European Journal of Preventive Medicine
2023; 11(2): 21-31
http://www.sciencepublishinggroup.com/j/ejpm
doi: 10.11648/j.ejpm.20231102.12
ISSN: 2330-8222 (Print); ISSN: 2330-8230 (Online)

Patterns, Peculiarities and Associated Risk Factors of Anemia in Pregnancy: A Case Study of Pregnant Women Attending Antenatal Clinic in North-Central Nigeria

Azubuike Uma Inya[1], Amaechi Peter Achara[1], Aloysius Obinna Ikwuka[2, *], Francis Chigozie Udeh[2], Ukoma Chi-kadibia[3], Ochima Onazi[1]

[1]Department of Obstetrics and Gynecology, Federal Medical Center, Keffi, Nigeria

[2]Department of Basic Sciences, American International University West Africa, Banjul, The Gambia

[3]Department of Hematology, Federal Medical Center, Keffi, Nigeria

Email address:

aloysiussweet@yahoo.com (Aloysius Obinna Ikwuka)

[*]Corresponding author

To cite this article:

Azubuike Uma Inya, Amaechi Peter Achara, Aloysius Obinna Ikwuka, Francis Chigozie Udeh, Ukoma Chi-kadibia, Ochima Onazi. Patterns, Peculiarities and Associated Risk Factors of Anemia in Pregnancy: A Case Study of Pregnant Women Attending Antenatal Clinic in North-Central Nigeria. *European Journal of Preventive Medicine*. Vol. 11, No. 2, 2023, pp. 21-31. doi: 10.11648/j.ejpm.20231102.12

Received: March 31, 2023; **Accepted**: April 19, 2023; **Published**: April 27, 2023

Abstract: *Background:* Anemia is a prevalent medical disorder during pregnancy, posing a significant global public health burden. In developing countries like Nigeria, it remains a major cause of maternal and perinatal morbidity and mortality. *Aim:* To determine the red cell morphological patterns, peculiarities (clinical characteristics) of anemia, and associated risk factors including socio-demographic factors, associated with anemia among pregnant women attending antenatal clinic of a tertiary care hospital in North-Central Nigeria. *Materials and Methods:* A prospective, analytical study on 415 pregnant women attending antenatal clinic over a period of 4 months was conducted. The red cell morphology, Packed Cell Volume (PCV), genotype, and HIV status of each participant were determined. Using structured questionnaires, their bio-data, obstetric and medical histories, and results of routine investigations were documented. Statistical software (SPSS version 20, Chicago 11, USA) was used to analyze the data obtained. Continuous variables were presented as mean±SD, and categorical variables were presented as numbers and percentages. Chi-square tests were used for comparative analysis and the level of statistical significance was set at $p<0.05$. In addition, the association between anemia and socio-demographic factors, clinical characteristics, and risk factors were tested using Chi-square test. *Results:* Mean age of the study participants was 29.7±5.3 years. The mean BMI was 28.0±7.2 kg/m^2, and the mean parity was 1.9±1.7. In addition, 7.8% of the pregnant women were HIV positive. The mean packed cell volume was 32.7±3.1%, and 42.5% of the participants were anemic, with 29.0% and 13.5% having mild and moderate anemia, respectively. The most common blood picture indicated iron deficiency anemia, with microcytic hypochromia and normocytic hypochromia. Educational level ($p=0.00$) and socio-economic class ($p=0.00$) were significantly and independently related to anemia, while gestational age ($p=0.55$) was not significantly related. Moreover, a history of fever during the current pregnancy was significantly related to anemia ($p=0.01$), while genotype ($p=0.33$) was not. Anemia was significantly related to HIV-positive status ($p=0.00$). *Conclusion:* Pregnant women should be encouraged to receive antenatal care, where they can receive hematinic supplements, appropriate investigations and treatments for fever or HIV. Poverty is a contributing factor to poor health outcomes during pregnancy. Implementing national and local policies to boost the economy can help alleviate poverty and improve health outcomes in pregnant women.

Keywords: Patterns, Peculiarities, Risk Factors, Anemia, Pregnancy, Antenatal Care, Tertiary Care, Nigeria

1. Introduction

Optimum hemoglobin concentration during pregnancy is crucial for both the mother and developing fetus, as it provides the necessary oxygen supply. If the hemoglobin levels fall below acceptable levels, it can adversely affect both [5]. Anemia is traditionally defined as a decrease in the blood's

ability to carry oxygen due to a reduced number of erythrocytes or a lower concentration of hemoglobin per erythrocyte, or a combination of both [1]. According to the World Health Organization (WHO), a hemoglobin concentration less than 11.0g/dl or packed cell volume (PCV) of less than 33.0% is considered anemia during pregnancy [9].

Anemia during pregnancy has been classified as mild if hemoglobin is between 10g/dl and 10.9g/dl, as moderate if hemoglobin is between 7g/dl and 9.9g/dl, and as severe if hemoglobin is below 7g/dl by the World Health Organization (WHO) [9]. In tropical regions, a pregnant woman is considered anemic when the hemoglobin concentration is less than 10g/dl or PCV is less than 30.0% [3]. Anemia is a significant public health issue in developing countries and the most common medical complication during pregnancy in Sub-Saharan Africa, especially with the prevalence of the HIV/AIDS pandemic [14].

Globally, the prevalence of anemia in pregnancy is estimated at 41.8%, with pregnant women being the most affected after pre-school age children according to WHO criteria [14]. In Africa, the prevalence of anemia in pregnant women is estimated to be between 52.8%-61.3%, while among non-pregnant women, the estimate is 43.4%-51.6%, and for pre-school age children, it is between 64.3%-71.0% [14]. The burden of anemia is highest in Asia and Africa, where an estimated 60% and 52% of women, respectively, are anemic, and 1%-5% respectively are severely anemic (Hb<7g/dl) [21, 36].

The etiological factors responsible for anemia in pregnancy are numerous, and their relative contributions vary by geographical area and season [25, 46]. In an animal experiment, tobacco (*Nicotiana tabacum*) is harmful to the kidneys of pregnant Wistar rats and distorts the histological architecture of the kidneys. Ingested tobacco impairs the blood-clearing function of the kidneys as serum creatinine and urea levels are elevated in the blood. In addition, tobacco ingestion by Wistar rats during gestation reduces the birth weight of their pups [48].

Malaria, a common cause of febrile illness and anemia among pregnant women in Nigeria, is endemic. However, simple interventions like iron supplements, long-lasting insecticidal nets, and intermittent preventive treatment have proven effective in the control of malaria [8, 29, 39]. Hookworm infection is also a significant cause of anemia in poor communities, yet its management during pregnancy has received less attention compared to other causes [19, 45].

Anemia during pregnancy is associated with significant maternal, fetal, and neonatal morbidity and mortality from reports gotten from studies done in both hospital and communities [6, 28, 30, 46]. Obtained results from different studies indicate that high levels of blood pressure, glucose and lipid metabolic disorders, asymptomatic hyperuricemia, activation of systemic immune inflammation and fibrogenesis, contribute to kidney damage [49, 52, 55, 56, 58-60], which can lead to anemia taking into account that erythropoietin (an important factor in erythropoiesis) is synthesized by the kidneys.

Maternal complications include pregnancy-induced hypertension, *abruptio placentae*, puerperal venous thrombosis, cardiac failure, infections (urinary tract infections, puerperal sepsis), postpartum hemorrhage (PPH), and maternal mortality.

Fetal complications from severe maternal anemia include limited oxygen supply which could lead to intrauterine growth restriction (IUGR), prematurity, preterm labor, preterm premature rupture of membranes, low birth weight, and increased perinatal or postnatal mortality [4, 7]. Even mild forms of anemia have been linked to permanent cognitive damage by decreasing attention span and shortening memory. Children born with anemia have intelligence quotients (IQs) that are two points lower per every 1g/dl decrease in hemoglobin than other children [43]. The costs of anemia to individual and national productivity are significant. Women with anemia during pregnancy have decreased work capacity and may be unable to earn their livelihood if the work involves manual labor [18, 43].

Anemia during pregnancy is a significant public health concern that can negatively impact both the mother and the baby. According to March of dimes, there are two major causes of anemia during pregnancy: iron deficiency which could be described as nutritional deficiency is the commonest cause, and genetic disorders like sickle cell disease or thalassemia is the second [27]. Aside these causes, there are other causes of anemia in pregnancy and predisposing factors. Many of these causes are preventable.

For iron deficiency anemia (IDA) during pregnancy, the women may use iron pills, although overdose or overuse of the pills can affect the stomach or colon causing side effects like nausea, vomiting, abdominal discomfort and constipation [26]. Dapagliflozin increases the effectiveness of treatment and improve the clinical course of type 2 diabetes mellitus and hypertension in patients with such comorbidities [50, 51, 53, 54, 57, 61-63].

Sickle cell anemia during pregnancy can be corrected right from the point of marriage. It will be advised that intending couples check their sickle cell trait (genotype) before they progress in the marriage, because this will help in keeping the next generation of women less susceptible to anemia during pregnancy. Therefore, identifying the prevalence of anemia and associated socio-demographic factors in the local environment can enhance patients' management, resulting in improved feto-maternal well-being, and reduced maternal and perinatal mortality and morbidity.

This study aimed to determine the red cell morphological patterns, peculiarities (clinical characteristics) of anemia, and associated risk factors including socio-demographic factors, associated with anemia among pregnant women attending antenatal clinic of a tertiary care hospital in North-Central Nigeria.

2. Materials and Methods

2.1. Study Area

This study was conducted at the antenatal clinic of the

Federal Medical Center (FMC) in Keffi, a sub-urban town located in the Keffi Local Government Area of Nasarawa State, North-Central Nigeria. FMC Keffi is a tertiary care hospital with a capacity of 277 beds. Established in April 2000, it serves as a major referral center and a training institution for postgraduate doctors. The Antenatal Clinic is a unit within the Department of Obstetrics and Gynecology, and offers a range of services such as health education, nutritional counseling, immunization, screening and treatment of common diseases during pregnancy.

2.2. Study Population

This study was a prospective, analytical study conducted from October 2018 to January 2019. The study population comprised pregnant women attending the antenatal clinic.

2.3. Sample Size

Kish Leslie formula for cross-sectional studies [9] was used for calculating the sample size.

$$n = \frac{Z^2PQ}{d^2}$$

Where:

n is the desired sample size;

Z is the standard normal deviate usually set at 1.96, which corresponds to the 95% confidence interval;

P is the proportion of the prevalence of anemia during pregnancy, which is 43.5% based on a similar, previously done study at Bingham University Teaching Hospital, Jos, Plateau State, North-Central Nigeria by Bassi *et al* [4];

Q is complementary proportion equivalent to 1-P; that is, 1-0.435 equals to 0.565;

d is the degree of accuracy desired (absolute precision), which is 5.0% (0.05).

Thus, $n = \frac{1.96^2 \times 0.435 \times 0.565}{0.05^2}$

$$n = \frac{0.944}{0.05^2}$$

$$n = 378$$

Based on the previous year's record, the antenatal clinic has an average booking rate of 52 pregnant women per week, with a total of 2,800 pregnant women booking for antenatal care. For this study, a total of 415 respondents were sampled, accounting for a 10% attrition rate from the required sample size of 378 respondents. The sampling pool consisted of singleton pregnant women (pregnant women with just a fetus) on the attendance list at every antenatal clinic, randomly selected and willing to participate in the study.

The following pregnant women were excluded: those attending follow-up antenatal visits, those who had received a blood transfusion during the current pregnancy, women already receiving treatment for anemia before their antenatal visit, pregnant women with multiple gestations, and those with a history of antepartum hemorrhage in the current pregnancy.

2.4. Study Procedure

Pregnant women who provided written consent were interviewed using a semi-structured questionnaire. The questionnaires were administered from the Department of Obstetrics and Gynecology to ensure accurate data collection. Each participant was assigned to one of five social classes based on her education level and her husband's occupation, using a scoring system developed by Olusanya *et al* [35]. For single or separated women, social class was determined by their occupation and educational status.

Social classes 1 and 2 were considered the upper class, comprising of elites, professionals such as doctors, lawyers, bankers, and individuals in managerial positions. Class 3 represented the middle class, which included nurses, clerks, technicians, artisans, and similar occupations. Social classes 4 and 5 were considered the least in the classification.

Blood samples were collected from the participants, and clinical examinations were conducted on each sample. Using the micro-method of hematocrit estimation, the packed cell volume (PCV) was determined [12]. Women with a PCV below 33.0% (Hb below 11g/dl) were provided with free iron and folic acid tablets for eight weeks and counseled for further investigation into the cause and characteristics of their anemia.

The morphology of red blood cells was determined using Leishman's staining technique, as described by Dayyal [13]. Microcytic hypochromic morphology was considered indicative of iron deficiency, while macrocytic blood picture was interpreted as megaloblastic anemia. A combination of both morphologies was interpreted as dimorphic anemia. Results of other clinical investigations like genotype and HIV screening were obtained from the laboratory and entered into the questionnaires.

2.5. Quality Control

The PCV measurement and red cell morphology were analyzed by a clinical hematologist who was dedicated to this study. Another clinical hematologist who was also dedicated to this study, randomly selected specimen samples at intervals for cross-checking and quality control. The purpose of this was to ensure quality control and reduce intra- and inter-observer errors.

2.6. Data Analysis

Statistical package for social sciences (SPSS package) version 20 was used to analyze the data. Descriptive statistics were computed for relevant variables. Chi-square test was used for comparative analysis and the level of significance was set at $p<0.05$. The association between anemia and socio-demographic factors, clinical characteristics, and associated risk factors were tested using Chi-square.

2.7. Ethical Consideration

Ethical clearance was obtained from the Health Research Ethics Committee of FMC Keffi. In designing this study,

signed consents from each participant was obtained. Confidentiality of respondents' responses and beneficence of participants were upheld.

3. Results

400 of the 415 collected blood samples were analyzed, 10 samples were not analyzable, and 5 were clotted. The study findings are presented in the following six tables. Table 1 displays the socio-demographic characteristics of the pregnant women, with mean age of 29.7±5.3 years and a mean parity of 1.9±1.7 children. 49% of the women had tertiary education (higher social class), while 29.75% and 31.75% were in the middle and lower social classes, respectively.

Table 1. *Socio-demographic characteristics of the women at antenatal clinic, n=400.*

Socio-demographic characteristics	Options	Frequency, *n* (%)
Age (year range)	<20	2 (0.5)
	20-24	66 (16.5)
	25-29	127 (31.75)
	30-34	123 (30.75)
	35-39	70 (17.5)
	≥40	12 (3.0)
	Total	400 (100)
	Mean age = 29.7±5.3	
Marital status	Married	397 (99.25)
	Single	2 (0.5)
	Widowed	1 (0.25)
	Total	400 (100)
Parity	0	93 (23.25)
	1-4	276 (69.0)
	≥5	31 (7.75)
	Total	400 (100)
	Mean age = 1.9±1.7	
Educational level	No formal	13 (3.25)
	Primary	38 (9.5)
	Secondary	153 (38.25)
	Tertiary	196 (49.0)
	Total	400 (100)
Social class	1	56 (14.0)
	2	98 (24.5)
	3	119 (29.75)
	4	107 (26.75)
	5	20 (5.0)
	Total	400 (100)
Occupation	Professional	23 (5.75)
	Skilled labor	152 (38.0)
	Unskilled labor	225 (56.25)
	Total	400 (100)
Husband's occupation	Professional	62 (15.62)
	Skilled labor	196 (49.37)
	Unskilled labor	139 (35.01)
	Total	397 (100)

Table 2 details the clinical characteristics of the pregnant women, with 68.5% booking for antenatal care during the second trimester of pregnancy. Among the women who already had previous delivery, the mean inter-pregnancy gap was 1.8±1.1 years. A total of 45.25% of the women experienced fever during the index pregnancy, with 7.75% being HIV seropositive, and 14.75% having the sickle cell trait. 40.5% and 27% of the women were overweight and obese, respectively.

Table 2. *Clinical characteristics of the women, n=400.*

Clinical characteristics	Options	Frequency, *n* (%)
Trimester	First	72 (18.0)
	Second	274 (68.5)
	Third	54 (13.5)
	Total	400 (100)
Inter-pregnancy interval	<2 years	172 (43.0)
	≥2 years	228 (57.0)
	Total	400 (100)
Miscarriage/Ectopic	Yes	130 (32.5)
	No	270 (67.5)
	Total	400 (100)

Clinical characteristics	Options	Frequency, *n* (%)
Bleeding during previous pregnancy	Yes	17 (4.25)
	No	383 (95.75)
	Total	400 (100)
Fever	Yes	181 (45.25)
	No	219 (54.75)
	Total	400 (100)
Genotype	AA	341 (85.25)
	AS	59 (14.75)
	Total	400 (100)
HIV positive status	Yes	31 (7.75)
	No	369 (92.25)
	Total	400 (100)
BMI	<18.5	6 (1.5)
	18.5-24.9	124 (31.0)
	25.0-29.9	162 (40.5)
	≥30	108 (27.0)
	Total	400 (100)

Table 3 shows the association between red cell morphology and anemia. It shows that the mean PCV was 32.7±3.1% with a range of 21% to 40%. Also, it shows that 42.5% of the pregnant women were anemic. Of the anemic women, 68.24% had mild anemia, 31.76% had moderate anemia, and none had severe anemia. The majority of women with normal red cell morphology were not anemic (94.79% and 87.87%, respectively), while the majority of those with microcytic hypochromic red cell morphology were anemic (85.5%).

Table 3. *Association between red cell morphology pattern of the pregnant women and anemia.*

RBC Morphology	Options	Non-anemic (%)	Anemic (%)	*p*-value	X^2
Normocytosis	No	30 (15.88)	159 (84.12)	0.00*	245.1
	Yes	200 (94.79)	11 (5.21)		
	Total	230 (57.5)	170 (42.5)		
Normochromia	No	20 (12.42)	141 (87.58)	0.00*	224.1
	Yes	210 (87.87)	29 (12.13)		
	Total	230 (57.5)	170 (42.5)		
Dimorphic	No	215 (61.43)	135 (38.57)	0.00*	17.7
	Yes	15 (30)	35 (70)		
	Total	230 (57.5)	170 (42.5)		
Hypochromia	No	210 (87.14)	31 (12.86)	0.00*	217.9
	Yes	20 (12.58)	139 (87.42)		
	Total	230 (57.5)	170 (42.5)		
Microcytosis	No	220 (81.18)	51 (18.82)	0.00*	192.8
	Yes	10 (7.75)	119 (92.25)		
	Total	230 (57.5)	170 (42.5)		
Macrocytosis	No	225 (57.54)	166 (42.46)	0.91**	0.014
	Yes	5 (55.56)	4 (44.44)		
	Total	230 (57.5)	170 (42.5)		

*Statistically significant *p* values; ** statistically insignificant *p* values

Table 4 displays the association between socio-demographic characteristics of the pregnant women at booking (antenatal clinic) and anemia, with pregnant women below 20 years having the highest prevalence of anemia. There was an inverse relationship between the prevalence of anemia and the level of education of the women ($x^2 = 17.6$, p=0.00). Anemia was significantly more common in women of lower social class ($x^2 = 14.5$, p=0.00).

Table 4. *Association between socio-demographic characteristics of the pregnant women at booking (antenatal clinic) and anemia.*

Characteristics	Options	Non-anemic (n)	Anemic (n)	*p*-value	X^2
Age (years)	< 20	1	1		
	20-24	34	32		
	25-29	71	56	0.78**	2.5
	30-34	77	46		
	35-39	40	30		
	≥40	7	5		
	Total	230 (57.5%)	170 (42.5%)		
Marital status	Married	229	168	0.50**	1.4

Characteristics	Options	Non-anemic (n)	Anemic (n)	*p*-value	X^2
	Single	1	1		
	Widow	0	1		
	Total	230 (57.5%)	170 (42.5%)		
Parity	0	58	35		
	1-4	155	121	0.55**	1.2
	≥5	17	14		
	Total	230 (57.5%)	170 (42.5%)		
Educational level	No formal	6	7		
	Primary	15	23	0.00*	17.6
	Secondary	80	73		
	Tertiary	132	64		
	Total	230 (57.5%)	170 (42.5%)		
Social class	1	29	21		
	2	51	47		
	3	69	50	0.00*	14.5
	4	73	34		
	5	8	18		
	Total	230 (57.5%)	170 (42.5%)		

*Statistically significant *p* values; ** statistically insignificant *p* values

Table 5 illustrates univariate analysis of clinical characteristics with anemia. There was significant association between history of fever in the index pregnancy and HIV status of the women with anemia (x^2 = 17.0, *p*=0.00). However, there was no significant association between gestational age (trimester of pregnancy) at booking and anemia (x^2 = 1.9, *p*= 0.58).

Table 5. *Univariate analysis between clinical characteristics of the pregnant women and anemia.*

Clinical Characteristics	Options	Non-anemic (%)	Anemic (%)	*p*-value	X^2
	First	35 (46.05)	41 (53.95)	0.55**	1.9
Gestational Age (trimester)	Second	108 (55.1)	88 (44.9)		
	Third	61 (52.58)	55 (47.42)		
	Total	204	184		
	<2years	103 (59.88)	69 (40.12)	0.19**	24.1
Inter-pregnancy interval	2+years	127 (55.7)	101 (44.3)		
	Total	230 (57.5%)	170 (42.5%)		
Fever	Yes	121 (66.85)	60 (33.15)	0.00*	17.9
	No	96 (43.84)	123 (56.16)		
	Total	217 (54.25%)	183 (45.75%)		
Genotype	AA	200 (58.65)	141 (41.35)	0.33**	3.4
	AS	30 (50.85)	29 (49.15)		
	Total	230 (57.5%)	170 (42.5%)		
HIV	Yes	5 (16.12)	26 (83.08)	0.00*	13.1
	No	213 (57.72)	156 (42.28)		
	Total	218 (54.5%)	182 (45.5%)		

*Statistically significant *p* values; ** statistically insignificant *p* values

Table 6 shows multivariate analysis of risk factors associated with anemia. Multivariate analysis showed that anemia was significantly related to the history of fever in the index pregnancy (OR = 0.4; *p*=0.00; 95% CI = 0.3-0.7), HIV positive status (OR = 0.2; *p*=0.01; 95% CI = 0.1-0.6), and low social class (OR = 0.3; *p*=0.00; 95% CI = 0.2-0.7).

Table 6. *Multivariate analysis of risk factors associated with anemia.*

Risk Factors	Odds Ratio (OR)	*p*-value	95% Confidence Interval (CI)
Fever in index pregnancy	0.4	0.00*	0.3-0.7
HIV positive status	0.2	0.01*	0.1-0.6
Para 0	1.4	0.21**	0.8-2.3
Para 1-4	2.1	0.69**	0.6-2.1
Para ≥5	1.2	0.40**	0.6-2.0
Social class 2	0.6	0.15**	0.3-1.2
Social class 3	0.3	0.00*	0.2-0.7

*Statistically significant *p* values; ** statistically insignificant *p* values

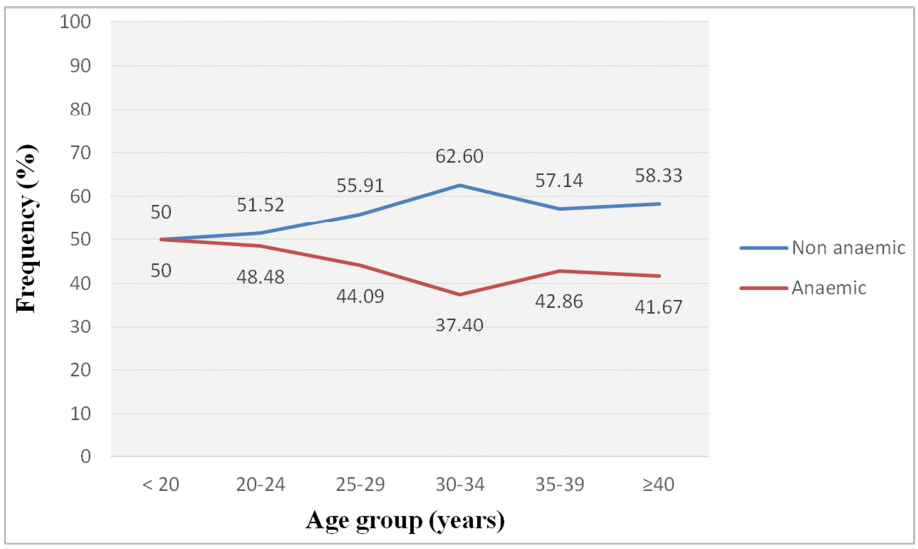

Figure 1. *Association between age groups of the pregnant women at booking and prevalence of anemia.*

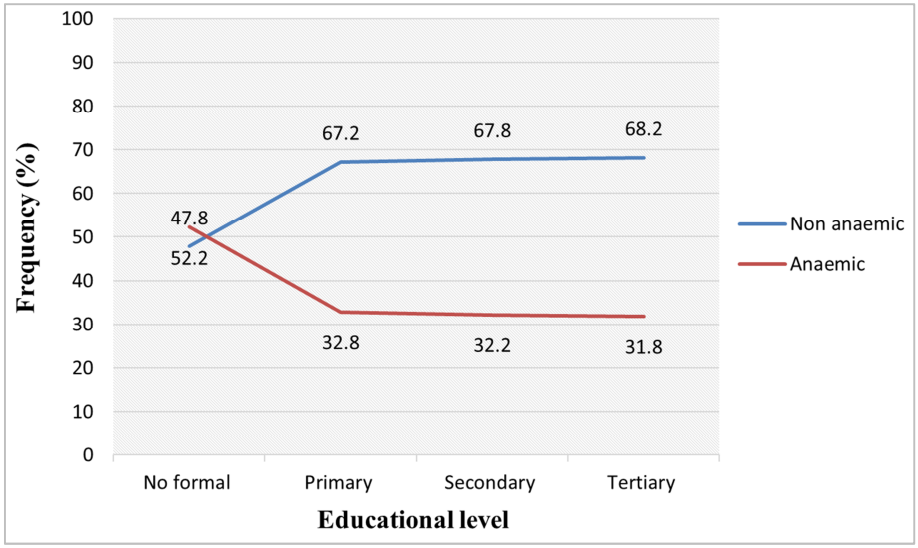

Figure 2. *Association between educational levels of the pregnant women at booking and prevalence of anemia.*

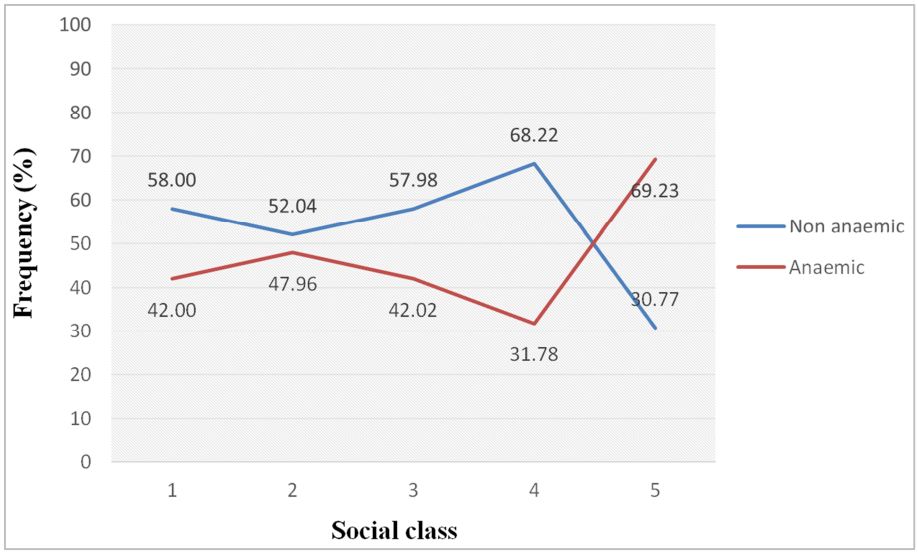

Figure 3. *Association between social classes of the pregnant women at booking and prevalence of anemia.*

4. Discussion

Diagnosing malaria during pregnant women's antenatal clinic visits is crucial as it enables proactive planning to prevent the complications of anemia. This is especially important in tropical regions where anemia during pregnancy is a common cause of high birth-related morbidity and mortality [5, 20, 23, 34].

Studies conducted in third-world countries have shown that the prevalence of anemia during pregnancy ranges from 35.0% to 75.0%, with primigravidae living in malaria-endemic areas experiencing higher severity and incidence of anemia [14, 40]. In this study, the prevalence of anemia among pregnant women was 42.5%, which falls within the mid-range when compared to findings from other studies in Nigeria and in South Eastern African countries [3, 10, 18, 31, 34, 36, 37]. There is consistency in this study with the 40.01% prevalence rate of anemia among pregnant women in Nigeria documented in the World Health Organization's Global database on anemia [14] as well as the findings from other studies in Jos, Plateau State, Nigeria [5]; Enugu, Southeast Nigeria [16]; and Jamitown, Southeast Ethiopia [15, 31, 42]. However, it is lower than the prevalence rates reported in Derna City, Libya [17], Abakaliki, Nigeria [18, 37], and in Maharashtra and Telangana, both in India [2, 38].

The high prevalence of anemia in this study is linked to the low socio-economic status of the women, which can adversely impact their nutritional status and health-seeking behavior [9, 47]. However, compared to the 1988 data quoted by the World Health Organization, which reported a 56.0% prevalence of anemia in Africa, the prevalence in this study is lesser and this suggests a modest improvement in prevalence rate of anemia in pregnancy over the past three decades, although it remains unacceptably high [41]. Nevertheless, the prevalence of anemia in this study is still higher than the rates reported in other regions like Surulere, Lagos, Southwest Nigeria (35.3%), Aymiba, Northwest Ethiopia (25.2%), Benin-city, Southern Nigeria (20.7%), and Kano, Northwest Nigeria (17.0%) [3, 11, 15, 31, 32, 42].

No pregnant woman was severely anemic in this study, but most of them had mild to moderate anemia with mild anaemia being dominant. This finding is consistent with other studies conducted in Nigeria [1, 5, 21, 36]. In contrast, severe anemia was observed in some studies conducted in different geo-political zones of Nigeria, such as Sagamu, Abeokuta, and Benin, with a prevalence of 0.7%, 1.7%, and 2.8%, respectively [11, 33]. Severe anemia in those studies was observed in pregnant women with sickle cell anemia and in patients with chronic illnesses or immunodeficiencies. However, our finding of no severe anemia is in agreement with the results of studies conducted in Enugu, Southeast Nigeria, and Ibadan, Southwest Nigeria [9, 33].

Moreover, this study shows that the mean Packed Cell Volume was 32.7%, indicating anemia according to WHO standards. The incidence of anemia among different age groups was not significantly different (p=0.78), which is consistent with findings from a study conducted in Port-Harcourt, Nigeria [10] and studies from other African countries [36, 46].

Interestingly, multiparity especially when the pregnancies occur within short inter-pregnancy intervals, is traditionally known to cause anemia during pregnancy due to repeated exhaustion of stored iron. However, no consistent relationship (p=0.55) between these two parameters: increasing parity and anemia, was discovered in this study. This finding is consistent with previous reports in Zaire and Port-Harcourt, Nigeria [10, 24], but differs from a Tanzanian report [22]. It would not be far-fetched to say that the interaction pregnant women get with other pregnant women at the antenatal clinic, knowledge and practice of feeding optimally on balanced diet, as well as the antenatal clinic experience gained from the first pregnancy, may play a role in reducing gestational anemia.

In addition, no relationship was observed between the prevalence of anemia and increasing age of gestation (trimester of pregnancy), indicating that all pregnant women were susceptible to anemia throughout gestation. As supported by previous studies conducted in Gondar, India, and Nigeria, early antenatal care could serve as an important preventive measure for anemia during pregnancy [10, 31, 32, 46].

Despite the high level of education of most participants, most of them were either in low or middle social class, as noted by Bukar*et al* [8]. This is likely due to a significant percentage (35.01%) of their husbands being in the unskilled labor class, with only 15.62% being professionals. In fact, 56.25% of the participants were in the unskilled labor class. The low socio-economic status of these women can have a significant impact on their nutritional status and health-seeking behavior, as they tend to feed on low micronutrients, low animal protein, and low vitamins but feeding heavily on carbohydrates and phytates, which interrupt the intestinal uptake of iron and trace minerals such as calcium and zinc [41]. In third-world countries, gestational anemia is commonly attributed to nutritional deficiencies, particularly iron deficiency in diet. The second and third trimesters of gestation are when the need for iron rises enormously. Unfortunately, this period was when 82% of the participants in this study booked for antenatal care. To prevent and manage anemia during pregnancy, early antenatal care and nutritional interventions are crucial, particularly among women of low socio-economic status. Therefore, economic empowerment of women could play a crucial role in reducing the prevalence of anemia.

In this study, approximately 57% of the parous women had an inter-pregnancy interval that is over 2 years. This feature may be attributed to the high level of education and civil/public service employment of the women. Consistent with the findings of Bukar*et al* [8], a higher percentage of women with an inter-pregnancy interval of less than 2 years had anemia.

Malaria is a major cause of fever and anemia. Feverish condition during pregnancy has been shown to be

significantly associated with anemia in this study. 73.5% of the 31 participants who tested positive for HIV were anemic, which is not surprising as HIV infection is a recognized risk factor for anemia. Mechanisms demonstrating the relationship of HIV infection with anemia include direct effects of the virus on red blood cells, bone marrow suppression due to cytokine release, and chronic inflammation or opportunistic infections, which may be worsened by the use of zidovudine or other antiretroviral drugs used in highly active antiretroviral therapy (HAART).

The most common types of anemia observed were normocytic hypochromia and microcytic hypochromia, which are characteristic of iron deficiency anemia. Diagnosing iron deficiency anemia using the gold standard of stained bone marrow aspirate examination is invasive. Analysis of serum ferritin is expensive and uncommon, and the ferritin level can rise if there is an inflammation, a common condition in Nigeria. In this study, a blood picture suggestive of iron deficiency was observed to complicate 97.6% of all cases of anemia, which is higher than the 64.0% reported by Vanderjagt *et al* [44].

5. Conclusion

History of fever during pregnancy, HIV positive status, and low socio-economic status are significant risk factors associated with anemia in pregnancy. The most common blood pictures seen among the anemic patients were normocytic hypochromia and microcytic hypochromia, which are characteristic of iron deficiency anemia. It is crucial to prioritize and intensify interventions to prevent and treat anemia during antenatal care visits. Furthermore, it is important to investigate and treat other causes of fever in pregnancy, apart from malaria. Development of effective diagnostic methods for early diagnosis of anemia in pregnancy, and clinically effective treatment regimen for proper management of anemia in pregnancy in order to avoid life-threatening, and possibly fatal complications are also very necessary and should be the direction of future research.

Conflict of Interest

The authors guarantee responsibility for everything published in this manuscript, as well as the absence of a conflict of interest and the absence of their financial interest in performing this research and writing this manuscript. This manuscript was written from an original research work and has never been published, neither is it under consideration for publication elsewhere.

Acknowledgements

Special thanks to the Staffs of the Department of Obstetrics and Gynecology and the Department of Hematology of the Federal Medical Center, Keffi, Nasarawa State, North-Central Nigeria; and to all the pregnant women who participated in this study - for their cooperation and support in carrying out this study.

References

[1] Agan TU, Ekabua JE, Udoh AE, Ekanem EI, Efiok EE, Mgbekem MA. Prevalence of anaemia in women with asymptomatic malaria parasitemia at first antenatal care visit at the University of Calabar Teaching Hospital, Calabar, Nigeria. *International Journal of Women's Health.* 2010; 2 (1): 229-233.

[2] Agarwal DK, Agarwal KN, Roychaudhary S. Targets in national anaemia prophylaxis programme for pregnant women. *Indian Paediatrics.* 1988; 25: 319-22.

[3] Arnolu RI, Oluwole AA, Abudu OO. Socio-demographic factors in anaemia in pregnancy at booking in Lagos, Nigeria. *Journal of Obstetrics and Gynaecology.* 2006; 28 (6): 773-776.

[4] Axemo P, Liljestrand J, Bergstrom S, Gebre-Medhin M. Aetiology of late foetal death in Maputo. *Gynaecol and Obstetrics Investigation*. 1995; 39: 103-109.

[5] Bassi AP, Idoko L, Dibigbo-Ibeaji NM, *et al*. Prevalence of anaemia in pregnancy among women visiting antenatal clinic in Bingham University Teaching Hospital, Jos, Nigeria. *Clinical Medicine Research*. 2016; 5 (3): 52-62.

[6] Brabin BJ, Ginny M, Sapau J, Galme K, Paino J. Consequences of maternal anaemia on outcome of pregnancy in a malaria endemic area of Papua New Guinea. *Annals of Tropical Medicine and Parasitology.* 1990; 84: 11-24.

[7] Brabin BJ, Premji Z, Verhoeff F. An analysis of anaemia and child mortality. *Journal of Nutrition.* 2001; 132: 636S-645S.

[8] Bukar M, Audu BM, Sadauki HM, Elnafaty AU, Mairiga AG. Prevalence of Iron Deficiency and Megaloblasticanaemia at booking in a secondary health facility in North-Eastern Nigeria. *Nigerian Journal of Medicine*. 2009; 50 (2): 33-37.

[9] Bull BS, Lichtman MA, Beutler B, Kipps TJ, Seligsohn U, Kaushansky K, Prchal JT. Morphology of the Erythron, In WJ Williams (Ed), *Williams Haematology*, McGraw-Hill, USA. 2006; 369-385.

[10] Buseri FI, Uko EK, Jeremiah ZA, Usanga EA. Prevalence and risk factors of anaemia among pregnant women in Nigeria. *Open Journal of Haematology.* 2008; 2: 14-19.

[11] Chukwudebelu WO, Obi GO. Anaemia in pregnancy in Nigeria. *Nigerian Medical Journal*. 1979; 9: 221-223.

[12] Dayyal D. Micro method for estimation of Packed Cell Volume (PCV) or hematocrit. *Bioscience.* 2018; Available online: https://www.bioscience.com.pk/topics/hemotology/item/782-micro-method-for-estimation-of-packed-cell-volume-pcv-or-hematocrit

[13] Dayyal D. Red cell morphology. *Bioscience.* 2017; Available online: https://www.bioscience.com.pk/topics/hemotology/item/799-red-cells-morphology

[14] De Benoist B, McLean E, Egli I, Cogswell M. Worldwide prevalence of anaemia 1993-2005. *WHO Global Database on Anaemia*. 2008; p. 7-25. WHO Press, Geneva, Switzerland. Available online: http://whqlibdoc.who.int/publications/2008/9789241596657_eng.pdf

[15] Dejere L, Matiyas Y, Weldesenbet S, Amanuel A, Mesfin W, Henock A, Misganaw B. Prevalence of anaemia among pregnant women receiving antenatal care at Boditii Health Centre, Southern Ethiopia. *Clinical Medicine Research*. 2015; 4 (3): 79-86.

[16] Dim CC, Onah HE. The prevalence of anaemia among pregnant women at booking in Enugu, South Eastern Nigeria. Medscape General Medicine. 2007; 9 (1): 11.

[17] Elzahaf RA, Omar M. Prevalence of anaemia among pregnant women in Derma city, Libya. InternationalJournalofCommunityMedicineandPublicHealth. 2016; 3 (7): 1915-1920.

[18] Esike CO, Anozie OB, Onoh RC, Sunday UC, Nwokpor OS, Umeora OU. The prevalence of anaemia in pregnancy at booking in Abakaliki, Nigeria. *Tropical Journal of Obstetrics and Gynaecology.* 2016; 33: 332-336.

[19] Garner P, Gilmezoglu AM. Drugs for preventing malaria in pregnant women. *Cochrane Database of Systemic Reviews.* 2006; 4: CD000169.

[20] Geelhoed D, Agadzi F, Visser L, *et al*. Severe anaemia in pregnancy in rural Ghana: A case-control study of causes and management. *ActaObstetriciaetGynaecologicaScandinavica.* 2006; 85 (10): 1165-1171.

[21] Harrison KA, John C, Stoffen B. Anaemia in pregnancy, Maternity care in developing countries. *Royal College of Obstetrics and Gynaecology Press.* 2001; 112-128.

[22] Hinderaker SG, Olsen BE, Bergsjo P, Lie RT, Gasheka P, Kwale G. Anaemia in pregnancy in the highlands of Tanzania. *ActaObstetriciaetGynaecologicaScandinavica.* 2001; 80: 18-26.

[23] Hogue M, Kadar SB, Hogue E, Mugero C. Prevalence of anaemia in pregnancy at Greytown, South Africa. *Tropical Journal of Obstetrics and Gynaecology.* 2006; 23 (1): 3-7.

[24] Jackson DJ, Klee EB, Green SD, Mokili JL, Cutting WA. Severe anaemia in pregnancy; a problem of primigravidae in rural Zaire. *Transaction of the Royal Society of Tropical Medicine and Hygiene.* 1986; 80: 249-255.

[25] Komolafe JO, Kuti O, Oni O, Egbewale BE. Socio-demographic characteristics of anaemicgravidae at booking; a preliminary study at Ilesha, Western Nigeria. *Nigerian Journal of Medicine*. 2005; 4 (2): 151-154.

[26] Kristei LMD. Featured Health and Wellness Contributor. 2009.

[27] March of dimes. Pregnancy & Newborn, complication of anaemia during pregnancy. 2010.

[28] Macleod J, Rhode R. Retrospective follow-up of maternal deaths and their associated risk factors in a rural district of Tanzania. *Tropical Medicine and International Health.* 1998; 3: 130-137.

[29] Mclean E, Cogswell M, Egli I, Wojdyla D, DeBonist B. Worldwide prevalence of anaemia, WHO, vitamin and mineral nutrition information system 1993-2005. *Public Health Nutrition*. 2009; 12 (4): 444-454.

[30] Mohammed YG, Emmanuel AU. The pattern of anaemia in Northern Nigerian Women. *Journal of Medicine and Medical Sciences*. 2013; 4 (8): 319-323.

[31] Muguleta M, Zelalem A, Meseret A, Banlaku E. Prevalence and predictors of maternal anaemia during pregnancy in Gondar, Northwest Ethiopia. An Institutional based cross-sectional study. *Anaemia.* 2013; 20 (14): CD108593.

[32] Nwizu EN, Iliyasu SA, Galadanci HS. Socio-demographic and maternal factors in anaemia in pregnancy at booking in Kano, Northern Nigeria. *African Journal of Reproductive Health.* 2011; 15 (4): 33-41.

[33] Ojo OA. The clinical features of anaemia in pregnancy in Ibadan. *Journal of Nigerian Medical Association.* 1965; 2: 224-233.

[34] Olatubosun OA, Abasiahai AM, Bassey EA, James RS, Ibanga G, Morgan A. Prevalence of anaemia among pregnant women at booking in the University of Uyo Teaching Hospital, Uyo, Nigeria. *Biomed Research International*. 2014; CD849080.

[35] Olusanya O, Okpere E, Ezimolehai M. The importance of social class in voluntary fertility control in developing countries. *West African Journal of Medicine.* 1985; 4: 205-207.

[36] Omigbodun OA. Recent trends in the management of anaemia in pregnancy. *Tropical Journal of Obstetrics and Gynaecology.* 2004; 21 (1): 1-3.

[37] Onoh RC, Ezeonu OP, Umeora OU, Onoh TJ, Anozie BO, Onyebuchi AK. Anaemia in pregnancy in Abakaliki, South East Nigeria. *International Federation of Gynaecology and Obstetrics Ireland.* 2014; 125 (3): 280-285.

[38] Rajamouli J, Ravinder A, SCK Reddy, SujathaPambi. Study on prevalence of anemia among pregnant women attending antenatal clinic at Rural Health Training Centre (RHTC) and ChalmedaAnandRao Institute of Medical Sciences Teaching Hospital, Karimnagar, Telangana, India. *International Journal of Contemporary Medical Research*. 2016; 3 (8): 2388-2391.

[39] Reviez L, Gyte GM, Cuervo LG. Treatments for Iron-deficiency anaemia in pregnancy. *Cochrane Database of Systematic Reviews*. 2007; 2: CD003094.

[40] Scholl TO, Hediger ML. Maternal anaemia as a factor in prematurity and perinatal mortality. *Scottish Medical Journal.* 1994; 8: 134.

[41] Stoltzfus RJ. Iron deficiency: Global prevalence and consequences. *Food and Nutrition Bulletin.* 2003; 24 (4): S99-S103.

[42] Tadesse SE, Seid O, Mariam Y, Fekadu A, Wasihun Y, Endris K, *et al*. Determinants of anemia among pregnant mothers attending antenatal care in Dessie town health facilities, Northern Central Ethiopia, unmatched case -control study. *PLoSONE*. 2017; 12 (3): e0173173.

[43] Van den Broek NR, Letsky EA. Etiology of anaemia in pregnancy in south Malawi. *The American Journal of Clinical Nutrition.* 2000; 72 (1): 247-256.

[44] Vanderjagt DJ, Brock HS, Melah GS, El-Nafaty AU, Crossey MJ, Glew RH. Nutritional factors associated with anaemia in pregnant women in northern Nigeria. *Journal* of *Health, Population and Nutrition*. 2007; 25 (1): 75-81.

[45] World Health Organization from Simon Brooker, Peter J. Hotez, Donald A. P. Bundy. Hookworm-Related Anaemia among Pregnant Women: A Systematic Review. 2008; DOI: 10.1371/journal.pntd.0000291. Available online: http://www/who.int/publications/iitem/pntd-0000291

[46] World Health Organization. The prevalence of anemia in women: A tabulation of available information. *WHO/MCH/MSM/92.22nd edition*. 1992.

[47] World Health Organization. Prevention and management of severe anaemia in pregnancy; report of a technical working group. *WHO/FHF/MSH/1993*. 1993; p. 5.

[48] Udeh FC, Ikwuka AO, Epete MA, Igwe EC. Effects of Local Tobacco Snuff Ingestion during Pregnancy on Renal Functions and Histology Architecture of Female Wistar Rats and on the Birth Weight of Their Pups. *American Journal of Medical Sciences and Medicine*. 2023; 11 (1): 1-5 DOI: 10.12691/ajmsm-11-1-1.

[49] Ikwuka AO. Features of kidney damage in patients with arterial hypertension and type 2 diabetes mellitus and optimization of treatment. *Specialized Academic Council IFNMU*. 2018; Available online: http://www.ifnmu.edu.ua/images/zagalna_informacia/spec_vcheni_radi/2017-2019/%D0%9420.601.01/Ikvuka/Avtoreferat.pdf

[50] Virstyuk NH, Ikwuka AO. Dapagliflozin influence on the clinical course of diabetes mellitus type 2 and essential hypertension in patients. *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions*. Springer International Publishing AG. 2018; p. 2007-2008 DOI: 10.1007/978-3-319-70548-4_582.

[51] Virstyuk NH, Ikwuka AO, Losyuk LV, KobrynskaOYa, Markiv HD. Dapagliflozin utility in patients with diabetes mellitus type 2 and essential hypertensive disease. *Actual Problems of Modern Medicine*. 2017; 4 (60) 1: 76-79.

[52] Ikwuka AO. Clinical effectiveness of GLP-1 RAs in patients with metabolic syndrome diseases. *Endocrine Practice*. 2019; 25 (1): 104-105 DOI: 10.1016/S1530-891X(20)46611-X.

[53] Ikwuka AO. Clinical effectiveness of SGLT-2 inhibitors in patients with diabetes mellitus type 2 and essential hypertensive disease. *Endocrine Practice*. 2018; 24 (1): 74.

[54] Ikwuka AO. Clinical dynamics in patients with diabetes mellitus type 2 and concomitant essential hypertensive disease treated with dapagliflozin. *Journal of the 22nd International Medical Congress of Students and Young Scientists*. 2018; p. 32.

[55] Ikwuka AO, Virstyuk NG, Luchko OR. Features of the functional state of kidneys in patients with diabetes mellitus type 2 and essential arterial hypertension. *Materials of scientific-practical conference with international participation "Babenkivski reading"*. 2017; p. 48.

[56] Ikwuka AO. Dyslipidemia risk severity in patients with diabetes mellitus type 2 and essential hypertension. *Journal of the 21st International Medical Congress of Students and Young Scientists*. 2017; p. 59.

[57] Ikwuka AO. Effectiveness of dapagliflozin in patients with diabetes mellitus type 2 and essential hypertension. *Book of abstracts of the 7th International Students' Scientific Conference of Young Medical Researchers*. 2017; p. 102.

[58] Ikwuka AO, Haman IO. Features of kidney damage in patients with diabetes mellitus type 2 and essential hypertension. *Journal of 86th Scientific and Practical Conference of Students and Young Scientists with International Participation "Innovations in medicine"*. 2017; p. 144.

[59] Virstyuk NG, Ikwuka AO, Haman IO, Adebomi MS. Diabetes mellitus type 2, arterial hypertension and dyslipidemia. *Materials of 2nd International Scientific and Practical Conference "Therapeutic readings: modern aspects of diagnosis and treatment of diseases of internal organs"*. 2016; p. 46-47.

[60] Ikwuka AO. Risk factors for the pathogenesis of diabetes mellitus type 2. *Materials of 84th Scientific and Practical Conference of Students and Young Scientists with International Participation "Innovations in medicine"*. 2015; p. 19.

[61] Ikwuka AO, Virstyuk N. Prognostic markers of nephropathy in patients with dual metabolic syndrome diseases (essential hypertensive disease and concomitant type 2 diabetes mellitus). *Endocrine Practice*. 2022; 28 (5): S65-S66 DOI: 10.1016/j.eprac.2022.03.164.

[62] Ikwuka AO, Virstyuk NG. Influence of SGLT2 inhibitor and A2RB (AT1) on fibrogenesis and heart failure in patients with essential hypertensive disease combined with diabetes mellitus type 2. *E-Poster No. 143 of the 44th & 45th Annual General and Scientific Meeting of the West African College of Physicians (WACP), 1 - 3 November, 2021*. 2021; DOI: 10.13140/RG.2.2.26912.87047.

[63] Virstyuk NH, Ikwuka AO, Luchko OR, Kocherzhat OI. Peculiarities of renal insufficiency in patients with diabetes mellitus type 2 and arterial hypertension. *Materials of scientific-practical conference with international participation "Achievements and prospects of experimental and clinical endocrinology" Twentieth Danilevsky readings*. 2021; p. 86-87.