Medical Laboratory Technology Journal
12(1), 2026, 108-120
Received 2026-28-03; Revised 2026-12-05; Accepted 2026-29-05
Available online at : http://ejurnal-analiskesehatan.web.id

Prevalence of Anemia among Blood Donors in Benin City: Cross-Sectional Study of Iron Status and Hematological Parameters

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Abstract: Despite the importance of blood donation in ensuring a constant supply of blood for emergency situations and surgical procedures, frequent blood donation leads to iron depletion and anemia, posing significant health risks to donors. The study aimed to evaluate the iron status and hematological parameters among blood donors in Benin City. A cross-sectional study involving 100 blood donors was conducted across blood donation facilities in Benin City. Hematological parameters and ferritin levels were analyzed using an automated hematology analyzer (BK3100, China) and enzyme-linked immunosorbent assay (ELISA), respectively. Data were analyzed using SPSS version 26.0. Chi-square, one-way ANOVA, and Pearson correlation tests were applied, with significance set at $p < 0.05$. Results of the participants, 64.0% were males and 36.0% females. The self-reported prevalence of anemia was 1.0%, while all participants had hemoglobin values below WHO reference cutoffs ($p<0.05$). Male donors showed significantly higher hemoglobin (12.37±0.23 vs 11.05±0.17 g/dL), packed cell volume (37.43±0.60 vs 33.20±0.48%), and ferritin levels (180.23±12.79 vs 117.48±17.43 ng/mL) compared to females ($p < 0.05$). Conversely, white blood cell and platelet counts were significantly higher in females ($p < 0.05$). No significant differences were observed across age groups and donation frequencies. Blood donation frequency showed weak negative, non-significant correlations with hemoglobin, packed cell volume, and ferritin levels ($p > 0.05$). Conclusion Despite the prevalence found in this study, these findings underscore the need to monitor hematological parameters and ferritin levels in blood donors, particularly among women, to ensure donor health and maintain a safe and adequate blood supply.
Keywords: Anemia; blood donors; donor management; ferritin; hemoglobin.

INTRODUCTION

Iron depletion can complicate donor management and impact the sustainability of the blood supply (Karregat et al., 2022). Frequent blood donation can lead to significant health risks, primarily due to iron depletion and the development of anemia. Notably, each donation removes approximately 210 – 240 mg AA. hemoglobin synthesis and oxygen transport (Ekroos et al., 2024). The loss of iron with repeated donations causes a gradual reduction in hemoglobin concentration, increasing the likelihood of iron deficiency anemia (IDA)(Spencer & Mast, 2022). Concerns regarding iron deficiency and anemia result in blood donors' unwillingness to donate blood,

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thereby affecting the sustainability of the blood supply in health facilities (Didriksen et al., 2021). Recovery of iron stores may take several months to over a year, depending on sex and individual factors, making frequent donors vulnerable to iron deficiency if adequate replenishment strategies are not implemented (Karregat et al., 2022).

Blood donation plays a vital role in global healthcare systems by ensuring the availability of safe and adequate blood supplies for various medical treatments, surgeries, and emergencies (Müller and Reuter-Oppermann, 2024). The sustainability of blood donation programs depends not only on donor recruitment but also on maintaining donor health, particularly concerning iron status and hematological parameters (Spencer & Mast, 2022).

Collectively, studies across regions have observed a prevalence of anemia among blood donors, which could be due to frequent donation, age, sex, and dietary habits (Ekroos et al., 2024; Van Den Hurk et al., 2024). However, these findings are often population-specific and may not be generalizable across settings. In Nigeria, especially in Benin City, data on the prevalence of anemia among blood donors remain limited, despite the increasing demand for blood transfusion services. The lack of localized evidence makes it difficult to optimize donor selection criteria and implement targeted interventions to prevent donor iron depletion. This study addresses the lack of localized data on anemia prevalence and ferritin levels, tailored donor management strategies, including improved screening protocols, iron supplementation, adjusted donation intervals, and targeted education to protect donor health and sustain the blood supply among blood donors in Benin City, Nigeria, highlighting the importance of monitoring these parameters to identify donors at risk of iron depletion, especially frequent donors.

Given these gaps, there is a pressing need for a comprehensive evaluation of anemia prevalence, iron status, and donation patterns among blood donors in this setting. The study aims to evaluate the prevalence of anemia among blood donors in Benin City using iron status and hematological parameters.

MATERIALS AND METHODS

We performed a cross-sectional analytical study across blood donor facilities in Benin City, including one hundred (100) donors, to assess iron status and hematological parameters. This approach evaluates correlations between iron status indicators and hematological profiles to inform donor management strategies for maintaining donor safety and optimizing blood supply. Benin City, the capital of Edo State in southern Nigeria, has a diverse healthcare infrastructure, including public and private facilities. Despite having general hospitals, specialist clinics, and tertiary healthcare centers, blood transfusion needs remain challenging. Blood donation in Benin City occurs through hospital-based blood banks and voluntary donor organizations, primarily driven by family replacement and emergency needs. Although collection facilities exist in major hospitals, increased public awareness is needed to improve voluntary donation rates and ensure a steady blood supply.

The study population included eligible blood donors in Benin City, comprising voluntary and family replacement donors at healthcare facilities. The sampling strategy was purposive and consecutive according to age, sex, and socioeconomic status. Participants were recruited from major hospitals and blood centers. The target population included donors meeting the local health authority criteria, encompassing voluntary, replacement, and paid donors within Benin City.

The sample size for this cross-sectional study was determined using Cochran's formula for sample size estimation. In the absence of a documented prevalence of the outcome among blood donors in the study area, a proportion of 0.5 was assumed to ensure maximum variability. At a 95% confidence level and 5% margin of error, the minimum sample size calculated was 384. However, due to the limited availability of eligible blood donors within the study period and logistical constraints, a total of 100 participants were recruited using consecutive sampling of all consenting eligible donors, which is considered adequate for generating preliminary findings.

$$n = \frac{Z^2 p (1-p)}{d^2}$$

where:
Z = Z-score corresponding to the confidence level (1.96 for 95%)
p = proportion of 0.5 was assumed
d = margin of error (5%)

$$n = \frac{Z^2 p (1-p)}{d^2} = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384$$

The inclusion criteria for the study were healthy adult blood donors residing in Benin City, Nigeria, who met the standard eligibility requirements for blood donation, including age and health status. Participants included volunteers, family replacements, or paid blood donors who consented to participate, attended designated blood donation centers or hospitals within Benin City, and agreed to participate in blood sample collection and questionnaire administration. The exclusion criteria included individuals with known anemia (with hemoglobin cut off value below 12 g/dl and 13 g/dl for females and males respectively) or currently diagnosed hematological disorders, donors on medication that could affect iron status or hematological parameters, those who declined to provide informed consent, donors residing outside the geographic area of Benin City, persons with acute or chronic illnesses that could confound iron status or hematological measurements, and recent blood donors who had donated outside the defined frequency limits or had incomplete donation history data.

Venous blood samples (5 mL) were collected using venipuncture with sterile vacutainer tubes and aseptic techniques. Samples were processed within 2 h to maintain integrity, with quality control procedures in place. Thereafter, 2 mL was dispensed into ethylenediamine tetra-acetic acid (EDTA) for hematological parameter analysis and serum separator tubes for ferritin measurement. Samples were labeled with unique identifiers and transported to the laboratory under controlled conditions. Demographic information and donation history were collected using a structured questionnaire administered through face-to-face interviews and self-completion, depending on the setting and participant preference. The questionnaire covered data such as age, sex, occupation, educational level, frequency, and type of blood donations (voluntary, replacement, or paid), and relevant medical history. Trained research assistants conducted interviews to clarify questions and ensure completeness of responses. Data confidentiality was maintained throughout the process, with responses linked to blood samples via unique codes to protect participant identity.

Hematological parameters were measured using an automated hematology analyzer (BK3100, China) calibrated according to the manufacturer 's instructions to ensure accuracy in whole blood samples. Serum ferritin concentration was determined using a commercially available enzyme-linked immunosorbent assay (ELISA) kit manufactured by AccuBind Ferritin (Monobind Inc.), with lot number (Catalog No:

2425-300; Lot No: FER24015), according to the manufacturer's instructions (Tsurusawa et al., 2021).

The assay was based on the sandwich ELISA principle in which ferritin present in the sample binds to anti-human ferritin antibodies coated on the microplate wells. Following incubation and washing, enzyme-conjugated secondary antibodies specific to ferritin are added. After a second incubation and washing step, tetramethylbenzidine (TMB) substrate is introduced, resulting in a color reaction proportional to the ferritin concentration. The reaction is stopped using a stop solution, and absorbance is measured spectrophotometrically at 450 nm.

Approximately 3 mL of venous blood was collected into plain tubes and allowed to clot. Samples were centrifuged at 3000 rpm for 10 minutes to obtain serum. Serum samples were analyzed immediately or stored at −20°C until analysis.

Before the analysis, all reagents and serum samples were allowed to equilibrate to room temperature. Standards, controls, and serum samples (25 µL) were then dispensed into appropriately labeled microplate wells, followed by the addition of enzyme conjugate reagent to each well. The microplate was incubated at 37°C for the duration recommended by the manufacturer. After incubation, the wells were washed several times using the wash buffer to remove unbound materials. Subsequently, the TMB substrate solution was added and incubated in the dark to allow color development. The reaction was terminated by adding a stop solution, and the optical density was measured at 450 nm using an ELISA microplate reader. Ferritin concentrations were determined based on the standard calibration curve generated from known standards. To ensure analytical accuracy and precision, low and high-ferritin control sera provided with the kit were included in each assay batch.

Statistical analyses were performed using SPSS version 26.0 (IBM Corp.). Data normality was evaluated using the Kolmogorov-Smirnov test, confirming the appropriateness of the parametric tests. Descriptive statistics were used to determine the prevalence of anemia. Pearson's correlation coefficient was used to assess the relationship between serum ferritin levels and hemoglobin concentration. Associations between donation frequency and anemia status were evaluated using the Pearson chi-square test, while the independent samples t-test and one-way analysis of variance (One-Way ANOVA) were performed to assess differences in mean values between groups. Statistical significance was set at $P < 0.05$.

Ethical approval was obtained from the Edo State Ministry of Health Ethics Committee in Benin City to ensure compliance with research standards (HM/04/1206. Dated, 15, April, 2025). Informed consent was obtained from all participants, providing clear information about the study's purpose, procedures, risks, benefits, and withdrawal rights. Consent forms were written in understandable language, and research personnel were available to answer questions. To protect confidentiality, data and samples were coded with unique identifiers, with access restricted to authorized personnel and secure storage following data protection guidelines.

RESULTS AND DISCUSSION

The socio-demographic characteristics of the 100 study participants indicated that 36.0% were female and 64.0% were male. Among the total subjects, 8.0% were students, 80.0% were traders, 4.0% were artisans, and 8.0% were engaged in other occupations. Regarding marital status, 23.0% were single, while 77.0% were married. Educational attainment showed that 41.0% had completed secondary education, and 59.0% had attained tertiary education. Additionally, 53.0% of participants had previously donated blood. The majority of donors (94.0%) donated blood between 0 and 4 times per year, with 6.0% donating 5 to 8 times annually. Age distribution revealed that 22.0% were between 18 and 25 years, 39.0% between 26 and 40 years, and 39.0% between 41 and 60 years. Donation motives included family replacement (36.0%), voluntary donation (34.0%), and paid donation (30.0%). Regarding recent donation history, 47.0% had not donated recently; 2.0% last donated in 2019, 5.0% in 2022, 4.0% in 2023, 40.0% in 2024, and 2.0% anticipated donation in 2025. Medication use was reported by 1.0% of participants, with 99.0% not on any medication. The prevalence of anemia was low, with 99.0% of subjects being non-anemic (Tables 1 & 2).

Table 1. Distribution of Demographic Factors of Respondents

Characteristics	Frequency	Percent	X^2	P-value
Sex				
Female	36	36.0		
Male	64	64.0	7.84	0.005
Occupation				
Students	8	8.0		
Traders	80	80.0		
Civil servants	4	4.0	161.76	0.001
Artisans	8	8.0		
Marital status				
Singles	23	23.0		
Married	77	77.0	29.16	0.001
Educational status				
Secondary	41	41.0		
Tertiary	59	59.0	3.94	0.072
Donated blood before?				
Yes	53	53.0		
No	47	47.0	0.360	0.549
Blood donation frequency				
0-4 times	94	94.0		
5-8 times	6	6.0	77.44	0.001

Values are expressed in percentage, X^2- Chi-square, P>0.05- Non-significant, P<0.05- significant

Table 3 presents the levels of hematological parameters and ferritin among blood donors. White blood cell count, hemoglobin, packed cell volume, and ferritin levels did not differ significantly ($p > 0.05$) among the donors, with the exception of platelet levels, which showed a significant difference ($p < 0.05$).

Table 4 presents the levels of hematological parameters stratified by sex among blood donors. Hemoglobin, packed cell volume, and ferritin levels were significantly higher in male donors than in female donors ($P < 0.05$), whereas white blood cell and platelet counts were significantly elevated in female donors relative to their male counterparts ($P < 0.05$).

Table 5 presents the hematological parameters across different age groups among blood donors. No significant differences were observed in white blood cell counts, hemoglobin, packed cell volume, platelet counts, or ferritin levels across the age groups ($p > 0.05$).

Table 2. Distribution of Demographic Factors of Responden

Characteristics	Frequency	Percent	X^2	p-value
Age (Yrs)				
18-25	22	22.0	5.78	0.056
26-40	39	39.0		
41-60	39	39.0		
Total	100	100.0		
When last do you donation? (year)				
Can't tell	47	47.0	131.48	0.001
2019	2	2.0		
2022	5	5.0		
2023	4	4.0		
2024	40	40.0		
2025	2	2.0		
Reasons for donation?				
Family replacement	36	36.0	0.560	0.756
Voluntary donation	34	34.0		
Paid donation	30	30.0		
Any medication intake?				
Yes	1	1.0	96.04	0.001
No	99	99.0		
Have you ever diagnosed of anemia?				
Yes	1	1.0	96.04	0.001
No	99	99.0		

Values are expressed in percentage, X^2- Chi-square, P>0.05- Non-significant, P<0.05- significant

Table 6 presents the levels of hematological parameters according to blood donation frequency among blood donors. No significant differences were observed in white blood cell count, hemoglobin, packed cell volume, platelet count, or ferritin levels across different donation frequency groups ($p > 0.05$). Table 7 presents the correlations between packed cell volume, hemoglobin, ferritin, and blood donation frequency. The analysis revealed a non-significant ($p > 0.05$) weak negative correlation between blood donation frequency and packed cell volume, hemoglobin, and ferritin levels.

The study found that males donate more blood compare female counterparts, with an overall prevalence of 1%. This suggests that healthy donors were selected in this region for blood donation. These findings align with previous studies in several respects. The predominance of male donors concurs with the research by Paalvast et al. (2022), who attributed higher male participation to sociocultural influences and physiological eligibility differences. The minimal prevalence of anemia (1%) is consistent with the reports of Van Den Hurk et al. (2024), reflecting effective donor screening protocols in healthy populations. The majority of donors donated infrequently (0–4 times per year), mirroring the observations by Paalvast et al. (2022), suggesting that most donors avoid excessive donation, thereby preserving iron stores and maintaining hematological health. The distribution of donation types, including family replacement, voluntary, and paid donations, reflects patterns noted in some

African contexts, as reported by Müller and Reuter-Oppermann (2024), where family replacement remains common alongside other donation types.

Table 3. Level of Haematological Parameters and Ferritin in Blood Donors

Parameter	Donor	N	Mean	Std. Error	F-value	P-value
WBC ($X10^9/L$)	Family replacement	36	4.84[a]	0.24	1.00	0.371
	Voluntary donation	34	5.64[a]	0.25		
	Paid donation	30	3.77[a]	0.17		
Hb (g/dl)	Family replacement	36	11.85[a]	0.26	1.49	0.229
	Voluntary donation	34	12.27[a]	0.30		
	Paid donation	30	11.53[a]	0.33		
PCV (%)	Family replacement	36	35.13[a]	0.77	1.28	0.283
	Voluntary donation	34	36.90[a]	0.75		
	Paid donation	30	35.71[a]	0.92		
Platelets ($x10^9/L$)	Family replacement	36	209.61[ab]	11.48	4.91	0.009
	Voluntary donation	34	243.79[b]	12.46		
	Paid donation	30	192.86[a]	10.28		
Ferritin (ng/ml)	Family replacement	36	154.22[a]	19.47	0.173	0.841
	Voluntary donation	34	166.48[a]	19.87		
	Paid donation	30	151.99[a]	15.48		

Values are expressed in mean ±SEM. WBC-white blood cells, PCV- Packed cell volume, mean with same superscript across the group are not significantly difference from each other(P>0.05), Mean with difference superscript across the group are significantly difference from each other(P<0.05), P>0.05- Non-significant, P<0.05- significant.

Table 4. Levels of Hematological and Ferritin in Sex Difference among Blood Donor

Parameter	Sex	N	Mean	SEM	T-value	P-value
WBC($X10^9/L$)	Female	36	5.58	0.24	4.20	0.001
	Male	64	4.35	0.17		
Hb(g/dl)	Female	36	11.05	0.174	-4.52	0.001
	Male	64	12.37	0.23		
PCV (%)	Female	36	33.20	0.48	-5.46	0.001
	Male	64	37.43	0.60		
Platelets($x10^9/L$)	Female	36	243.66	10.43	3.09	0.003
	Male	64	200.76	8.58		
Ferritin(ng/ml)	Female	36	117.45	17.43	-2.93	0.004
	Male	64	180.38	12.79		

Values are expressed in mean ±SEM. WBC-white blood cells, Hb- hemoglobin.PCV-Packed cell volume, P>0.05- Non-significant, P<0.05- significant, Hb cutoff (for male < 13g/dl, for female < 12g/dl)

Table 5 Levels of Hematological Parameters and Ferritin in Age Group among Blood Donors

Parameter	Age (year)	N	Mean	SEM	F-value	P-value
WBC($X10^9$/L)	18-25	22	4.80[a]	0.30	0.654	0.522
	26-40	39	4.59[a]	0.23		
	41-60	39	4.99[a]	0.25		
Hb(g/dl)	18-25	22	11.45[a]	0.29	0.957	0.388
	26-40	39	12.07[a]	0.32		
	41-60	39	11.97[a]	0.24		
PCV (%)	18-25	22	34.22[a]	0.89	2.39	0.097
	26-40	39	36.91[a]	0.83		
	41-60	39	35.84[a]	0.68		
Platelets($x10^9$/L)	18-25	22	211.90[a]	15.85	0.200	0.819
	26-40	39	213.12[a]	10.26		
	41-60	39	221.71[a]	11.68		
Ferritin(ng/ml)	18-25	22	139.99[a]	25.38	0.670	0.514
	26-40	39	171.91[a]	18.64		
	41-60	39	153.54[a]	14.34		

Values are expressed in mean ±SEM. WBC-white blood cells, PCV- Packed cell volume, mean with same superscript across the group are not significantly difference from each other(P>0.05), Mean with difference superscript across the group are significantly difference from each other(P<0.05), P>0.05- Non-significant, P<0.05-significant.

Table 6. Levels of Hematological Parameters and Ferritin in Blood Donation Frequency among Blood Donors

Parameter	Blood Donation Frequency	N	Mean	SEM	T-value	P-value
WBC	0-4 times	94	4.82	0.15	0.621	0.536
($X10^9$/L)	5-8 times	6	4.42	0.56		
Hb	0-4 times	94	11.94	0.17	1.08	0.284
(g/dl)	5-8 times	6	11.16	0.62		
PCV	0-4 times	94	36.06	0.48	1.35	0.182
(%)	5-8 times	6	33.41	1.92		
Platelets	0-4 times	94	215.08	7.29	-0.640	0.524
($x10^9$/L)	5-8 times	6	233.83	17.55		
Ferritin	0-4 times	94	161.91	11.11	1.56	0.122
(ng/ml)	5-8 times	6	92.05	29.20		

Values are expressed in mean ±SEM. WBC-white blood cells, PCV- Packed cell volume, P>0.05- Non-significant, P<0.05- significant.

However, certain contrasts with other studies are evident. The relatively high proportion of paid donors (30%) diverges from trends in many developed countries that emphasize voluntary, non-remunerated blood donation, as noted by Sheldon et al. (2022), highlighting regional differences in blood donation systems. The lower representation of young donors aged 18–25 years contrasts with findings that reported a larger youth donor base, possibly due to demographic or awareness disparities in Benin City (Sheykhsoltan et al., 2021). Additionally, the higher educational attainment (59% tertiary education) compared to some regional studies (Baidoo et al., 2024) suggests a more educated donor base in Benin City, which may affect donation behavior and health awareness.

Table 7. Correlation between Packed Cells Volume, Haemoglobin, Ferritin and Blood Donation Frequency

		PCV (%)	Hb (g/dl)	Ferritin (ng/ml)	Blood Donation Frequency
Blood Donation Frequency	r- value	-0.09	-0.13	-0.001	1
	p-value	0.383	0.195	0.992	

PCV- Packed cell volume, Hb- haemoglobin, r- Pearson's correlation, P>0.05- Non-significant, P<0.05- significant

The study found that white blood cell counts, hemoglobin, packed cell volume, and ferritin levels did not differ significantly among blood donors (p>0.05), whereas platelet levels showed a significant difference (p<0.05). This finding aligns with several studies reporting stable hemoglobin and ferritin levels across donor groups, suggesting effective donor screening and maintenance of iron stores in healthy donors (Drechsler et al., 2023). For example, Mantadakis et al. (2022) observed minimal variation in hemoglobin and ferritin among blood donors, reflecting adequate donor health and iron status. Similarly, Mantadakis et al. (2022) reported consistent hematological parameters in donors with low-to-moderate donation frequencies.

The significant difference in platelet levels contrasts with some studies in which platelet counts remained relatively stable among donors. This variation may be influenced by donor-specific factors, such as donation type, physiological stress, or transient inflammatory responses, as platelets play a key role in hemostasis and immunity (Kreft et al., 2023). Some literature suggests that platelet counts can fluctuate due to donation frequency or underlying health conditions, which may explain the observed differences in this study (Thuer et al., 2021).

In contrast, other studies have reported significant changes in ferritin and hemoglobin with increased donation frequency (Prinsze et al., 2021), highlighting potential iron depletion risks not observed here. The lack of significant differences in ferritin and hemoglobin levels may reflect the predominance of donors with low donation frequency (0–4 times/year) in this context.

The significant elevation of hemoglobin, packed cell volume (PCV), and ferritin levels in male donors compared to female donors is in accordance with the findings of multiple studies. This sex-based difference is often attributed to physiological and hormonal factors; males generally have higher muscle mass and testosterone levels, which stimulate erythropoiesis, leading to increased hemoglobin and PCV (Senefeld & Hunter, 2024). Similarly, higher ferritin levels in males reflect greater iron stores, consistent with reports by (Senefeld & Hunter, 2024)., which emphasize that females, particularly premenopausal women, are more prone to lower iron stores due to menstrual blood loss and other factors.

Conversely, the significantly higher white blood cell (WBC) counts and platelet levels in female donors compared to males are also supported by the literature, in which females tend to exhibit higher baseline WBC and platelet counts, potentially influenced by hormonal variations and immune system differences (Gasbarrino et al., 2024). These differences in hematological parameters between sexes have been documented in various populations and are considered physiological norms rather than pathological findings.

However, some studies have reported minimal sex differences in certain hematological parameters, highlighting the influence of population demographics, nutritional status, and donation frequency on these measures (Fransen et al., 2023). Nonetheless, the present findings are largely consistent with established evidence, underscoring the need to consider sex-specific reference ranges and screening thresholds in donor evaluation to ensure accurate assessment and donor safety.

The study findings revealed no significant differences in white blood cell counts, hemoglobin, packed cell volume, platelets, and ferritin levels across different age groups among blood donors ($p>0.05$). This finding aligns with several previous studies, which have indicated that hematological parameters and iron stores remain relatively stable across adult age groups in healthy donor populations when other confounding factors are controlled. For instance, Borai et al. (2023) reported consistent hemoglobin and ferritin levels across age ranges, suggesting that age alone may not be a major determinant of these parameters in blood donors. Similarly, Prinsze et al. (2021) observed stable hematological indices among donors with varying ages, especially when donation frequency was low to moderate (Prinsze et al., 2021).

However, some studies contrast these findings by reporting age-related variations in hematological parameters. Certain studies note that older donors may experience declines in hemoglobin or iron stores due to physiological changes, comorbidities, or nutritional factors (Ruzhanskaya et al., 2024). These discrepancies may be influenced by differences in study populations, health status, or regional factors. The lack of significant age-related differences in this study could reflect the relatively healthy and homogenous donor population in Benin City, where other variables, such as donation frequency and sex, have more pronounced effects.

The study found that there were no significant differences in white blood cell counts, hemoglobin, packed cell volume, platelets, and ferritin levels across different blood donation frequencies among the donors ($p>0.05$). This finding aligns with the study by Mantadakis et al. (2022), who reported stable hematological parameters and iron stores in donors with low to moderate donation frequencies, suggesting effective donor screening and adequate recovery of iron stores between donations. This evidence suggests that regular blood donation up to four times per year does not significantly impact hematological indices in donors. Studies have indicated that within this donation frequency range, parameters such as hemoglobin and ferritin levels remain relatively stable among regular donors. For example, interventions, such as ferritin-guided iron supplementation in blood donors, help maintain hemoglobin levels and reduce low hemoglobin deferrals, facilitating safe donations within regular intervals (Drechsler et al., 2023). In contrast, some studies have documented significant decreases in hemoglobin and ferritin levels with increased donation frequency (Spencer & Mast, 2022), highlighting the risk of iron depletion and anemia among frequent donors. The lack of significant differences in this study may be due to the predominance of donors with low donation frequencies (0–4 times/year), which reduces the likelihood of cumulative iron deficiency. Additionally, regional differences in donor nutrition, supplementation practices, and donation intervals may contribute to these contrasting findings.

The study findings indicated that the frequency of blood donation was not significantly ($p>0.05$) associated with packed cell volume (PCV), hemoglobin (Hb), and ferritin levels. This indicates that as the frequency of blood donation increases, there is a slight but statistically insignificant decrease in these hematological parameters and iron stores among donors. The weak negative correlation suggests minimal impact of donation frequency on PCV, Hb, and ferritin within this study population, possibly due to the predominance of donors who donate infrequently (0–4 times per year). These findings align with the study's results, indicating stable hematological and ferritin levels across different donation frequencies and support the notion that current donation intervals may be adequate to maintain donor iron status and hematological health in this cohort. (Moazzen et al., 2022).

This study was limited by its relatively small sample size and cross-sectional design, which may restrict the generalizability of the findings and prevent causal inferences between blood donation frequency and iron depletion. The predominance of low-frequency donors in the study population may also have reduced the likelihood of detecting significant hematological and ferritin alterations associated with repeated blood donation. Furthermore, inflammatory markers such as C-reactive protein, which could influence ferritin interpretation, were not assessed.

CONCLUSION

This study showed a low prevalence of self-reported anemia among blood donors in Benin City, although measured hemoglobin levels were relatively lower than the WHO cutoff values. Male donors exhibited significantly higher hemoglobin, packed cell volume, and ferritin levels than female donors, while donation frequency showed weak, non-significant associations with hematological and iron parameters. These findings highlight the importance of routine ferritin assessment and hematological monitoring, particularly among female and regular donors, to promote donor safety and maintain a sustainable blood supply.

ACKNOWLEDGMENTS

The authors express their sincere gratitude to the management of the Edo Specialist Hospital and Blood Transfusion Center, Benin City; the Ethics Committee of the Edo State Ministry of Health; and the patients who consented to participate in this study.

FUNDING

This study did not receive any external funding.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRİBUTİONS

FOO and AAE were responsible for the conceptualization of the study. The methodology was developed SE and OEI. Data curation was performed by BIGA. FOO prepared the original draft, and SE and BIGA contributed to the review and editing of the manuscript. FOO provided supervision throughout the study. Funding acquisition was managed by FOO. All authors have read and approved the final version of the manuscript.

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