was done using Parasite-F strip and manual thin film stained with giemsa stain. Other investigations

include serum iron, ferritin, transferrin, TIBC, Hb Genotype and HIV testing using rapid strip method approved by WHO. Of the four hundred children tested, 139 (34.8%) were anaemic while 261 (65.2%) were non-anaemic. This study revealed five types of anaemia among the children; iron deficiency 59(14.7%), sickle cell 50 (12.5%), normocytic normochromic 20(5%), anaemia of chronic diseases 9(2.2%) and megaloblastic 5 (1.3%). This study observed a prevalence of 34.8% of anaemia among the children in Sokoto Serum iron and ferritin levels, as measured by ELISA can be used reliably for the differential diagnosis of iron deficiency anaemia (from other anaemia) among children.

KEYWORDS: Anaemia, causes and types, children, haematological parameters, iron.

INTRODUCTION

Anaemia is described to be among the major global public health problem. It is characterized by a decreased haemoglobin concentration parallel to decrease in the haematocrit (PCV) level. Anaemia is a condition identified by the by the 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 new born.[1] It affects more than 56 million people worldwide, and more than two thirds of them being from poor resources countries.[2] The causative agents of anaemia are multi-factorial, including iron deficiency, other macro- and micronutrient deficiencies, excessive blood loss, inheritance of haemoglobin disorders, malaria and other parasitic infections (hookworm and schistosomiasis infestations), HIV- infection and drug-related complications.[3] Several factors are known from both nutritional and non-nutritional that contributed to the onset of anaemia, with iron deficiency and malaria parasite playing most important role.[4] It is the most common clinical problem identified, especially in tropic region, among the under-five years children in everyday paediatric practice. In haematology department, anaemia is typically diagnosed using a complete blood count. The number of red blood cells and haemoglobin levels can be reported manually while 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 and different types 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.

Other diagnosis such as electrophoresis at alkaline pH, serum transferrin, serum iron and total iron binding capacity are also required to differentiate between types of anaemia.[5] It is

associated with many unwanted effects on the patient, such as, congestive cardiac failure, chest pain, jaundice, splenomegaly, joints pain, fever, swelling of the limbs etc. Severe anaemia which is a life threatening condition is a common occurrence in children emergency units in most hospitals in developing countries and most anaemia related -deaths encountered are usually due to severe anaemia. It is a common blood disorder in children and imposes an economic burden on the parents/caregivers and the country as a whole.

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 1:2.[8] In other African settings, about 12 to 29% of hospital admitted children might have severe anaemia, with fatality rate ranging between 8 and 17%.[9] Anaemia of chronic diseases (ACD) and iron deficiency anaemia (IDA) are the two major types of anaemia in many hospitalized patients.[10] However, the differential diagnosis between these two causes of anaemia is often difficult in clinical practice. The diagnosis is even a greater challenge in case of the combination of ACD and IDA in the same patient. Serum ferritin with cut-off level of 15-120ng/ml has been the most commonly used single laboratory parameter to discriminate between ACD and IDA.[11] Therefore, this study was aimed to investigate the major types and causes of anaemia among the children attending Usmanu Danfodyo University Teaching Hospital (UDUTH), Sokoto, North-Western, Nigeria.

MATERIAL AND METHODS

STUDY AREA

This study was carried out in 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 $4'0^0$ 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.[12] Majority of the Hausas' are farmers while Fulanis are nomadic and are engaged in animal rearing.[13] Based on 2006 population census, Sokoto State had a population of 3,696,999[14], with an average estimate of 4,806,098 in 2015 based on the population annual growth rate of 3%.[15]

STUDY POPULATION

A total of 400 children aged 0-15 years with mean age 5.27 ±4.63 years whose parents offered a written informed consent for their wards to participate in the study were recruited

for this prospective cross-sectional study. The subjects were recruited from Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital, Sokoto, North- Western Nigeria. The age of 15years is considered as the limit for Paediatrics patients in UDUTH, Sokoto.

STUDY DESIGN

This was a prospective cross-sectional study designed to investigate the causative agents, prevalence and the types of anaemia among 400 children attending Paediatrics Wards of Usmanu Danfodiyo University Teaching Hospital, Sokoto, North- Western Nigeria. Whole blood samples from the subjects were tested for full blood count, malaria parasites, blood film reports, Hb electrophoresis. Serum sample was tested for serum iron, total iron binding capacity, serum transferrin, serum ferritin and HIV screening.

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

Methods: About three to five miles of were collected from the subjects (about 2.5ml in K_3EDTA containers while the remaining were pour into plan containers. The anti-coagulated samples were used for full blood counts using automated haematological analyser, blood films stained with leishman's stain were used for blood morphology, malaria parasite was tested using giemsa stain, Haemoglobin electrophoresis was carried out at PH8.4 using the procedure described by Monica, ceeshbough, 2008. Samples in coagulated containers were allowed to clot and serum was separated for the investigations of; serum iron, serum ferritin, serum transferring, HIV test using determine, Total iron binding capacity using ELISA techniques.

STATISTICAL ANALYSIS

The data collected were entered into the data editor of statistical package for social sciences (SPSS Version 20) software. Analysis was based on simple percentages, proportions and values were expressed as Mean ± SD and ANOVA was used to compare the mean values. 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 comprising 224(56.0%) male and 176(44.0%) female aged 0.0-15.0 years were used for this study. These children include; pre-primary school (0.0- 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 the haematological and biochemical parameters were also showed below.

Table 4.1: Mean Values and Standard Deviation of the Haematological Variables.

Variable	Mean ± Std
Age	5.27 ± 4.63
Haemoglobin (g/dl)	11.12 ± 2.51
Packed Cells Volume (%)	33.30 ± 7.99
Red Blood Cells (x 10^{12}/l)	3.81 ± 0.82
Total Leucocytes Count (x 10^{9}/l)	9.20 ± 6.89
Platelets count (x 10^{9}/l)	310.60 ± 136.70
Serum Iron (µg/dL)	82.59 ± 31.55
Serum Ferritin (ng/ml)	56.66 ± 27.92
Serum Transferrin (mg/dL)	253.72 ± 82.81
Total Iron Binding Capacity (mg/dL)	304.30 ± 99.60
Mean Cells Volume (fl)	88.28 ± 12.41
Mean Cells Haemoglobin (pg)	28.72 ± 4.38
Mean Cells Haemoglobin Concentration (g/dL)	32.39 ± 15.39
Red Cells Distribution Width (%)	16.62 ± 7.35

This table shows the Mean Values and Standard Deviation of the Haematological variable, iron and iron related/biochemical parameters. From the general view, they appear relevant and appropriate to the requirement of our manipulation. STD = Standard Deviation, g/dl = gram/decilitre, % = percent, X= multiply µg = microgram, ml = millilitres, mg = milligrams, fl = fentolitres, pg = picogram, l = litre.

Table 4.2: Age and Gender Distribution of the Study Population.

This research work examined the haematological, iron and iron-related parameters of four hundred children attending Paediatrics Department of UDUTH, Sokoto, North-western Nigeria. Out of the four hundred children tested, 224(56.0%) were male while 176(44.0%) were female. The children include; pre-primary school (0.0-5.0 years), schooled (5.1-10.0 years) and post primary school (10.1-15.0 years) as shown below.

	Gender		
Age (years)	**Male**	**Female**	**Total**
0.0 – 5.0	126(31.5%)	102(25.5%)	228(57.0%)
5.1 – 10.0	62(15.5 %)	35(8.8%)	97(24.3%)

10.1 - 15.0	36(9.0%)	39(9.7%)	75(18.7%)
Total	224(56.0%)	176(44.0%)	400(100.0%)

This table indicates the characteristics age and gender distribution of the total study population. These are the total subjects used in this study. $X^2 = 4.47$; *df = 2 p-value = 0.107 df = degree of freedom.*

Table 4.3: Prevalence of Anaemia among the Study Population.

Of the four hundred children tested, 139 (34.8%) children were anaemic while 261 (65.2%) were not anaemic (normal) as shown in table 4.3 below. Children aged 0.0-5.0 years are more affected with anaemia compared to those above 5.0 years.

Age (years)	Not anaemic	Anaemic	Total
0.0 – 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%)

The overall prevalence of 139 (34.8%) of anaemia was observed among the children attending UDUTH, Sokoto, North-Western Nigeria ($X^2 = 1.42$; *df = 2 p-value = 0.500). Linear by linear association (*$X^2 = 0.684$ *; df = 1, p-value = 0.038, df = degree of fredom).*

Table 4.4: Severity of Anaemia among the Study Population.

Children whose Haemoglobin (Hb) were ≥ 13g/dl were considered not anaemic, mild anaemic children had Hb of 12-12.9g/dl, moderate anaemic children had Hb of 10-11.9g/dl while severe anaemic children had Hb of < 7.5g/dl[15], as indicated below.

		Degree	of Anaemia		
Age (years)	**Not Anaemic**	**Mild A.**	**Moderate A**	**Severe A.**	**Total**
0.0 – 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%)

This table has assessed the severity of anaemia in the total population and indicates that children aged 0-5.00 years are more severe than those above 5.00 years. $X^2 = 9.7$; *df = 6, p-value = 0.133, df = degree of freedom. A = Anaemia.*

The Results obtained revealed that there was no significant association between the age groups of the children in different aetiological groups of anaemia; was not significantly different (>0.05).

Table 4.5: Aetiological Classification of Anaemia among the Study Population based on Age Group.

Age (Years)	NB	Aetiological IDA	Classification SCA	of NNA	Anaemia ACD	MBA	Total
0 – 5.0	153(38.3%)	37(9.3%)	23(5.8%)	9(2.2%)	5(1.2%)	1(0.2%)	228(57%)
5.1 – 10.0	58(14.5%)	11(2.7%)	14(3.5%)	7(1.7%)	3(0.7%)	4(1.0%)	97(24.3%)
10.1– 15.0	46(11.5%)	11(2.7%)	13(3.2%)	4(1.0%)	1(0.3%)	0	75(18.7%)
Total	257(64.3%)	59(14.7%)	50(12.5%)	20(5.0%)	9(2.3%)	5(1.2%)	400(100%)

X^2 = 15.2; df = 10 p-value = 0.126 NA = Normal Blood, IDA = Iron Deficiency Anaemia, SCA = Sickle Cells Anaemia NNA = Normocytic Normochromic Anaemia, ACD = Anaemia of Chronic Diseases, MBA = Macrocytic/Megloblastic Anaemia.

Of the 400 children tested in this present study, microcytic anaemia has the highest prevalence of 18.2%. Slides with some different types of anaemia were shown in appendix pages

Table 4.6: Morphologic Classification of Anaemia among the Study Population based on Age Group.

		Cells	Morphology		
Age(years)	**NB**	**NA**	**MACA**	**MICA**	**Total**
0.0 – 5.0	154(38.5%))	26(6.5%)	6(1.5%)	42(10.5%)	228(57.0%)
5.1 – 10.0	59(14.8%)	11(2.7%)	11(2.8%)	16(4.0%)	97(24.3%)
10.1 – 15.0	48(12.0%)	11(2.7%)	1(0.3%)	15(3.7%)	75(18.7%)
Total	261(65.3%)	48(12.0%)	18(4.5%)	73(18.2%)	400(100%)

Morphological classification reveals that microcytic anaemia has the highest prevalence among the study population concordant with the highest prevalence of iron deficiency anaemia in the children. X^2 = 1.42; df = 2, p-value = 0.50. NA = Normal Blood, NA = Normocytic Anaemia, MACA = Macrocytic anaemia, MICA = Microcytic Anaemia.

The proportion of the main parameters of iron status of the anaemic children were established based on the International Organisation. Only PCV Haemoglobin show statistically significance difference for p-value<0.05. Slides with different types of anaemia among others were shown in appendix pages.

Table 4.7: Age Specific comparison of the Biochemical Parameters of Iron Status among the Anaemic Children.

		AGE(Years)				
Biochemical P/meters	**0.0-5.0**	**5.1-10.0**	**10.1-15.0**	**F-value**	**df**	**p-value**
PCV (%)	25.49 ± 4.10	23.15 ±4.28	24.07 ±3.63	4.536	2	0.011
Haemoglobin (g/dl)	8.49 ± 2.17	7.52 ±1.98	8.01 ±2.12	1.212	2	0.010
Serum Iron (ug/dl)	48.58 ± 20.0	59.11 ±22.5	53.11 ±22.6	0.288	2	0.750
S. Ferritin (ng/ml)	25.18 ± 18.7	33.31 ±18.7	36.84 ±32.1	0.130	2	0.878
S. Transferrin (mg/dl	282.7 ±118.1	242.5 ±111	256.1 ±110	0.685	2	0.505
TIBC (ug/dl)	337.9 ±140.7	293.2 ±132	313.4 ±133	0.456	2	0.634

TIBC = Total Iron Binding Capacity, g/dl = gram/decilitre, % = percent, Ug = microgram, ml = mile, mg = milligram, l = litre, S = serum, PCV = Packed Cell Volume, P = parameters, Pre Primary School (0.0-5.0), Primary School (5.1-10.0), Post Primary School (10.1-15.0). The df = degree of freedom, F = ANOVA value. Only serumFerritinand TIBC show statistically significance difference for p-value<0.05.

Table 4.8: Gender Specific comparison of the Biochemical Parameters of the Iron Status among the Anaemic Children.

Biological Parameters	Male	Female	F value	Df	p-value
Packed Cell Volume (%)	24.39±4.4	25.17±3.8	3.751	1	0.053
Haemoglobin(g/dL)	8.51±2.72	8.88±2.97	1.833	1	0.052
Serum Iron (ug/dL)	50.98±22.22	54.62±20.34	1.295	1	0.256
Serum Ferritin (ng/ml)	27.10±18.7	33.97±26.26	3.764	1	0.053
Serum Transferrin (mg/dL)	281.55±114.5	241.37±113.7	6.808	1	0.009
TIBC (µg/dL)	336.66±137.3	294.63±135.4	4.785	1	0.029

All biochemical parameters of iron status had normal values. TIBC = Total Iron Binding Capacity, g/dl = gram/decilitre, % = percent, µg = microgram, ml = mile, mg = milligram, l = litre, S = serum, PCV = Packed Cell Volume, P = parameters, Mean ± Standard Deviation (Values), df = degree of freedom, F = ANOVA value.

Of the 400 children recruited for this study 395 was tested for haemoglobinopathies, the remaining 5 were not suitable for the test because they were less than three months.

Table 4.9: Prevalence of Haemoglobinopathies among the Study Population.

Electrophoretic Pattern	Frequency	Percent
AA	276	70.0
AC	8	2.0
AF	1	0.3
AS	60	15.2
SC	6	1.5

SS	20	5.0
SS+F	24	6.0
Total	395	100.0

A = Normal Haemoglobin, S = S Haemoglobin (trait), C = C Haemoglobin (trait), F = foetal Haemoglobin, AA = Healthy, AS = Carrier, SS = sickle cells, SC = sickle Cells Disease.

Only anaemic children were considered in these cases (139). Malaria accounted for 43.1% of the anaemic population indicating that there is association between malaria and anaemia among the children especially in the pre-school children hence there is statistically significance difference $p<0.05$. But comparison of HIV and anaemia shows no significant difference ($p>0.05$), possibly due to increased awareness.

Table 4.10: Malaria and HIV Prevalence among the Anaemic Children.

	Positive	Negative	Percent	p-value
HIV	16(11.5%)	123(88.5%)	139(100%)	0.000
MP	60(43.1%)	79(56.9%)	139(100%)	0.67

$X^2 = 0.85$; df = 2, p-value = 0.67. HIV = Human Immune Virus, MP = Malaria Parasite.

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). 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%).[16]

Four hundred subjects comprising 224(56.0%) male and 176(44.0%) female were used in this study. Out of four hundred children tested, 139 (34.8%) children were anaemic as shown in table 4.3. A total of 16 (4%), 103 (25.8%) and 20 (5%) children had mild, moderate and severe anaemia respectively while 261 (65.2%) were not anaemic (normal). The mean values and standard deviation of the haematological and biochemical parameters. The tests performed on iron and iron related biochemical parameters were haemoglobin (Hb) concentration, packed cell volume (PCV), serum iron (SI), total iron binding capacity (TIBC), serum ferritin (SF), serum transferrin (TS), mean cell volume, mean haemoglobin concentration mean cell haemoglobin concentration and red cell distribution width. The mean values obtained for haemoglobin concentration, packed cell volume, serum ferritin (SF), serum iron (SI), total iron binding capacity (TIBC), serum transferring (TS), mean cell volume (MCV), mean haemoglobin concentration (MCH), mean cell haemoglobin

concentration (MCHC) and red cell distribution width (RDW) of the anaemic children were; 11.12±2.51g/dl, 33.3±7.99%, 56.66±27.92ng/ml, 82.59±31.55ug/dl, 304.3±99.60ug/dl, 253.72±82.81g/dl, 88.22±12.41fl, 28.72±4.38pg, 32.39±15.39g/dl and 16.62±7.35% respectively. Our observation 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.[17] These observations are also similar to the report by Bainton *et al*., 1971[17]; which showed a mean MCV, MCH, MCHC and haemoglobin of 74 fl, 20 pg, 28% and 7.6 gm/dL respectively in patients with IDA.[19]

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%.[20] Our observed prevalence is however lower compared to the local findings which recorded high prevalence rate of anaemia of 49.6% in children in South Eastern Nigeria.[21] Similarly, our 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[22], Ibadan[23], Anambra State[24] and Enugu[25] respectively. The low prevalence observed in our study may be linked to the fact 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 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). In this present study, we observed prevalence of severe anaemia, mild anaemia and moderate anaemia of 20(14.4%), 64(46.0%) and 55(39.6%) respectively among our cohort of children in Sokoto, Nigeria. Our observed prevalence varies slightly from 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.[26]

However, our observed prevalence is higher than a 29% prevalence of anaemia reported in Katsina.[27] Several factors may be responsible for the high prevalence of anaemia among children recorded in our 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.[28] 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. This may be due to poor nutrition, mal-absorption, poor environment or poor socio-economic background.

In this study, we observed an overall prevalence of 14.7% of iron deficiency anaemia among our study population. According to WHO criteria, the accepted cut-off point for iron deficiency anaemia screening in children is set at 11gm/dl, 70fI 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 12.5%, normocytic normochromic anaemia 5.0%, anaemia of chronic diseases 2.3% and macrocytic/megaloblastic anaemia 1.2%. The findings from this study is lower compared to the finding in a study done in Ibadan, Nigeria, where iron deficiency anaemia was recorded among 31.5% of children aged between one and ten years, attending University College Hospital Ibadan.[29] Our finding is also lower compared to the prevalence rate of 34.3% reported in Enugu South East Nigeria by Ekwochi *et al*., 2014. The higher prevalence recorded in the previous studies 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. 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 16 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.[30]

Three hundred and ninety-five (395) subjects were tested for haemoglobinopathies while five subjects (4 male and 1 female) were excluded, because they were less than six months when this study was carried out. This present study recorded the frequencies of HbAA, HbAS, HbSS, HbAF, HbSS+F, HbAC and HbSC to be 70.0%, 15.2%, 5.0%, 0.3%, 6.0%, 2.0%, and 1.5% respectively. These findings are consistent with the previous reports, in which the prevalence of 70%, 23.25%, 4.75%, 1.25%, 0.75% were observed for HbAA, HbAS, HbSS, HbAC, and HbSC respectively.[31] Similarly, a prevalence of 69.35%, 26.94%, 3.54% 0.12%, and 0.02% of HbAA, HbAS, HbSS, HbAC, and HbSC respectively observed in Anambra.[32] Also in Ogbomoso a prevalence of 71.03%, 22.11%, 0.54%, 5.26%, and 0.805 was observed for HbAA, HbAS, HbSS, HbAC, and HbSC respectively.[33] The observed frequency of HbAA is within the normal range of 55 – 75% earlier reported for Blacks.[34] The results of

our finding revealed a prevalence of 5.0% HbSS + 6.0% HbSS+F (11.0%) among the study subjects. This finding is also consistent with other published reports in Nigeria; 3.0% in the South-West region of Nigeria[35], 2% among undergraduate students in Bayelsa State[36] and 3% in Rivers State[37] both in the South-South of Nigeria. Our finding is however at variance with previous report in Kenya, East Africa[38] and among 620 University students in Port Harcourt Nigeria[39] which both obtained a 0% prevalence of HbSS. The zero frequencies observed in these studies, possibly imply that the sickling gene pool is gradually reducing in some African populations due to increase awareness and pre-marital counselling. The low prevalence of HbSS observed in these studies could be attributed to increased awareness of the disease, improved socio-economic conditions, improved pre-marital counselling, environmental and genetic factor which have an overall effect on the sickling gene pool. The zero prevalence may also be attributed to an active program of prenatal diagnosis among pregnant women in Nigeria. The finding from our study is consistent with prevalence of HbSS observed among the Black population in the United States which was reported to be 9% and 30%–40% generally for Africans.[40-41] Sickle haemoglobin (HbS) is the most common and clinically significant haemoglobin structural variant. This present study recorded zero percent of HbCC which is inconsistent with the previous findings: 0.24% in Akwa Ibom[42], 0.18% in Ogbomoso by Akhigbe *et al*., 2009 and 0.01% in Anambra by Uzoegwu and Onwurah, 2003. The zero frequencies observed in our studies, may be attributed to sample size and other environmental conditions. The number of people with homozygous HbSS for both male and female respectively in Sokoto, is high. The reason for this high prevalence may be due to the absence of carrier testing programs and premarital counselling/testing for prospective couples prior to marriage in a bid to reduce the prevalence of haemoglobinopathies in the area. Other factors such as persisting high concentration of foetal haemoglobin could invariably influence the prevalence of SCA in a population. Sokoto State in particular and Nigeria in general can benefit from universal neonatal screening program. It can be an effective way to diagnose and monitor the trend of haemoglobinopathies in the state. Evidenced-based data from Belgium, a country with universal neonatal screening programme has shown that neonatal screening is an excellent health education tool.[43] The Nigerian government can benefit by implementing a similar program in a bid to improving the healthcare services offered to patients with haemoglobin disorders.[44] There is also a need for a sickle cell disease clinical care programs which should include: infection prophylaxis with penicillin and malarial prophylaxis; family training to identify early, severe, or persistent symptoms and increased awareness of the gravity of

malarial crises; the evaluation of the patient's nutritional status and fluid intake; and education about the importance of regular medical visits.

The results from this study observed that *P. falciparum* malaria accounted for 60 (43.1%) of the anaemic children. This finding is inconsistent with previous finding which has been affirmed by the finding of Muoneke and colleagues, 2011[45], which indicated that malaria was the aetiological cause of severe anaemia in 64% of the study subjects. This trend was also observed in other Nigerian studies where malaria was noted to be responsible for 51.5%[46] and 52.6% by Ojukwu, 2002, of severe anaemia in under-5 children respectively. Similarly, a high prevalence rate of 64% (44% moderate, 20% severe) was observed in children with malaria from a hospital mostly attended by patients of comparatively low economic status in Sokoto.[47] Recently, a high prevalence rate of (50%) of severe anaemia in malaria was also reported in same paediatrics department of Usmanu Danfodiyo University Teaching Hospital, Sokoto by Jiya *et al.*, 2014. Malaria has consistently been demonstrated to be the commonest cause of severe anaemia among children living in malaria endemic regions by Eleje, *et al*., 2005. The high prevalence rates of severe anaemia following malaria in these studies may be linked to the fact that the study areas are within the known malaria endemic zones. The climatic changes in the area facilitate the thriving of the mosquito vector. Although the immunity level is developed by this age against malaria among those in malaria endemic regions, the immunity however is not protective enough.[48] Other related complications to anaemia included; human immune deficiency virus (HIV), which accounted for 17(12.2%), leukaemia (3 (1.3%), thrombocytosis 7(2.7%) and thrombocytopenia 5(2.5%). These complications did not seem to make significant impact on the causes of anaemia in this study. These may be due to increase awareness and interventions such as mass media campaigns, peer or outreach education on HIV/AIDS, life skill programmes to educate parents on the advantages of early medical attention and compliance with the use of prescribed medications.[49]

CONCLUSION

This study reported the prevalence of 34.8% anaemia among the children attending Usmanu Danfodiyo University Sokoto. The major types of anaemia observed among the study children include, iron deficiency anaemia (14.75), sickle cell anaemia (12.5%), normocytic normochromic, anaemia (5.0%), anaemia of chronic diseases (1.2%) while megaloblastic anaemia (1.2) was the least from the total study subjects. Serum iron and ferritin levels, as

measured by ELISA can be used reliably for the differential diagnosis of iron deficiency anaemia (from other anaemia). There is need for iron and other micro nutrient supplement for children particularly those diagnosed with anaemia.

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Authors' contributions: IKK, wrote the manuscript UEK, JNM, EO and MAS, designed the topic and project YMH and DMK, performed data analysis and interpretations while UA, SM and GA performed reagents preparations and samples analysis.

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REFERENCES

1. World Health Organization (WHO). Evaluation (Phase 1) of the Uni-Gold^{TM} HIV using Whole Blood Specimens, 2005^{a}: 5-12.
2. Eleje GU, Muojieje CC, Ulebe AO, Malizu E V. Severe anaemia among children admitted in a tertiary health care institution: the experience at Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria. *Medizik Journal,* 2005*;* 7: 32-36.
3. Pavord S, Myers B, Robinson S, Allard S, Strong J, Oppenheimer C. British Committee for Standards in haematology. UK guidelines of the management of iron deficiency in pregnancy. *British Journal of Haematology,* 2012*;* 156(5): 588-600.
4. Tower J, Butler R. Modern Obstetric for Midwives. 2th edition. Lloyd Duke Ltd. London, 2006; 219-225.
5. Nemeth E, Ganz T. Regulation of iron metabolism by hepcidin. *Annual Revision Nutrition,* 2006; 26: 323-342.
6. Saimak T, Nabili MD, Melissa C, Stöppler MD. *eMedicineHealth > anemia article*, 2009; 3-7.
7. Ernest SK, Anunobi NE, Adeniyi A. Correlates of emergency response interval and mortality from severe anaemia in childhood. *West African Journal of Medicine,* 2002*; 21: 177-179.*

8. Jiya NM, Isezuo KO, Waziri UM, Jangebe MA. Severe malaria anaemia in children. A 22 – month retrospective review 2014. *www.panconf2015.org/wp - Content/.../322 - ABSTRACT_SMA.*
9. Ojukwu JU. Severe anaemia in childhood. Abstracts of proceedings: Annual General and scientific conference of Paediatric Association of Nigeria. Asaba 2001. *Nigerian Journal of Paediatrics,* 2002*;* 29: 84.
10. Joosten E, Pelemans W, Hiele M, Noyen J, Verhaeghe R, Boogaerts MA. Prevalence and causes of anaemia in a geriatric hospitalized population. *Gerontology,* 1992; 38(1-2): 111-117.
11. Weiss G, Goodnough LT. Anaemia of chronic disease. *The New England Journal of Medicine* 2005; 352(10): 1011-1023.
12. Mamman AB. Sokoto State. In: A people united, a future assured (Survey of States). Mamman AB, Oyebanji JO, Peters SW. (eds.). Vol. 2. Gabumo Publication Company Ltd, Calabar, Nigeria, 2000; 123-134.
13. Iman A. Prevention of Coliform Bacteria on environmental surface in day care centre and nursery schools in Sokoto metropolis. *Nigerian Journal of Basic and Applied Sciences,* 2006*; 16(1): 82-86.*
14. Sokoto State Diary. Ministry of Information Sokoto, 2008; 4-5.
15. National Population Commission. NPC. Malaria indicator survey 2010. Abuja Nigeria 2006; 2-9.
16. World Health Organization (WHO). (2008). Worldwide prevalence of anaemia 1993–2005. Geneva: 1-25.
17. World Health Organization (WHO). Worldwide prevalence of anaemia 1993 – 2005. WHO global database on anaemia. Geneva Switzerland, 2005; 71: 16-24.
18. Abu- Syed MM Abu –Sayeed MM, Milton H, Chowdhury, MMH. Study of Hematological Parameters in Children Suffering from Iron Deficiency Anaemia in Chattagram Maa-o-Shishu General Hospital, Chittagong, Bangladesh 2014. http:/dx.doi.org/10.1155/2014/503981.10.
19. Bainton DF, Ullyot JL, Farquhar MG. "The development of neutrophilic polymorphonuclear leukocytes in human bone marrow*," The Journal of Experimental Medicine,* 1971*;* 134(4): 907–934.
20. Allen LH. "Pregnancy and iron deficiency: unresolved issues. "Nutrition Reviws", 1997; 55(4): 91–101.

21. World Health Organization (WHO). Prevention and management of severe anaemia in pregnancy, 1993; 123-129.
22. UNICEF/FGN. The nutritional status of women and children in Nigeria, 1994; 1-15.
23. Onimawo IA, Ukegbu PO, Asumugha VU, Anyika JU, Okudu H, Echendu CA. Assessment of anaemia and iron status of school aged children (aged 7-12years) in rural communities of Abia State, Nigeria. *African Journal of Agriculture, Nutrition and Development*, 2010; 10: 2570-2586.
24. Anumudu C, Afolami M, Igwe C, Nwagwu M, Keshinro O. Nutritional anaemia and malaria in pre-school and school age children. *Annual African Medical Journa*l, 2009; 7: 11-17.
25. John OC, Uchenna BC. The prevalence of anaemia in rural primary school in Ekwusigo local government area of Anambra state Njgeria. *Oriental Journal of Medicin*e, 2014*; 1*26: 3-4.
26. Ekwochi E, Osuorah DIC, Odetunde OI, Egbonu I, Ezechukwu CC. Prevalence of iron deficiency anaemia in anaemic under-5 children in Enugu South East Nigeria. *Nigerian Journal of Paediatrics*, 2014; 41(2): 2-7.
27. Umar RA, Jiya NM, Ladan MJ, Abubakar MK, Hassan SW, Nata'ala U. Low prevalence of anaemia in a cohort of pre-school children with acute uncomplicated Falciparum malaria in Nigeria. *Trends in Medical Research*, 2007; 2: 95-101.
28. Mannir S. Anaemia as seen in Hassan Usman Hospital, Katsina. *Biological Environment Science Journal Tropica*l, 2006*;* 3: 73-75.
29. deBenoist B. Focusing on anaemia -Towards an integrated approach for effective anaemia control, 2004; 10-12.
30. Akinkugbe FM. Prevalence of anaemia in the urban population (University College Hospital GOPD, Ibadan. *Journal of Tropical Paediatrics*, 1977*;* 23: 271-275.
31. Mousa ZA. A comparison of selected nutrient intakes in anaemic and non-anaemia adolescent girls in Kuwait. *Journal of Nutrition research*, 2003; 23: 425-433.
32. Yakubu A, Zama II, Osaro E, Sanusi, BM, Frank PU, Ezimah AC, Yeldu M, Abdulahi W, Emmanuel KU, Teddy CA, Iwueke IP, Dorcas I, Festus A, Osazuwa I, Isah AB. Haemoglobin electrophoretic pattern among resident in Sokoto, Nigeria. *Journal of Medical Disorder*, 2013; 10.724/2053-3659-1-2.
33. Uzoegwu PN, Onwurah AE. Prevalence of Haemoglobinopathy and Malaria Diseases in the Population of Old Aguata Division, Anambra State, Nigeria. *Nigeria Society for Environmental Biology*. Biokemstr, 2003; 15(2): 57-66.

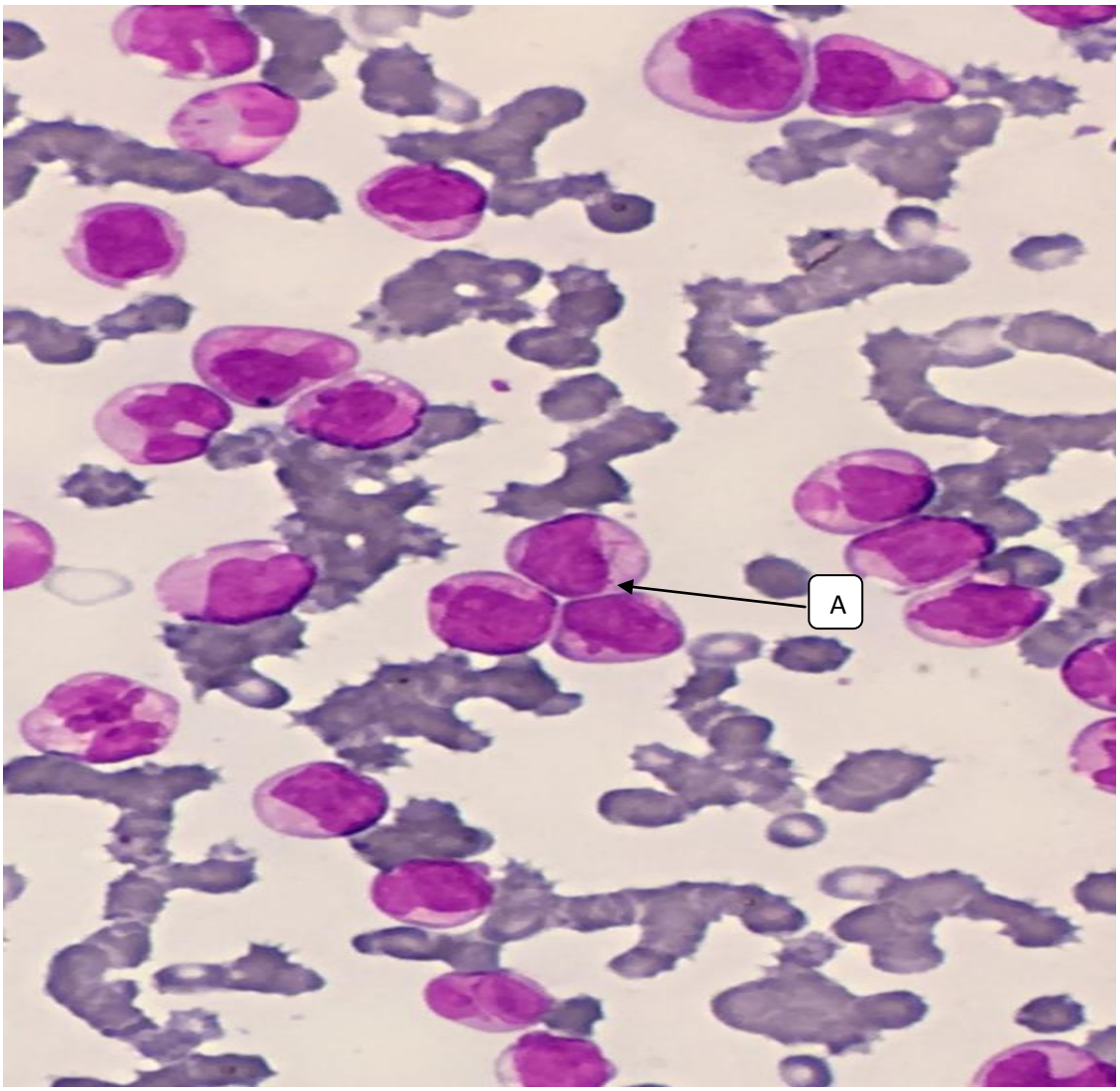
34. Akhigbe RE, Ige SF, Afolabi AO, Azeez OM, Adegunlola GJ, Bamidele JO. Prevalence of Haemoglobin Variants, ABO and Rhesus Blood Groups in Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. *Trends in Medical Research,* 2009*;* 4: 24-29.
35. Fleming AF, Lehman H. Sickle cell disease: A handbook for General clinician. Edinburgh: Churchill Livingstone, 1982; 10-17.
36. Nwafor A, Bamigo BM. A comparison of measured and predicted hemoglobin genotype in a Nigerian population in Bonny, Rivers State, Nigeria. Journal of Applied Science and Environmental Management, 2001; 5: 79–81.
37. Egesie UG, Egesie OJ, Usar I, John-bull TO. Distribution of ABO, Rhesus blood and haemoglobin electrophoresis among the undergraduate students of Niger Delta State University, Nigeria. *Nigerian Journal of Physiological Science*, 2008; 23: 5-8.
38. Moormann AM, Embury PE, Opondo J, Sumba OP, Ouma JH, Kazura JW, John CC. Frequencies of sickle cell trait and glucose-6-phosphate dehydrogenase deficiency differ in highland and nearby lowland malaria-endemic areas of Kenya. *Trans Royal Society of Tropical Medicine and Hygiene Journa,* 2003*;* 97: 513-514.
39. Richard AW. Textbook of Black related diseases. New York, USA: McGraw Hill;. Lewis RA. Sickle cell: Clinical features in West Africans. Accra, *Ghana: Ghana University Press*, 1975; 1970. 5-15.
40. Jeremiah ZA. Abnormal haemoglobin variants, ABO and Rh blood groups among student of African descent in Port Harcourt, Nigeria. *African Journal of Health Science,* 2006; 6: 177-81.
41. Gulbis B, Vertongen, F, Ferster A. Neonatal screening and clinical care programmes for sickle cell disorders in sub-Saharan Africa: lessons from pilot studies. *Journal of Public Health,* 2009*;* 122: 933-941.
42. Sinou MT. Antenatal screening of sickle cell disease. 8th postgraduate course for training in reproductive medicine and reproductive biology. *Cameroon,* 2003; *10-21.*
43. Umoh AV, Abah GM, Ekanem TI, Essien EM. Haemoglobin genotypes: a prevalence study and implications for reproductive health in Uyo, Nigeria. *Nigerian Journal of Medicine,* 2010*;* 19(1): 36-41.
44. Tshilolo L, Kafando E, Sawadogo M, Cotton F, Vertongen F, Ferster A, Gulbis B. Neonatal screening and clinical care programmes for sickle cell disorders in sub-Saharan Africa: lessons from pilot studies. *Public Health,* 2008*;* 122: 933-941.

45. Reid HL, Famodu A. ASpectrophotometric quantitation of haemoglobin S fraction in heterozygous sickle-cell trait (HbAS). *Medical Laboratory Science*, 1988*;* 45: 143-145.
46. Muoneke VU, ChidiIbekwe R. Prevalence and Aetiology of Severe Anaemia in Under-5 Children in Abakaliki South Eastern Nigeria. *Paediatrics Therapeutic*, 2011*;* 1: 107.
47. Seriki O. Severe anaemia in the first two years of life. *Nigerian Journal of Paediatrics*, 1974*;* 1: 33-35.
48. Umar RA, Hassan SW. The relationship between the levels of parasitaemia and anaemia in children with malaria. *Sahel Medical Journal*, 2002*;* 5: 58-62.
49. AnonymousS. Relationship between anaemia and malaria in Tropical Africa. *Trans Royal Society of Tropical Medicine and Hygiene Journa*l, 1998*;* 92: 556-567.

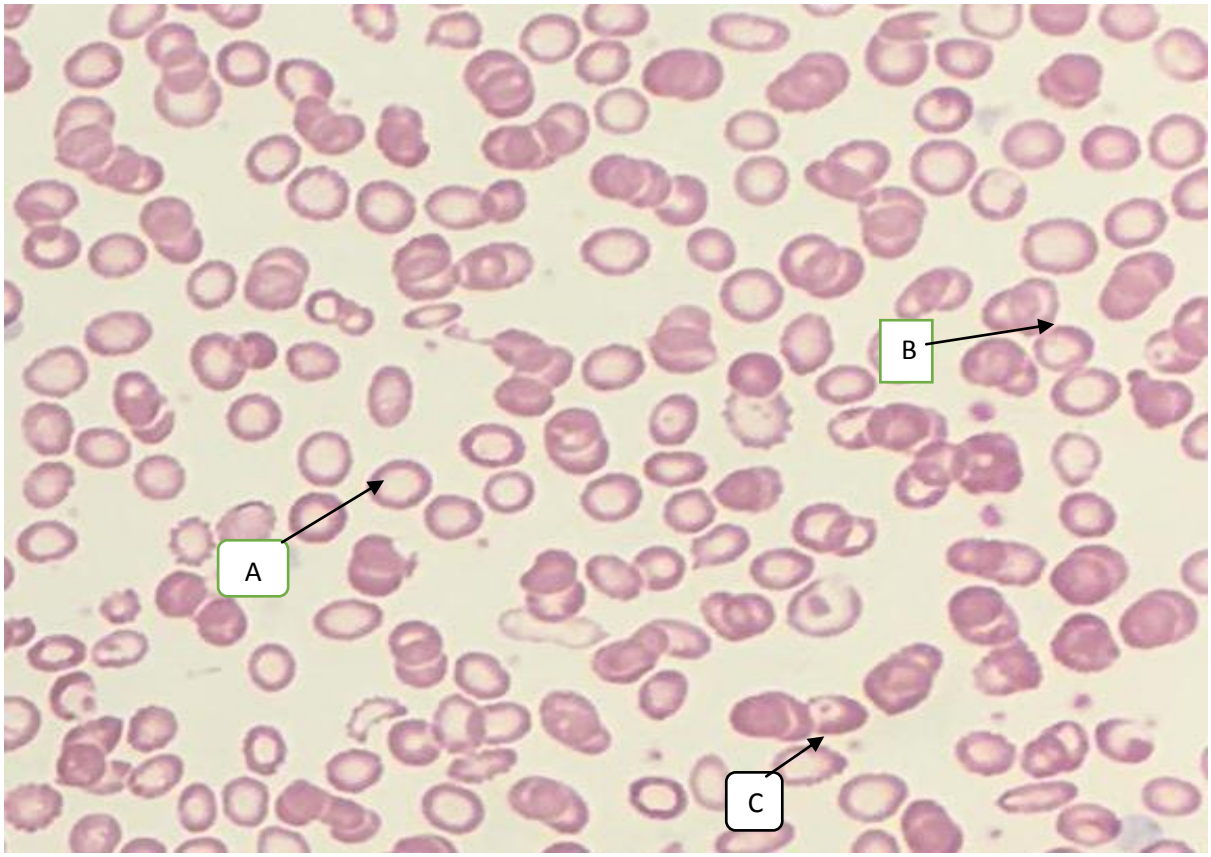
APPENDICES

APPENDIX I

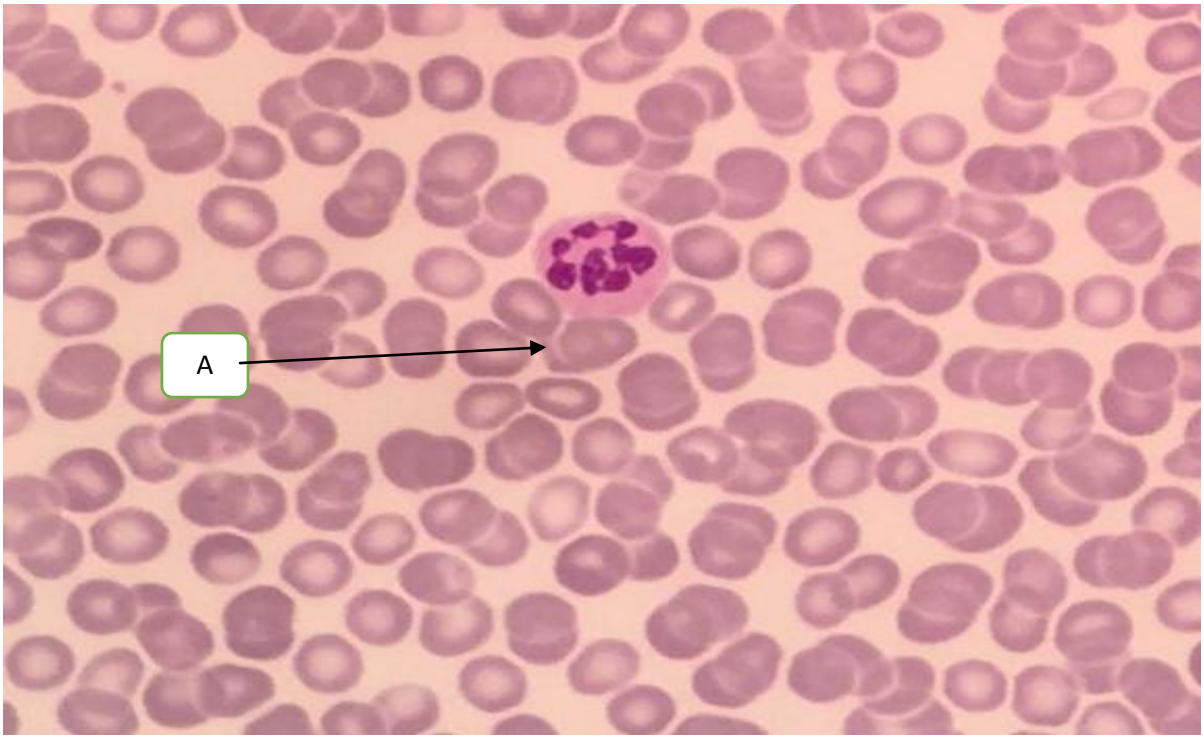
APPENDIX II



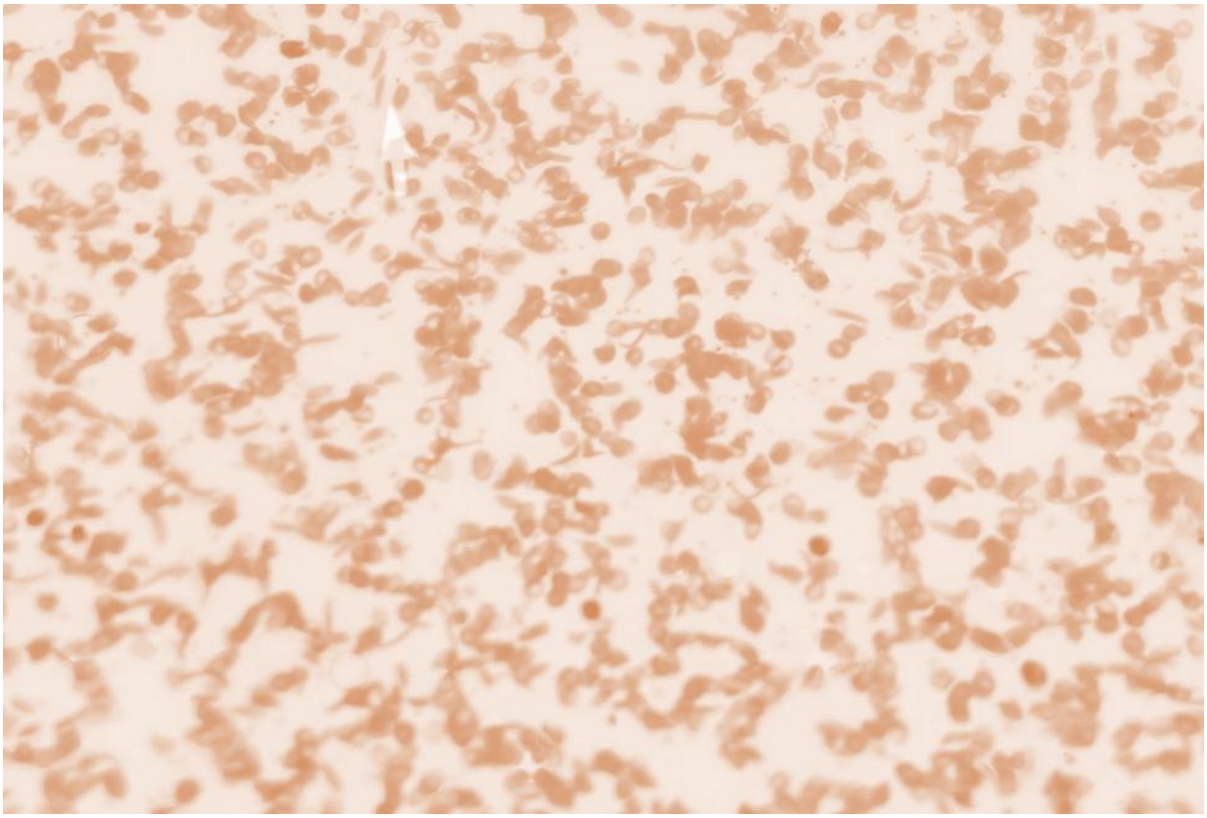
Slide 1: A typical acute myeloblastic leukaemia (AML3) mostly characterized by severe anemia. A; indicates some blast with auer rod. (Mag. X100).



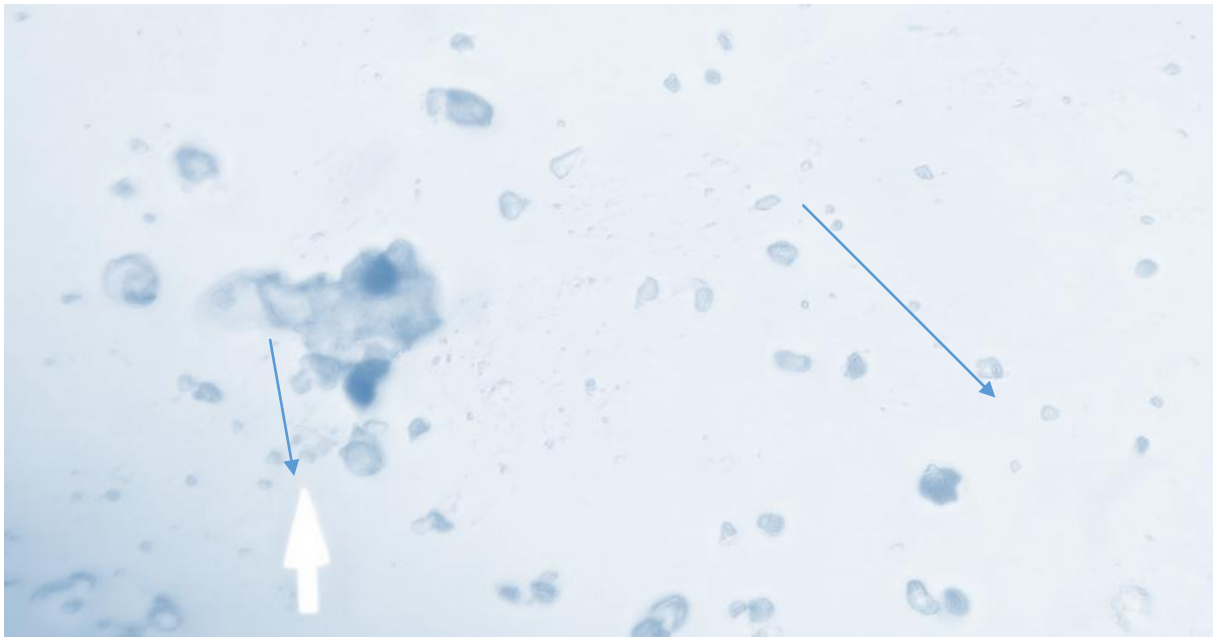
Slide 2: Hypochromic Microcytic Anaemia. A: Ovalocyte cell, B: hypochromic cell, C: Target cell (Mag. X100).



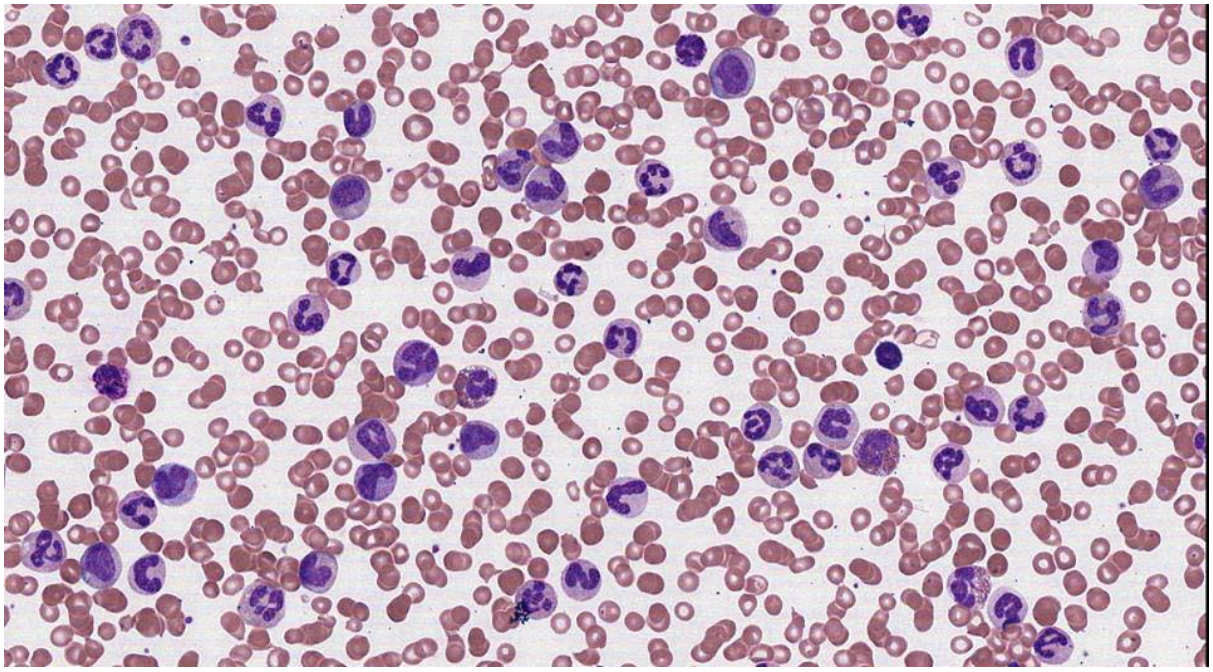
Slide 3: Blood film from the patient with Iron Deficiency anaemia showing (A) hypersegmented neutrophil (Mag. X100).



Slide 4: Blood film from sickle cell anaemic patient showing many sickle cells (Mag. X60).



Slide 5: Blood film stained with giemsa from the patient suffering from malaria, some ring forms are indicated (mag. X60).



Slide 6: Blood film from Patient with Anaemia of chronic disease, indicating a typical chronic myelocytic leukaemia (CML) (Mag. X40).