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Impact of Repeated Blood Donations on Erythrocyte Indices Among Blood Donation Candidates in Luanda, Angola

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Abstract

Background

Blood donation safety is a critical challenge in sub-Saharan Africa, where anaemia and iron deficiency are prevalent among donor populations. This study evaluated the impact of repeated blood donations on erythrocyte indices among blood donation candidates in Luanda, Angola.

Methods

This cross-sectional study enrolled 189 blood donors between June 2025 and February 2026. Participants were classified according to donation frequency, age, gender, and donor type. Erythrocyte indices including mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), red cell distribution width (RDW), haemoglobin, haematocrit, and reticulocyte count, were compared using the Mann–Whitney U test ($p<0.05$).

Results

Of 189 donors, 92.6% had ≤2 donations and 7.4% had >2 donations. No differences in erythrocyte indices were observed between donation frequency groups ($p>0.05$). Overall, median erythrocyte indices were MCV (75.2 fL, 69.6–82.8), MCH (24.1 pg, 21.9–26.8), MCHC (31.9 g/dL, 31.3–32.5), RDW (42.9 fL, 40.3–46.6), haemoglobin (11.5 g/dL, 10.8–12.2), haematocrit (35.4%, 33.2–38.0), and reticulocytes (0.07%, 0.05–0.09). Gender was determinant of

erythrocyte status, with male donors showing higher haemoglobin (12.0 vs 11.0 g/dL, p<0.001) and haematocrit (36.7% vs 34.0%, p<0.001) than females.

Conclusions
Donation frequency was not associated with erythrocyte index differences, but low population-level haemoglobin and MCV values indicate a high baseline burden of anaemia and iron depletion in Angolan donors.

Keywords: Blood Donation, Erythrocyte Indices, Donor Safety, Angola

Introduction
Blood donation is essential for healthcare systems worldwide. However, maintaining an adequate and safe blood supply remains a major challenge in sub-Saharan Africa because of limited resources, high disease burden, and chronic donor shortages [1,2]. The World Health Organization (WHO) African Region collects approximately 4.9 million blood units annually, but demand continues to exceed supply, with many countries still relying heavily on family replacement donors [3,4].

Repeated whole blood donation removes approximately 200–250 mg of iron per donation, increasing the risk of iron depletion and anaemia when appropriate monitoring is lacking [5]. Previous studies conducted in Africa have reported anaemia and iron deficiency among blood donors, highlighting iron depletion as an important regional public health concern [6–11]. Erythrocyte indices, including mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), red cell distribution width (RDW), haemoglobin, haematocrit, and reticulocyte count, are simple and cost-effective markers of iron-deficient erythropoiesis and can facilitate the early identification of donors at risk before overt anaemia develops [12,13].

Despite increasing evidence from sub-Saharan Africa, data on the impact of repeated blood donation on erythrocyte indices in Angola are scarce. Therefore, this study evaluated the impact of repeated blood donations on erythrocyte indices and the influence of age, gender, and donor type on these parameters among blood donation in Luanda, the capital city of Angola.

Materials and Methods
Study Design and Setting
This was a cross-sectional study carried out at the Angolan National Blood Institute located in Luanda, Angola, from June 2025 to February 2026. During the study period, 189 eligible blood donation candidates were consecutively enrolled. The study protocol complied with the ethical principles of the Declaration of Helsinki and received approval from the General, Technical and Scientific Directorate of the Angolan National Blood Institute (approval No. 201/GDG/INS/2026). Prior to participation, all candidates were informed about the purpose and procedures of the study and provided informed consent. Participant anonymity and the confidentiality of all collected information were ensured throughout the research.

Data Collection and Laboratory Procedures
Data were collected using a questionnaire administered by trained healthcare professionals. Information obtained included age, gender, donor category, and history of previous blood donations. Venous blood (5 mL) was collected into EDTA tubes following routine blood collection procedures. Haematological analysis was performed using the Mindray BC-780 Automated Haematology Analyser (Mindray, Germany), according to the manufacturer's instructions. The erythrocyte indices evaluated included MCV, MCH, MCHC, RDW, haemoglobin, haematocrit, and reticulocyte count.

Statistical Analysis
Statistical analyses were performed using RStudio v2026.04 and SPSS v31. Continuous variables are presented as median and interquartile range (IQR), whereas categorical variables are expressed as frequencies and percentages. Comparisons between blood donation candidates with ≤2 and >2 previous donations were performed using the Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Erythrocyte indices (MCV, MCH, MCHC, RDW, haemoglobin, haematocrit, and reticulocyte count) were also compared according to age group (<30 vs. ≥30 years), gender, and donor type (replacement vs. voluntary). All statistical tests were two-tailed, and a p<0.05 was deemed statistically significant.

Results
Repeated Blood Donations and Demographic or Erythrocyte Profile
Table 1 presents the demographic characteristics and erythrocyte indices according to the number of previous blood donations among blood donation candidates in Luanda, Angola. A total of 189 blood donation candidates were included in the study, of whom 175 (92.6%) had donated blood two times or less, whereas 14 (7.4%) had donated more than two times. The median age of the study population was 31 (25–38) years, and no statistically significant difference was observed between candidates with ≤2 and >2 previous donations [31 (24.5–38) vs. 34.5 (27.3–37.8), p=0.360] years, respectively. Likewise, the distribution of age groups did not differ according to donation frequency (p = 0.173).

Although donors aged ≥30 years represented 54.0% of the study population, they accounted for 71.4% of candidates with more than two previous donations, compared with 52.6% among those with two or fewer donations. Similarly, the distribution of gender was similar between donation groups (p=0.195). Male candidates represented 62.4% of the studied population and accounted for 78.6% of individuals with more than two previous donations, whereas females represented 37.6% of the study population and 21.4% of those with more than two donations. Donor type also showed no statistically significant association with donation frequency (p=0.084). Replacement donors represented the majority of participants (87.3%), while voluntary donors accounted for 12.7%. Among candidates with more than two previous donations, voluntary donors represented 28.6%, compared with 11.4% among those with two or fewer donations. Regarding erythrocyte indices, the median MCV was 75.2 (69.6–82.8) fL in the overall population and did not differ between candidates with ≤2 and >2 previous donations (75.2 vs. 71.9 fL, p=0.763). Likewise, the median MCH was similar between groups (24.1 vs. 23.4 pg, p=0.833), as was MCHC (31.9 vs. 32.3 g/dL, p=0.715). No statistically significant differences were observed for RDW (42.9 vs. 43.0 fL, p=0.328), haemoglobin concentration (11.5 vs. 11.4 g/dL, p=0.763), haematocrit (35.4% vs. 34.9%, p=0.630), or reticulocyte percentage (0.07% vs. 0.06%, p=0.223). Overall, none of the evaluated erythrocyte indices differed significantly according to the number of previous blood donations.

Independent Variables	**N (%)**	**Number of Donations**		
		≤2 (%)	**>2 (%)**	**P-value**
Overall	189 (100)	175 (92.6)	14 (7.4)	
Demographic Characteristics				
Age, median (IQR)	31 (25-38)	31 (24.5-38.0)	34.5 (27.3-37.8)	0.360
Age distribution				
<30yo	87 (46.0)	83 (47.4)	4 (28.6)	0.173
≥30yo	102 (54.0)	92 (52.6)	10 (71.4)	
Gender				
Female	71 (37.6)	68 (38.9)	3 (21.4)	0.195
Male	118 (62.4)	107 (61.1)	11 (78.6)	
Donor type				
Replacement	165 (87.3)	155 (88.6)	10 (71.4)	0.084
Voluntary	24 (12.7)	20 (11.4)	4 (28.6)	
Erythrocytes indices, median (IQR)				
Mean corpuscular volume - MCV (fL)	75.2 (69.6-82.8)	75.2 (69.9-82.7)	71.9 (68.7-83.3)	0.763
Mean corpuscular haemoglobin - MCH (pg)	24.1 (21.9-26.8)	24.1 (22-26.7)	23.4 (21.3-27.3)	0.833
Mean corpuscular hemoglobin concentration - MCHC (g/dL)	31.9 (31.3-32.5)	31.9 (31.3-32.5)	32.3 (31.4-32.8)	0.715
Red cell distribution width - RDW (fL)	42.9 (40.32-46.55)	42.9 (40.05-46.65)	43.0 (41.5-45.6)	0.328
Haemoglobin (g/dL)	11.5 (10.8-12.2)	11.5 (10.8-12.2)	11.43 (10.8-11.9)	0.763
Haematocrit (%)	35.4 (33.2-38)	35.4 (33.2-38.1)	34.9 (34.3-37.3)	0.630
Reticulocyte (%)	0.07 (0.05-0.09)	0.07 (0.05-0.09)	0.06 (0.05-0.08)	0.223

Table 1: Demographic Characteristics and Erythrocyte Indices of Blood Donors According to Donation Frequency

Erythrocyte Indices by Age, Gender, and Donor Type

Table 2 summarizes the comparison of erythrocyte indices according to the number of previous blood donations after stratification by age group, gender, and donor type. Within both age groups (<30 years and ≥30 years), no statistically significant differences were observed in MCV (p=0.261), MCH (p=0.532), MCHC (p=0.217), RDW (p=0.297), haemoglobin concentration (p=0.756), haematocrit (p=0.257), or reticulocyte percentage (p=0.556). Similarly, stratification by gender showed no statistically significant differences in MCV (p=0.935), MCH (p=0.977), MCHC (p=0.163), RDW (p=0.065), or reticulocyte percentage (p=0.784). However, haemoglobin concentration differed significantly between female and male candidates (11.0 vs. 12.0 g/dL, p<0.001). Likewise, haematocrit values were significantly higher among males than females (36.7% vs. 34.0%, p<0.001). According to donor type, no statistically significant differences were observed in MCV (p=0.761), MCH (p=0.831), MCHC (p=0.713), RDW (p=0.327), haemoglobin concentration (p=0.761), haematocrit (p=0.628), or reticulocyte percentage (p=0.222) between replacement and voluntary donors.

Independent Variables	Age Group			Gender			Donor Type		
	<30yo (%)	≥30yo (%)	P-value	Female	Male	P-value	Replacement	Voluntary	P-value
Overall	87 (46)	102 (54)		71 (37.6)	118 (62.4)		165 (87.3)	24 (12.7)	
MCV (fL) vs donations, median (IQR)	75.2 (73.5-79.1)	75.0 (72.7-77.2)	0.261	75.2 (73.2-79.1)	75.2 (73.6-78.4)	0.935	75.2 (74.0-78.4)	73.0 (70.0-78.3)	0.761
≤2 donations	75.6 (73.8-79.3)	75.0 (72.7-77.2)		75.2 (73.3-79.0)	75.2 (73.6-78.1)		75.2 (74.0-78.4)	73.6 (70.0-80.8)	
>2 donations	69.3 (63.0-85.0)	77.1 (69.4-83.7)		72.7 (67.4-83.7)	71.1 (68.4-85.0)		76.5 (69.4-85.0)	70.1 (65.0-81.4)	
MCH (pg) vs donations, median (IQR)	24.2 (23.0-25.6)	23.8 (23.0-25.5)	0.532	24.1 (23.1-25.9)	24.1 (22.9-25.4)	0.977	24.1 (23.1-25.3)	24.0 (21.8-26.2)	0.831
≤2 donations	24.3 (23.1-25.6)	23.7 (23.0-25.6)		24.3 (23.1-25.8)	24.1 (23.0-25.6)		24.1 (23.1-25.3)	24.2 (21.8-26.4)	
>2 donations	21.1 (18.9-27.4)	25.1 (21.4-28.2)		23.8 (19.3-28.3)	22.9 (21.3-27.4)		25.0 (21.4-28.2)	22.2 (19.3-26.4)	
MCHC (g/dL) vs donations, median (IQR)	31.8 (31.7-32.1)	32.1 (32.0-32.4)	0.217	32.1 (31.9-32.5)	31.8 (31.7-32.1)	0.163	31.9 (31.8-32.1)	32.1 (31.4-32.8)	0.713
≤2 donations	31.8 (31.7-32.1)	32.1 (31.8-32.2)		32.1 (31.9-32.4)	31.8 (31.7-32.1)		31.9 (31.8-32.1)	32.1 (31.4-32.8)	
>2 donations	31.1 (28.7-32.3)	32.3 (31.6-33.0)		32.9 (28.7-33.7)	32.2 (31.3-32.4)		32.3 (31.3-33.0)	32.1 (28.7-32.9)	
RDW (fL) vs donations, median (IQR)	42.7 (41.6-44.0)	43.2 (41.8-44.6)	0.297	44.0 (42.7-45.3)	41.9 (41.1-43.2)	0.065	42.7 (41.8-43.9)	43.2 (41.8-44.6)	0.327
≤2 donations	43.0 (41.6-44.2)	42.8 (41.5-44.6)		43.9 (42.7-45.5)	41.9 (41.0-43.7)		42.7 (41.7-44.2)	43.2 (41.8-44.6)	
>2 donations	41.5 (44.0-51.3)	43.6 (41.5-45.7)		45.3 (41.0-51.3)	42.7 (41.5-45.7)		42.6 (41.5-45.3)	47.0 (41.0-59.1)	
Haemoglobin (g/dL) vs donations, median (IQR)	11.5 (11.3-11.9)	11.4 (11.1-11.9)	0.756	11.0 (10.9-11.3)	12.0 (11.9-12.1)	<0.001	11.5 (11.3-11.8)	11.2 (10.6-12.0)	0.761
≤2 donations	11.6 (11.3-11.9)	11.4 (11.0-12.0)		11.0 (10.9-11.2)	12.0 (11.9-12.1)		11.5 (11.3-11.9)	11.1 (10.5-12.2)	
>2 donations	11.1 (6.70-11.8)	11.5 (11.4-12.1)		10.2 (6.70-11.6)	11.5 (11.4-12.1)		11.4 (10.7-12.1)	11.5 (6.70-12.0)	
Haematocrit (%) vs donations, median (IQR)	35.8 (35.2-36.9)	35.2 (34.6-36.0)	0.257	34.0 (33.3-35.0)	36.7 (35.8-37.1)	<0.001	35.5 (35.1-36.4)	34.7 (33.4-38.1)	0.628
≤2 donations	35.8 (35.2-36.9)	35.3 (34.3-36.0)		34.2 (33.4-35.0)	36.7 (35.9-37.5)		35.5 (35.0-36.5)	34.7 (33.0-38.1)	
>2 donations	35.1 (22.3-37.5)	34.9 (34.2-37.4)		29.4 (22.3-34.7)	35.7 (34.5-37.5)		35.4 (34.2-37.5)	34.7 (22.3-37.1)	
Reticulocyte (%) vs donations, median (IQR)	0.07 (0.06-0.08)	0.06 (0.06-0.08)	0.556	0.07 (0.06-0.08)	0.07 (0.06-0.08)	0.784	0.07 (0.06-0.08)	0.06 (0.05-0.08)	0.222
≤2 donations	0.07 (0.06-0.08)	0.06 (0.06-0.08)		0.07 (0.06-0.08)	0.07 (0.06-0.08)		0.07 (0.06-0.08)	0.07 (0.06-0.08)	
>2 donations	0.06 (0.04-0.08)	0.06 (0.05-0.10)		0.04 (0.04-0.05)	0.07 (0.05-0.10)		0.06 (0.04-0.10)	0.05 (0.04-0.08)	

Note: Bold number means that the results were statistically significant for the Mann–Whitney U test ($p<0.05$).

Table 2: Erythrocyte Indices Stratified by Age Group, Sex, and Donor Type According to Donation Frequency

Discussion

To the best of our knowledge, this is the first study to evaluate the relationship between repeated blood donation and erythrocyte indices among blood donation candidates in Angola. No significant differences in MCV, MCH, MCHC, RDW, haemoglobin, haematocrit, or reticulocyte count were observed between donors with ≤2 and >2 previous donations.

However, the overall median haemoglobin (11.5 g/dL) and MCV (75.2 fL) were below reference values, suggesting a high background burden of anaemia and iron deficiency irrespective of donation frequency. Gender was the main factor associated with erythrocyte indices, with male donors presenting significantly higher haemoglobin and haematocrit levels than females ($p<0.001$).

The absence of significant differences in erythrocyte indices between donation frequency groups contrasts with findings from other African cohorts where repeated donation was associated with changed iron parameters. In Zimbabwe, Vhanda et al. (2021) reported that repeated donations were associated with significantly lower serum ferritin, serum iron, and transferrin saturation, and with higher total iron-binding capacity, indicating progressive iron depletion with increasing donation frequency [11]. Similarly, Adediran et al. (2013) in Nigeria found lower ferritin levels in regular donors compared with first-time donors, even when haemoglobin and haematocrit differences were not statistically significant [14].

The overall median haemoglobin of 11.5 g/dL and median MCV of 75.2 fL observed across the entire cohort are particularly important, as both values fall below established WHO reference ranges and below the minimum haemoglobin thresholds typically required for blood donation (≥12.5 g/dL for women and ≥13.0 g/dL for men). These values suggest that many donors in this Angolan cohort presented with pre-existing iron deficiency or nutritional anaemia at the time of donation, independent of donation history. Comparable findings have been reported elsewhere in the region. In Brazzaville, Republic of Congo, Galiba Atipo-Tsiba et al. (2023) documented anaemia in 31.7% of blood donors [8]. In West Cameroon, Kourouma et al. (2019) found that 28% of donors had anaemia, with 55.6% of anaemic cases presenting as microcytic hypochromic forms, a pattern consistent with the low MCV values observed in the present study [10]. In Port Harcourt, Nigeria, Jeremiah and Koate (2010) reported anaemia in 13.7% of donors with concurrent iron deficiency in 20.6%, while iron-deficiency anaemia affected approximately 10% of donors in Sokoto [6,7]. In Uganda, Dhabangi et al. (2023) found iron deficiency in a substantial proportion of whole blood donors, and in South Africa, van den Berg et al. (2019) highlighted the challenge of balancing donor safety against blood demand given prevalent iron deficiency [15]. Together, these findings establish sub-optimal iron and haemoglobin status as a consistent regional challenge with implications for both donor safety and the quality of donated blood products.

The significant sex-based differences in haemoglobin ($p<0.001$) and haematocrit ($p<0.001$) observed in this study are largely consistent with findings from across sub-Saharan Africa. Male donors had higher haemoglobin and haematocrit values in both donation frequency subgroups, reflecting the well-established androgenic regulation of erythropoiesis and the additional iron losses associated with menstruation among female donors of reproductive age [16,17]. In Namibia, Gonzo et al. (2016) found that 74% of donors deferred for low haemoglobin were female, illustrating that gender is a major driver of haemoglobin-based deferral in African donor programmes [16]. The borderline trend toward higher RDW values in females ($p=0.065$) might reflect incipient iron deficiency in this subgroup, as elevated RDW is an early marker of iron-deficient erythropoiesis preceding frank microcytosis [12]. The absence of significant sex differences in MCV, MCH, MCHC, or reticulocytes might indicate that iron depletion in female donors in this cohort had not yet progressed to the stage of measurable morphological erythrocyte changes, emphasizing the importance of ferritin-based screening to detect subclinical depletion in at-risk groups.

The high proportion of replacement donors (87.3%) in this cohort reflects the broader pattern of blood banking in sub-Saharan Africa, where family or replacement donation remains predominant despite WHO recommendations advocating for voluntary non-remunerated donation [3,4]. Voluntary donors were numerically more represented among those with >2 donations (28.6% vs. 11.4%), suggesting that voluntary donors donate more frequently than replacement donors, consistent with reports from Nigeria and Ghana [7,18]. In the present study, the absence of significant erythrocyte index differences between replacement and voluntary donors might partly reflect the small sample of frequent donors and the limited sensitivity of erythrocyte indices as early iron depletion markers [12,13]. Ferritin and soluble transferrin receptor measurements would be expected to reveal more pronounced differences between donor type subgroups, as documented in Ghanaian cohorts [16].

This study has some limitations. The cross-sectional design precludes causal inference. The small number of donors with >2 previous donations limited statistical power. Biomarkers of iron status (serum ferritin and transferrin receptor), were not evaluated, preventing assessment of early iron depletion. Recruitment from a single blood centre may also limit the generalisability of the findings. Despite these limitations, we provide the first description of erythrocyte indices among blood donation candidates in Angola and contributes important baseline data for donor health monitoring. Further studies with larger cohorts of frequent donors, longitudinal follow-up, and iron biomarkers are needed to better characterize the effects of repeated donation on donor health and to inform evidence-based donor monitoring strategies in Angola.

Conclusion

Repeated blood donation was not associated with erythrocyte indices among blood donation candidates in Luanda, Angola. Nevertheless, the low haemoglobin and MCV values observed across the study population indicate a high occult burden of anaemia and iron deficiency. These findings support strengthening routine donor monitoring, including assessment of iron status, particularly among frequent donors and female donors. Further studies incorporating iron

biomarkers are warranted to better characterize the impact of repeated blood donation on donor health.

Ethics Approval and Consent to Participate

The study was approved by the National Blood Institute of Angola (No. 201/GDG/INS/2026, February 27, 2026). Informed consent was obtained and confidentiality was maintained throughout the study.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

Conceptualisation: FC, JV, and CSS. Data curation: FC and CSS. Formal analysis: CSS. Funding acquisition: CSS. Methodology: FC and CSS. Investigation: CSS, FC, JV, JMKS, MM, EM, EC, MC, EE-V, ES, JM, and DM. Project administration: CSS. Supervision: CSS. Validation: CSS. Writing – original draft: CSS. Writing – review & editing: ES, EC, EE-V, JM, and CSS. All authors have seen and approved the submitted version of this manuscript.

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References

1. Loua, A., Nikiema, J. B., Kasilo, O. M., & Tayou, T. C. (2018). Blood safety and availability in the WHO African region. Global Surgery, 4(3), 1-7.
2. Field, S. P., & Allain, J. P. (2007). Transfusion in sub-Saharan Africa: does a Western model fit?. Journal of Clinical Pathology, 60(10), 1073-1075.
3. Loua, A., Nikiema, J. B., Sougou, A., & Kasilo, O. J. M. (2019). Transfusion in the WHO African region. Transfusion Clinique et Biologique, 26(3), 155-159.
4. Dei-Adomakoh, Y., Asamoah-Akuoko, L., Appiah, B., Yawson, A., & Olayemi, E. (2021). Safe blood supply in sub-Saharan Africa: challenges and opportunities. The Lancet Haematology, 8(10), e770-e776.
5. Cable, R. G., Glynn, S. A., Kiss, J. E., Mast, A. E., Steele, W. R., Murphy, E. L., ... & NHLBI Retrovirus Epidemiology Donor Study-II (REDS-II). (2012). Iron deficiency in blood donors: the REDS-II Donor Iron Status Evaluation (RISE) study. Transfusion, 52(4), 702-711.
6. Jeremiah, Z. A., & Koate, B. B. (2010). Anaemia, iron deficiency and iron deficiency anaemia among blood donors in Port Harcourt, Nigeria. Blood Transfusion, 8(2), 113.
7. Buhari, H. A., Erhabor, O., Sani, I., Wase, A., Onuigwe, F., Okwesili, A., Isaac, Z., Abdulrahaman, Y., Kabiru, D., & Haruna, Y. M. (2015). Prevalence of iron deficiency anaemia among blood donors in Sokoto, North Western, Nigeria. Journal of Coastal Life Medicine, 3(4), 312–316.
8. Galiba Atipo-Tsiba, F. O., Gayaba Mouyabi, E. Q., Angounda, B. M., Mokono, S. O., Ocko Gokaba, L. T., & Elira Dokekias, A. (2023). Prevalence of iron deficiency, anemia, and associated factors in a blood donor population in Brazzaville, Congo. Anemia, 2023(1), 8827984.
9. Dhabangi, A., Ssenyonga, R., Siu, G., Elaborot, S. A., Kyeyune, D., & Bates, I. (2023). Iron deficiency in whole blood donors in a resource-poor setting: A cross-sectional study in Uganda. Transfusion Medicine, 33(3), 213-220.
10. Kourouma, K., Ndanchi Tiotdia, A., Kanmangne, F., Fotsing Kwetche, P., Kouamouo, J., & Kaptue, L. (2015). Profil de l'hémogramme chez les donneurs de sang à l'Ouest du Cameroun. Transfusion Clinique et Biologique, 22(4), 216.
11. Vhanda, D., Chinowaita, F., Nkomo, S., Timire, C., & Kouamou, V. (2021). Effects of repeated blood donation on iron status of blood donors in Zimbabwe: a cross-sectional study. Health science reports, 4(4), e426.
12. Reddy K, V., Shastry, S., Raturi, M., & Baliga B, P. (2020). Impact of regular whole-blood donation on body iron stores. Transfusion Medicine and Hemotherapy, 47(1), 75-79.
13. Alvarez-Ossorio, L., Kirchner, H., Klüter, H., & Schlenke, P. (2000). Low ferritin levels indicate the need for iron supplementation: Strategy to minimize iron-depletion in regular blood donors. Transfusion Medicine, 10(2), 107–112.
14. Akinbami, A. A., Dosunmu, A. O., Adediran, A., Oshinaike, O. O., Adebola, P., & Ajibola, S. O. (2013). Iron stores in

regular blood donors in Lagos, Nigeria. Journal of Blood Medicine, 4, 75–80.
15. van den Berg, K., Swanevelder, R., Ingram, C., Lawrie, D., Glencross, D. K., Hilton, C., & Nieuwoudt, M. (2019). The iron status of South African blood donors: balancing donor safety and blood demand. Transfusion, 59(1), 232-241.
16. Gonzo, M., Shuuveni, A., Mukesi, M., Chipare, I., & Moyo, S. (2016). Assessment of donor deferral rates and deferral reasons at the Namibia blood transfusion services. Int J Blood Transfus Immunohematol, 5, 37-43.
17. Erhabor, O. L. (2014). Female gender participation in the blood donation process in resource poor settings: case study of Sokoto in North Western Nigeria. Journal of Blood Disorders & Transfusion, 5.
18. Abdullah, S. M. (2011). The effect of repeated blood donations on the iron status of male Saudi blood donors. Blood Transfusion, 9(2), 167.