Anaemia among Female Undergraduate Students of Usmanu Danfodiyo University Sokoto, Nigeria.

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Abstract

Introduction: Anaemia is a major public health problem affecting a significant number of the world's population.

Objectives: This case study was performed on seventy-two (72) female undergraduates' students of the Usmanu Danfodiyo University, Sokoto , Nigeria with a mean age 22.38 ± 1.98 years with the aim of determing the prevalence and etiological factors responsible for anaemia among the study population.

Methods: Five millimeters of blood of blood were collected from each subject for the measurement of ESR using Westerngreen method. Full blood count parameters were determined using the auto haematology analyzer (Genesis, HA6000, China). Serum ferritin was determined using ELISA method (Melsin Medical, China). All data management and statistical analysis were performed using SPSS software version 26.0 (SPSS Inc., Chicago, USA).

Results: Results showed that there was a statistically significant decrease in neutrophil count, haemoglobin and packed cell volume (p < 0.05) among the anaemic compared to non-anaemic subjects. There were no statistically significant (p>0.05) differences in RBC count, white cell, platelets, MCV, MCH, MCHC, lymphocyte, neutrophil, MXD, RDW, ESR, and ferritin level between the anaemic and non-anaemic subjects. The prevalence of anaemia, iron deficiency anaemia, thrombocytopenia, leukocytosis, leucopenia, lymphopenia, raised RDW, MPV and PLCR among the female subjects were 40.28, 2.7, 23.6, 1.38, 2.77, 1.38, 4.16, 5.55 and 26.38%, respectively. Statistically significant (p< 0.05) negative correlations were observed between selected hematological parameters (PLC vs WBCs; MCV vs RBC; MCHC vs RBCs; MCHC vs PLC; Neutrophils vs MCV and RDW vs MCV) among the subjects. In contrast, we observed statistically significant (p<0.05) positive correlations between Lymphocytes and Neutrophils, MXD and Lymphocytes, and MXD and neutrophils among the subjects. The findings of this study indicates that anaemia, iron deficiency anaemia, and other haematological abnormalities are prevalent among female students of the Usmanu Danfodiyo University, Sokoto, Nigeria.

Conclusion and Recommendations: There is need for routine monitoring of full blood counts, serum ferritin and ESR particularly anaemic female students. Serious attention should be paid by the Nigerian government regarding anaemia among female university students as their academic performance and productivity may be adversely affected by this health condition. Implementation of intervention strategies such as iron fortification, provision of long-lasting insecticide-treated nets (LLINs), intermittent preventive treatment (IPT) of malaria, and regular administration of anthelmintic drugs may be effective in decreasing the prevalence of anaemia among female students in Usmanu Danfodiyo University , Sokoto in particular and Nigeria in general.

Keywords: Anaemia; Female; Undergraduate; Students; Usmanu Danfodiyo University; Sokoto; Nigeria

Introduction

Anaemia is a condition in which the number of red cells (RBC) or their oxygen carrying capacity is inadequate to meet the physiologic needs of the body, which vary by age, gender, altitude, smoking and pregnancy status [1]. Anaemia is the most frequent blood disorder. resulting from the qualitative or quantitative reduction in the level of healthy RBC in the human body which it is said to occur when the RBC are deficient in haemoglobin-the oxygen carrying pigment of blood [2]. Anaemia is defined by the World Health Organization (WHO) as (Hb) < 12 g/dL in adult non-pregnant female, Hb < 11g/dL in pregnant females, Hb < 13g/dL in adult men, Hb < 12 g/dL in male children, Hb < 11 g/dL in female children, and Hb < 13 g/dL in newborns [3].

Anaemia is a problem of global concern, and a menace to social and economic development. It affects more than 56 million persons globally, with two thirds of them from developing countries [4]. Anaemia is the world's second leading cause of disability [5]. Worldwide, the World Health Organization (WHO) estimated the number of anaemic persons to be about 2 billion and approximately 50% of all cases can be attributed to iron deficiency [6]. Anaemia is responsible for about 1 million death a year, out of which three-quarters occur in Africa and South-East Asia [7]. In 1993, the World Bank ranked anaemia as the eighth leading cause of disease in girls and women in developing countries [8].

The aetiological factors of anaemia are multifactorial and include: Iron deficiency, other micronutrient deficiency, excessive blood loss, inheritance of the disorders of haemoglobin synthesis, malaria and other parasitic infections (hookworm and schistosomiasis infestations), HIV- infection and drug complications [9]. Among the numerous factors, both nutritional and non-nutritional that contribute to the onset of anaemia, iron deficiency and malaria play the most critical role in developing countries contexts [10]. The prevention and control of aneamia is complex and depending on the setting, might require the implementation of a set of control measures. Iron fortification, long-lasting insecticidal nets (LLINs), intermittent preventive treatment (IPT) of malaria, and regular administration of anthelmintic drugs can be effective strategies to decrease the prevalence of aneamia in developing countries [11-13].

Nutritional anaemia though global in occurrence is more of concern in developing countries because of the high prevalence in these regions [14]. Anaemia is attributed to dietary inadequacy due to poor purchasing power, illiteracy, ignorance regarding nutritional value of available cheap food, cultural taboos, superstition, large families etc. Iron deficiency anaemia in adolescent girls is a significant risk factor for maternal mortality, high incidence of low birth weight babies, high perinatal mortality and foetal wastage, which ultimately results in higher fertility [15].

Anaemia is the most common disorder of the blood, affecting about a quarter of the people globally [16]. Anaemia is a global health problem and it contributes to morbidity and mortality among women. It predisposes women in Africa to blood transfusion. Many patients, particularly in sub-Saharan Africa, do not have access to safe and adequate supply of blood when they need it. Anaemia constitutes a substantial obstacle to women and girls social and economic development and can cause lack of concentration, irritability and impair academic performance of students. In addition to tiredness and impaired cognitive performance, the consequences of anaemia include reduced educational achievement and work capacity, increased mortality and morbidity from infectious diseases, and poor pregnancy outcomes. This study aimed to investigate the etiology of anaemia among female students of Usmanu Danfodio University, Sokoto, Nigeria. Evidence-based data gathered can be used to develop potentially anaemia among students in Nigerian Universities.

Materials and Methods

Study area

The study was carried out in Usmanu Danfodiyo University Sokoto , Nigeria. Sokoto is located in the extreme Northwest of Nigeria between longitude 05° and 11° to 13° and 03° East and between latitude 13° and 0° to 13° and 06° North. The state shares border with the Republic of Niger to the North, Kebbi State to the West and Southeast and Zamfara State to the East. The state covers land area of

about 60.33 km^2. Report from the 2007 National population commission indicated that the state had a population of 3.6 million [17]. The indigenous inhabitants of the area are mainly Hausa and Fulani. Traders form the greater percentage of the population, while the rest are civil servants and farmers. Sokoto has an annual rainfall between 500 mm to 1300 mm. Dry season starts from October and ends up in May and wet season begins in May and last up to October every year [17].

Study population

A total of 72 subjects were recruited for this study. All the subjects were recruited among the female students of the Usmanu Danfodio University, Sokoto, Nigeria.

Study subject/selection

Inclusion and exclusion criteria

All adult female students of the Usmanu Danfodio University, Sokoto, Nigeria were invited to participate in the study. They were screened and counseled and those who consented and signed a written informed consent form were recruited into the study. All non-adult, non-female and non-consenting female students were excluded from participation in the study.

Study design

This was a case control study designed to investigate the etiology of anaemia among female students of the Usmanu Danfodiyo University Sokoto, Nigeria. A structured questionnaire was used to collect relevant socio-demographic information from the consenting female students.

Sample size determination

The sample size of the study was determined using the standard formula for calculation of minimum sample size [18]:

n = Z^{2}pq/d^2

Where

n = Minimum sample size

z = Standard normal deviation and probability.

p = Prevalence or proportion of value to be estimated from previous studies

q = Proportion of failure

d = Precision, tolerance limit, the minimum is 0.05.

Therefore n = z^{2}pq/d^2

Where z = 95% (1.96)

 p = 5% (0.05) (Jiya., *et al.* 2017).

 q = 1 - 0.05(=0.95)

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d = 5% (0.05)

Therefore n = $(1.96)^2 (0.05) (0.95)/(0.05)^2$

n = 72

Sample collection

Five millimeters (mL) of blood was collected from the subjects (about 2.5 mL in K2 EDTA containers and 2.5 mL in plain non anti-coagulated container). The anti-coagulated samples were used for the determination of full blood counts and ESR. Samples in the EDTA anticoagulated containers was allowed to clot and centrifuged to obtain serum that was be used for serum ferritin determination. The samples were tested in the Haematology Laboratory of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria.

Laboratory testing

The testing for full blood count was carried out using the Genesis HA6000 Auto Haematological Analyser (Perlong Medical Equipment Company, China). The analyzer determines haematological parameters which include: Red Blood Cell Count, Haemoglobin (HGB) Haematocrit (HCT), Total White Cell Count and differential leucocyte count.

Erythrocyte Sedimentation Rate estimation was determined using the EDTA anticoagulated blood sample. When drawn into a vertically positioned Westergren pipette and left undisturbed, red cells aggregate, stack together to form rouleaux, and sediment through the plasma. The ESR is the rate at which this sedimentation occurs in 1 hour as indicated by the length of the column of clear plasma above the red cells, measured in mm.

Serum ferritin estimation was determined based on immune-enzymatic sequential assay. The enzyme activity on the well is directly proportional to the antigen concentration (Monobind Inc, U.S.A).

Study instrument

Questionnaire

A semi structured interviewer-administered questionnaire was used to obtain socio-demographic information, nutritional and medical history from consenting study participants.

Informed consent

Written informed consent was sought and obtained from each participant after explaining the aim and objectives of the research to them.

Ethical consideration

Ethical approval for this study was obtained from the Ethical Committees of Usman Danfodiyo University, Sokoto Nigeria and the Ministry of Health, Sokoto, Nigeria.

Statistical analysis

The data obtained from the survey was initially subjected to descriptive statistics that includes frequency runs to describe the distribution of the study population. Furthermore, the chi-square inferential statistics was used to test the null hypothesis of the existence

of independent associations between selected socio demographic characteristics and the health outcome among the study participants (Anemic and normal). The t-test was then used to compare, if differences exist between the haematological parameters means by health status of the study population (Anaemic and normal). Correlation analysis was used to determine the direction of relationships among the parameters by health outcome among the study participants. All statistical tests were two-tailed and used probability level of 0.05 as the threshold for declaring statistical hematological significance. All data management and statistical analysis were performed using SPSS software version 26.0 (SPSS Inc., Chicago, USA).

Results

In this study, the full blood counts, serum ferritin and erythrocyte sedimentation rate were measured among 72 consecutively-recruited female students of the Usmanu Danfodiyo University, Sokoto, Nigeria with mean age of 22.38 ± 1.98 years. Table 1 shows the socio-demographic characteristics of Study population. Study participants were mainly within the age of 21 - 24 years old. About 86.11% of the study participants were single and, 91.61% of them had no child. Table 2 shows association of selected demographic characteristics and health Status of study participants based ontheir anaemic status (Hb < 12 g/dl). Out of the 72 students tested 29 (40.28%) were anaemic and 43 of them are non anaemic (50.72%). There was no statistical significant (p>0.05) age group, marital status, number of children and iron status related differences in the number of anaemic and non- anaemic subjects. Table 3 shows comparison of haematological parameters by health status of study participants. We noted a statistically significant differences in neutrophil count (p=0.0234), haemoglobin (p< 0.0001) and PCV values (p=0.0006), respectively with lower values of these parameters obtained for subjects than in the control group. There were no statistically significant differences in RBC count, white cell, platelets, MCV, MCH, MCHC, lymphocyte, neutrophil, MXD, RDW, ESR and ferritin level (p > 0.05). Table 4 shows correlations between haematological parameters among anaemic and normal healthy study participants. Statistically significant (p < 0.05) negative correlations were observed between selected hematological parameters (PLC vs WBCs; MCV vs RBC; MCHC vs RBCs; MCHC vs PLC; Neutrophils vs MCV and RDW vs MCV) among the anaemic subjects. In contrast, we observed statistically significant (p < 0.05) positive correlations between Lymphocytes and Neutrophils; MXD and Lymphocytes, and MXD and neutrophils among the anaemic subjects. Table 5 shows the prevalence of anaemia, Iron deficiency anaemia and Thrombocytopenia among study participants. Table 6 shows the prevalence of Leucopenia, Lymphopenia, Raised MPV, Raised RDW, Leukocytosis, P-LCR Platelet and Raised MPV. The prevalence of anaemia, iron deficiency anaemia, thrombocytopenia, leukocytosis, leucopenia, lymphopenia, raised RDW, MPV and PLCR among the female subjects were 40.28, 2.7, 23.6, 1.38, 2.77, 1.38, 4.16, 5.55 and 26.38%, respectively.

Characteristic	N	%
Overall	72	100.00
Age Group (Years)		
<=20	14	19.44
21-24	48	66.67
25+	10	13.89
Marital Status		
Single	62	86.11
Married	10	13.89
Number of Children		
No Child	66	91.67
One or more Children	6	8.33
Menstrual Bleeding		
Normal	72	100.00

Table 1: *Socio-demographic characteristics of study population.*

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Characteristic	Study Group				Test Statistics	
	Anaemic (n = 29)		Normal (n = 43)			
	n	%	N	%	X^2	p-value
Overall	29	40.28	43	59.72		
Age Group (Years)						
<=20	5	6.94	9	12.50		
21 - 24	21	29.17	27	37.50		
25+	3	4.17	7	9.72	0.801	0.6700[ns]
Marital Status						
Single	23	31.94	39	54.17		
Married	6	8.33	4	5.56	1.878	0.1706[ns]
No of Children						
No child	27	37.50	39	54.17		
One or more Children	2	2.78	4	5.56	0.131	0.7172[ns]
Menstrual Bleeding						
Normal	29	40.28	43	59.56		
Iron Status						
Deficient	4	5.56	10	13.89		
Normal	25	34.72	33	45.83	0.990	0.3197[ns]

Table 2: Association of selected demographic characteristics and health status of subjects.

Parameter	Health Status of Study Population (N = 72)		Test Statistics	
	Anaemic [n = 29]	Normal [n = 43]		
	Mean ± SEM	Mean ± SEM	t - value	p-value
HB (g/dl)	10.81 ± 0.150[a]	12.82 ± 0.123[b]	-10.33	< 0.0001****
PCV (%)	34.97 ± 0.567 [a]	37.61 ± 0466[b]	-3.60	0.0006***
RBC (x 10^6/μL)	4.28 ± 0.123	4.53 ± 0.101	-1.57	0.1218[ns]
WBC (x 10^3/μL)	5.53 ± 0.244	5.36 ± 0.198	0.54	0.5924[ns]
Platelets (x 10^3/μl)	243.83 ± 9.747	267.79 ± 8.005	-1.90	0.0616[ns]
MCV (fl)	82.48 ± 0.779	84.17 ± 0.640	-1.68	0.0979[ns]
MCH (Pg)	26.41 ± 0.475	26.27 ± 0.391	0.23	0.8169[ns]
MCHC (g/dl)	32.20 ± 0.188	32.04 ± 0.154	0.66	0.5115[ns]
Lymphocytes (x10^3/μL)	2.54 ± 0.099	2.50 ± 0.081	0.31	0.7611[ns]
Neutrophils (x 10^3/μL)	1.85 ± 0.122[a]	2.21 ± 0.100[b]	-2.32	0.0234*
MXD (x 10^3/μL)	0.79 ± 0.068	0.75 ± 0.056	0.43	0.6659[ns]
RDW (%)	13.68 ± 2.716	16.16 ± 2.231	-0.71	0.4824[ns]
ESR (mm/hr)	16.07 ± 0.325	16.28 ± 0.267	-0.50	0.6190[ns]
Ferritin (ng/ml)	63.79 ± 6.502	52.96 ± 5.340	1.29	0.2023[ns]

Table 3: Comparison of haematological parameters by health status of study participants.

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Parameter	By Parameter	Study Participants' Health Status			
		Anaemic		Normal	
		Correlation Coefficient (r)	p-value	Correlation Coefficient (r)	p-value
PCV (%)	HB (g/dl)	0.328	0.0825	0.316	0.0391*
Platelets (× 10^3/μl)	WBC (× 10^3/μl)	-0.443	0.0182*	0.133	0.3941
MCV (fl)	RBC (× 10^6)	-0.410	0.0272*	-0.180	0.2488
MCV (fl)	WBC (× 10^3/μl)	0.185	0.3458	-0.324	0.0343*
MCHC (g/dl)	RBC (× 10^6)	-0.573	0.0012**	-0.069	0.6605
MCHC (g/dl)	Platelets (× 10^3/μl)	-0.397	0.0330*	-0.051	0.7469
NEUT (×10^3/μl)	MCV (fl)	-0.382	0.0408*	0.021	0.8952
LYMPH (× 10^3/μl)	WBC (× 10^3/μl)	0.028	0.8856	0.436	0.0034*
LYMPH (× 10^3/μl)	NEUT (×10^3/μl)	0.476	0.0090*	0.272	0.0781
MXD (× 10^3/μl)	NEUT (×10^3/μl)	0.369	0.0491*	-0.107	0.4946
MXD (× 10^3/μl)	LYMPH (× 10^3/μl)	0.375	0.0453*	0.035	0.8228
RDW (%)	HB (g/dl)	-0.091	0.6373	0.003	0.9865
RDW (%)	RBC (× 10^6)	-0.152	0.4321	0.358	0.0183*
RDW (%)	MCV (fl)	-0.502	0.0056**	0.028	0.8598
Ferritin (ng/ml)	HB (g/dl)	-0.134	0.4871	-0.326	0.0329*

Table 4: Correlations between haematological parameters among anaemic and normal healthy study participants.

Haematological Abnormality	Number (N)	Percentage (%)
Anaemia Hb < 12 g/dl	29	40.28
Thrombocytopenia (platelet count < 150 × 10⁹/L)	17	23.6
Iron deficiency anaemia (Ferritin < 30 ng/ml)	2	2.7

Table 5: Prevalence of anaemia (Hb), thrombocytopenia and iron deficiency anaemia.

Characteristics	Number (N)	Percentage (%)
Leucopenia (WBC count < 3.5 × 10⁹/L)	2	2.77
Lymphopenia (Lymphocyte count < 1.0 × 10⁹/L)	1	1.38
Raised RDW (< 15%)	3	4.16
Leukocytosis (WBC count > 10 × 10⁹/L)	1	1.38
Raised MPV (> 25 FL)	4	5.55
P-LCR (> 35%)	19	26.38

Table 6: Prevalence of leucopenia, lymphopenia, raised MPV, raised RDW, leukocytosis, P-LCR platelet and raised MPV.

Discussion

According to WHO, if the prevalence of anaemia is more than 40%, it is considered as problem of high magnitude [19]. Anaemia is the major health problem worldwide. High prevalence of anaemia among the young females is alarming due to its consequences on the health

and productivity [20]. Poor Health status of young girls generally tend to reflects gender discriminations right from their birth in our society. Inequitable distribution of health resources within household and society has been reported as the leading cause of nutritional anaemia among the females [21].

We observed that the HB and PCV was significantly lower among the anaemic compared to non-anaemic students with the overall prevalence of anaemia (Hb < 12 g/dl) among female students of the Usmanu Danfodiyo University, Sokoto being 40.8%. Our finding is consistent with declaration by the WHO [22] which indicated that anaemia is a severe public health problem particularly among women and children. Our observed prevalence is also in agreement with a previous study carried out among university students in India [23]. among University students in Bangladesh as being anaemic [24]. Students aged 20 - 22 years were more anaemic (43.4%) than other age-groups. In this study, majority of the anaemic subjects were between the 21 - 24 years. Previous report from India indicated an age group of less than 25 years old were the most affected [25]. Possible reasons for the high prevalence of anaemia observed among female university students in this study might be due to poor dietary habit, menstrual blood loss, and lack of awareness of iron-deficiency and nutritional status [26]. The fact that the prevalence of anaemia among medical students who are supposed to be among the educated elites have increased is an indication that anaemia has obviously become a big problem. In the seventies, university undergraduates were well. catered for and were provided with a balanced diet of three square meals. However, with the collapse of the Nigerian economy and the onset of structural adjustment in the mid- eighties, students have been left to care for themselves and this has probably led to a decline in the standard of nutrition which is now manifesting as anaemia. Prolonged negative iron balance due to insufficient dietary iron intake or poor bioavailability, increased requirements for iron during development and pregnancy and increased iron losses resulting from menstruation and worm infestations are contributing factors [27]. It is estimated that 42 mg of iron is lost per menstrual cycle as documented by various studies conducted in different areas is the leading cause of anaemia in females [28]. Proper nutrition is required to provide this essential element and other micronutrients to reduce the risk of anaemia. The prevalence of anaemia and the aetiologies vary in different populations. In developed countries anaemia is more common in women than in men with pregnant women, children under 5 years and elderly being the most susceptible groups. Anaemia is also common in the elderly, affecting roughly 10% of people over 65 years with to a third of these cases remaining unexplained. In developing countries, factors influencing the prevalence of anaemia include climate, socioeconomic conditions and most importantly, the incidence of coexistent diseases [29]. It is generally assumed that 50% of the cases of anaemia are due to iron deficiency anaemia. Iron deficiency anaemia is the most common disorder of the blood affecting about a quarter of people globally [16]. The anaemia estimates are provided by the region for all population groups, based on data collected from 1993 to 2005 [30]. The data coverage is about 70% or more for preschool-age children (76.1%), pregnant (69%) and non-pregnant (73.5%). Coverage for the remaining population groups is much lower; 33% for school aged children, 40.2% for men and 39.1% for elderly. Overall, the coverage for the general population is 24.8% and it is estimated that 1620 million people are affected by anaemia [30].

The highest prevalence rate of (82%) was also recorded in Abia state [31], 66.7% in Anambra state [32], 57.1% in Enugu [33] and 62% in Ibadan [34]. Although low prevalence of anaemia between 16.7 - 22.2%; mild anaemia is 13.9%, moderate anaemia 8.3% [35] was recorded in Sokoto and a prevalence of 29% [36] in Katsina. A study conducted in Sokoto [37] found a prevalence 64% among children with malaria in a hospital mostly attended by patients of comparatively low economic status. The low prevalence rate of anaemia obtained in Sokoto may be because, the study was carried out in teaching hospital frequently attended by people of higher economic and better nutritional status [35]. Recently, high prevalence (50%) of severe anaemia in patients with malaria infected children was reported in Usmanu Danfodiyo University Teaching Hospital, Sokoto [38]. Additionally, the global prevalence of anaemia in school-age children is 25.4%, in men 12.7% and 23.9% in the elderly [30]. The highest prevalence is in Africa (57.1%) and in South East Asia (48.2%), followed by the Eastern Mediterranean (44.2%), Western Pacific (30.7%) and the European Americas regions, respectively. Overall, 56.4 million pregnant women are anaemic (41. 8% prevalence globally) [30]. A large proportion of the 17.2 million anaemic pregnant women in Africa live in West African sub-region. The prevalence rate in some of the countries ranges from 50.2% in Togo, 66.7% in Nigeria, 68.3% in Burkina Faso, 72.7% in Benin to 75.1% in Gambia [39]. A previous report among pregnant women in Zaria indicated that iron deficiency was present in 75.6% of pregnant subjects [40]. Similarly, prevalence studies from other parts of Nigeria ranged from

35.3% in Lagos [41], 62.6% in Rivers [42], 23.1% in Sokoto [43] to 72.0% in Kano state [44]. In non-pregnant women, the prevalence of anaemia is slightly lower than in pregnant women. Overall, 468.4 million non-pregnant women are anaemic (30.2% prevalence globally) [30]. The highest prevalence of anaemia is also found in Africa (47.5%) and in South-East Asia (35.7%). In 2008, WHO estimated the worldwide prevalence of anaemia by regions and population groups. Women and young children are most vulnerable to anaemia. The proportion of women and children is highest in the Africa region where 57% of pregnant women (17 million), 48% of non-pregnant women (70 million), and 68% of pre-school children (84 million) are anaemic. In South East Asia, 48% of pregnant women (18 million), 46% of non-pregnant women (182 million), and 66% of pre-school children (115) suffer from anaemia [30]. Iron supplementation programmes have been carried out in many places throughout the world over the last two decades. Still, the prevalence of iron deficiency anaemia does not appear to be declining [45].

Findings from this study shows that most of the anaemic patients were single, The contributing factors could be stress of the professional course that demands long study hours, attending night postings, changes in the dietary habits among most of the students, as they enter the university system, and increased tendency to lose weight for zero size [46].

Mild iron deficiency anaemia affects another 375 million people [47]. A moderate degree of iron deficiency anaemia affects approximately 610 million people worldwide or 8.8% of the population. It is slightly more common in females than males (7.8%), among children, during pregnancy and in the elderly [16]. According to WHO, the most common cause of anaemia is iron deficiency anaemia. Iron plays a pivotal role in erythropoiesis [48]. Findings from this study shows that 5.56 of anaemic patient were iron deficient. This finding is consistent with the previous report that women of childbearing age are the groups most affected by iron deficiency [49]. Iron-deficiency anaemia is the most common type of nutritional anaemia which results from long-term negative iron balance and is responsible for approximately 50% of all anaemia [50,51]. It is a severe stage of iron shortage in which haemoglobin or haematocrit falls below the normal range. It is more widespread and severe in young children and women of reproductive age but it can be found in people of any age-group. Deficiency of iron usually develops slowly and is not clinically evident until anaemia becomes severe [52]. Several studies showed that, as in Sokoto, Nigeria, university students of other countries are also affected by iron-deficiency anaemia. In Indian medical students [53], the prevalence of IDA was 32.0%, of which 44.0% were girls, and 20.0% were boys. Similarly, the prevalence of IDA was 3.8% in Iranian university students [54]. Anaemia prevalence rate was also found to be 29.0% in Emirati students of 18 - 24 years age-group [24]. Females students are prone to iron deficiency anaemia because of menstruation and due to social customs; they get a diet of inferior quality compared to males. Iron deficiency is the commonest cause of anaemia worldwide and is frequently seen in general practice. The anaemia of iron deficiency is caused by defective synthesis of haemoglobin, resulting in red cells that are smaller than normal (microcytic and contain reduced amounts of haemoglobin (hypochromic) [55]. Iron is a constituent of haemoglobin and rate limiting for erythropoiesis. The metabolism of iron in the body is dominated by its role in haemoglobin synthesis. Normally, the total iron content of the body remains within narrow limits: absorption of iron from food (usually 10-30mg/day) must replace any iron losses. Iron is not excreted as such but is lost in desquamated cells, particularly epithelial cells from the gastrointestinal tract. Menstruating women will lose an additional highly variable amount of iron, and in pregnancy the rate of iron utilization is about 3 - 5 times greater than in normal men. The storage forms of iron, ferritin and haemosiderin, constitute about 13% of total body iron [29].

We observed a prevalence of thrombocytopenia (platelet count < 150 x 10^9/L) of 23.6% among our cohort of female students in Usmanu Danfodiyo University Sokoto Nigeria. Our observed prevalence is higher than the 8.8% obtained among pregnant women attending antenatal care service at Gondar University Teaching Hospital in Northwest Ethiopia [56].

Similarly, a prevalence of thrombocytopenia of 8.8% was observed among pregnant women in India. The reason for this high prevalence of thrombocytopenia among our cohort of female undergraduate students is unknown.

The prevalence of leukocytosis, leucopenia, lymphopenia, raised RDW, MPV and PLCR among the female subjects was 1.38, 2.77, 1.38, 4.16, 5.55 and 26.38% respectively. These findings indicate that haematological abnormalities are common among female students of Usmanu Danfodiyo University Sokoto, Nigeria. Our finding is consistent with previous reports among female students in Bangladesh, India and Nigeria [24-26].

We observed statistically significant ($p < 0.05$) negative correlations (PLC vs WBCs; MCV vs RBC; MCHC vs RBCs; MCHC vs PLC; Neutrophils vs MCV and RDW vs MCV) among the anaemic subjects indicating an inverse relationships between the parameters. A strong statistically significant ($p < 0.05$) positive correlation was observed between (Lymphocytes vs Neutrophils; MXD vs Lymphocytes and MXD vs neutrophils) among the anaemic subjects indicating a proportional relationship between the parameters.

Conclusion and Recommendations

In summary, anaemia, iron deficiency anaemia and other haematological abnormalities are prevalent among female medical student of the Usmanu Danfodio University, Sokoto, Nigeria and may have significant impact on their academic productivity and efficiency. Frequent screening of the students for the presence of anaemia and regular health checkups should be made mandatory for all female university students irrespective of their socio-economic class, including students undergoing professional courses. Also, nutritional programs, to help them recognize healthy nutritional habits, body nutritional requirements, quality and quantity of diet should be implemented. It is recommended that further studies be carried out among Nigerian University students using large sample sizes to assess the causes - genetic, nutritional and behavioral factors associated with anaemia in this population.

Acknowledgements

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