Transfusion and Apheresis Science 64 (2025) 104201

Contents lists available at ScienceDirect

Transfusion and Apheresis Science

journal homepage: www.elsevier.com/locate/transci

Evaluation of iron levels and hematological indices among blood donors at the Southern Zonal Blood Center, Accra, Ghana

Samuel Antwi-Baffour [a,*], Benjamin Tetteh Mensah [a], Dorinda Naa Okailey Armah [a], Hannah Nana Amene Asiedu [a], Lawrence Annison [b]

[a] Department of Medical Laboratory Sciences, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana, P. O. Box KB 143, Korle-Bu, Accra, Ghana
[b] Department of Medical Laboratory Technology, School of Medical Sciences, Accra Technical University, Accra, Ghana

ARTICLE INFO

Keywords:
Blood donation
Blood donors
Iron stores
Serum ferritin
Iron deficiency
Iron deficiency anemia

ABSTRACT

Background: Blood donation is essential for maintaining life-saving supplies, but screening often focuses only on hemoglobin, neglecting iron stores. While hemoglobin recovers quickly, iron takes longer to replenish, putting frequent donors at risk. Even without anemia, low iron can cause fatigue, reduced endurance, and cognitive issues, potentially leading to iron-deficiency anemia. Many programs overlook iron status, leaving regular donors vulnerable to chronic depletion.
Objective: The objective of the study was to assess the iron status and haematological indices of categories of blood donors.
Methods: This cross-sectional study recruited 350 blood donors of which 146 were first-time donors, 146 repeat donors, and 58 hemoglobin-deferred donors from the Southern Zonal Blood Center, Accra, Ghana. For each participant, about 3 mL of blood sample was obtained to estimate FBC for haematological parameters and serum ferritin concentration for iron status.
Results: The study involved 350 blood donors and found a median Hb of 12.4 g/dL and ferritin levels ranging from 11.8 to 500 ng/mL. First-time donors showed a positively skewed Hb distribution, while repeat donors had greater variation with outliers. Significant differences ($p < 0.001$) in Hb, MCV, MCHC, RDW, and serum ferritin were observed across the groups, though MCH showed no significant difference ($p = 0.062$). Iron depletion was present in 16.7 % of participants, whilst 8.3 % had iron-deficient erythropoiesis, and 75 % had normal ferritin levels.
Conclusion: The findings of the study highlight the differences in iron reserves and hematological parameters among donor categories, emphasizing the impact of donation frequency on iron status. This study provides new evidence from Ghana on how blood donation frequency affects iron reserves and haematological indices.

1. Introduction

Blood donation is a critical activity for maintaining the supply of blood and its components, that are essential for life-saving medical interventions [1]. To ensure donor safety, blood donors are typically screened for hemoglobin levels before being cleared to donate [2]. Hemoglobin, the oxygen-carrying protein in red blood cells, serves as a proxy for assessing an individual's blood health [2]. However, hemoglobin measurement alone may not provide a comprehensive picture of a donor's iron stores [3]. This may further be exercibated if copper sulfate solution is used as the method of hemoglobin estimation by blood centers which may not be able to identify such persons low iron stores during the donor screening. There are sex-specific haemoglobin levels (Men: $\geq$ 13.5 g/dL and Women: $\geq$ 12.5 g/dL) that qualifies individual to donate and some people may attain those levels and yet have low iron stores.

Meanwhile, iron is a vital component of hemoglobin synthesis and plays a significant role in various physiological processes [4]. But blood donation removes a substantial amount of iron from the body, and while hemoglobin levels may recover within weeks, the replenishment of iron

* Corresponding author.
E-mail addresses: ssantwi-baffour@ug.edu.gh (S. Antwi-Baffour), mykroworld@gmail.com (B.T. Mensah), dhoryndhaa@gmail.com (D.N.O. Armah), nana.hannah1012@gmail.com (H.N.A. Asiedu), larryannison@gmail.com (L. Annison).

https://doi.org/10.1016/j.transci.2025.104201
Received 25 April 2025; Received in revised form 27 June 2025; Accepted 30 June 2025
Available online 3 July 2025

stores can take significantly longer [5]. This delayed recovery of iron stores poses a risk to frequent donors, as they may continue to donate while harboring depleted iron stores, that may not be detectable through the routine hemoglobin screening as stated above [3,5].

Depleted iron stores without anemia can lead to latent iron deficiency, characterized by symptoms such as fatigue, reduced exercise tolerance, and impaired cognitive function [6]. If unaddressed, frequent donation under these conditions can progress to iron-deficiency anemia, exacerbating health risks for donors [7]. Despite these potential consequences, many blood donation programs including the Ghanaian context do not include iron stores evaluation, such as ferritin measurement, as part of their standard donor screening protocols.

The absence of iron stores monitoring is particularly concerning for frequent donors, whose cumulative iron loss may lead to more severe and chronic depletion [7]. This oversight does not only affect the donor's health but may also impact the sustainability of blood donation programs, as affected donors might eventually become ineligible to donate due to anemia or other related health issues.

This study seeks to evaluate the iron stores and haematological parameters of blood donors, emphasizing the importance of monitoring iron levels beyond hemoglobin screening. By identifying at-risk individuals and implementing preventive strategies, such as iron supplementation or extended donation intervals, the long-term health of donors can be safeguarded, ensuring a sustainable blood supply.

2. Methods

2.1. Study design

The study was a cross-sectional study conducted between July 2023 and September 2024.

2.2. Study setting

This study was carried out at the Southern Zonal Blood Center, Accra, Ghana where the donor samples were collected, Liberty Diagnostics and the Haematology Laboratory of the School of Biomedical and Allied Health Sciences, University of Ghana where samples analysis took place.

2.3. Study population

The study population consisted of 350 individuals selected from the blood donors who visited the Southern Zonal Blood Center in Accra, Ghana during the study period. Participants were recruited using purposive convenience sampling and categorized into age groups. The center records over 42,000 donor visits annually.

The study population comprised of 350 blood donors who attended the Southern Zonal Blood Center, Accra, Ghana within the study period. Participants were recruited through a purposive convenient sampling and put in age groups. More than 42,000 blood donors visit the centre annually.

2.4. Inclusion criteria

Participants included those who met the eligibility criteria (Hb cut off for Men: $\geq$ 13.5 g/dL and Women: $\geq$ 12.5 g/dL) for blood donation at the Southern Zonal Blood Center, first-time donors, repeat donors who had donated blood in the last two years, and individuals who had previously been deferred due to low hemoglobin (10 -11g/dL) levels but had since qualified by the cut off stated above to donate.

2.5. Exclusion criteria

The study excluded participants who did not meet the eligibility criteria for blood donation at the Southern Zonal Blood Center, qualified blood donors who were unwilling to participate, and individuals with a history of medical conditions such as Chronic kidney disease, Gastro-intestinal disorders and hypertension or on medications such as aspirin, antibiotics, NSAIDs and antiepileptics that could affect iron metabolism or hemoglobin levels.

2.6. Sampling method/procedure

Blood samples were collected from the donors at the Southern Zonal Blood Center for the study. Special codes were generated for each donor to keep their identity confidential. Donor data including age, gender and frequency of donation were collected after consent was received using interviewer-administered questionnaire. Participants were categorized into first time donors, repeat donors and Hb-deferred (those who could not donate previously due to low Hb) donors. Vacutainer tubes were labelled with donor codes. For each donor, about 3 mL of blood was collected from their sampling pouch into two tubes; a gel separator tube and an EDTA tube and then transported to the laboratory in a chest with ice cubes at 4 – 8^{0}C for analysis. The whole blood in EDTA was used to estimate hemoglobin and other haematological parameters using a Biobase five-tier auto analyzer BK-6310 (Biobase group – China). Samples in gel separator tubes were spun to separate serum from cell components. Serum was transferred into labelled eppendorf tubes using a Pasteur pipette, placed in cryobox and stored at −20 degrees Celsius until analysis. For the analysis, stored serum was thawed and processed using a rapid quantitative test to generate ferritin levels.

2.7. Serum ferritin testing

Serum ferritin was measured using the Finecare Ferritin Rapid Quantitative Test (Wondfo Biotech Co., Ltd. Guangzhou) based on fluorescence immunoassay technology. Serum ferritin of participants was categorized into Iron Depletion (ID), Iron Deficient Erythropoesis (IDE) and Normal (N) based on the following cut off points; $<$ 30 ng/mL, 30–60 ng/mL and $>$ 60 respectively. The measuring range for the assay was 5 – 1000 ng/mL.

2.8. Data management and analysis

The data collected from the above analysis were entered into Microsoft Excel (Microsoft-USA) and exported to Statistical Package for Social Sciences version 26.0.1 on an encrypted computer. The information was presented in tabular form and conveyed using summary and descriptive statistics like frequency, percentages, mean, median and standard deviation as necessary. An Analysis of variance was used to analyze the mean differences between the three groups of blood donors. Statistical significance was defined as a p-value $<$ 0.05.

2.9. Ethical consideration

An application for full ethical approval was made to the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, University of Ghana and written ethics consent was received on July 17, 2023. The ethics approval number is SBAHS/AA/MLAB/10810036/2022–2023. Participants' written informed consents were obtained, and each participant was made to understand that they could withdraw from the study at any time**.** The data collected for this research was kept and analyzed on an encrypted (password protected) personal computer to ensure privacy. Physical copies were securely stored in a locked steel cabinet. Access to participant information was strictly limited to key members of the research team, maintaining confidentiality and safeguarding the participants' data.

3. Results

3.1. Demographic data of the participants

A total of 350 participants were involved in this study, comprising 256 males and 94 females. Participants were categorized by age, with the highest number falling within the 30–39-year age group. Based on their donation history, they were further classified as first-time donors, repeat donors, or Hb-deferred donors (Table 1).

Repeat donor 1 refers to an individual who has donated blood once prior to the current donation. **Repeat donor 2** has donated twice before, while **repeat donor** > /=**3** refers to individuals who have donated three or more times previously.

Hb-deferred donors are those initially unable to donate due to low hemoglobin levels but later became eligible after their Hb improved—often as a result of education and guidance provided during their deferral.

3.2. Descriptive statistics of the red cell indices and ferritin levels among the participants

Red blood cell indices of mean Hb, MCV, MCH, MCHC and RDW and ferritin levels were measured. The median Hb was 12.40 (9.50 – 16.80) g/dL (with standard deviation and range being 1.64 and 7.30 respectively. Ferritin levels spanned from 11.80 ng/mL to 500 ng/mL among the participants with range of 488.30 ng/dL. The median ferritin concentration was 97.80 g/dL and the mean was 106.64 ng/mL with standard deviation of 78.94 (Table 2).

3.3. Association between the iron reserves and donation period of participants

The iron reserves of participants were compared among the donor groups using the derived red cell indices and serum ferritin concentration. The study used a box and whisker plot to display the five-number summary of Hb, MCV, MCH, MCHC, RDW and ferritin among the first-time donors, repeat donors and Hb-deferred donors (Fig. 1).

In Fig. 1, the dotted line represents the mean whilst the solid line represents the median of the data set for all the categories of participants. The average hemoglobin for first time donors was 13. 068 g/dL and their box plot distribution was positively skewed. Also, the mean Hb for repeat donor > 3 was 12.41 g/dL and the single data points represent the outliers for repeat donor > 3. The upper or higher single point also represents the maximum value for repeat donor > 3. The lower fence or minimum value for repeat donor 2 is 12 g/dL, and it is close to the 1st quartile with value of 12.1. The 1st quartile (q1) Hb for repeat donor 1 is 12.55 and the 3rd quartile (q3) is 14.2. The mean and median hemoglobin are 13.3 g/dL and 13.2 g/dL respectively.

As shown in Fig. 2, the box plot distribution for first time donors' Mean Cell Volume (MCV) is negatively skewed. The mean and median MCV of first-time donors lie around the same point with values of 87.072 fl and 87.1 fl respectively. The box plot distribution for repeat donor > 3 is positively skewed with mean value of 84.6 fl and median value 82.3 fl. The box plot distribution for repeat donor 2 is also positively skewed. The single data points which are above the upper fence and below the lower fence represent the outliers for repeat donor 1 and are the maximum and minimum values respectively. The mean and median MCV for repeat donor 1 is 84.34 fl and 84.30 fl respectively. The dotted line represents the mean, and the solid line represents the median for all the participants.

With regards to Mean Cell Hemoglobin (MCH), all the donor categories, with the exception of repeat donor 2, have values which lie outside the overall distribution pattern. These are outliers for their MCH. The interquartile range (IQR) of first donor MCH can be obtained from the difference between the 3rd quartile (q3) and 1st quartile (q1) (Fig. 3).

The figure illustrates the distribution of MCH values among the different blood donor categories. The solid horizontal line within each box represents the median (25th percentile), while the dotted line indicates the mean MCH value for each group. The interquartile range (IQR) for each category is defined by the difference between the 3rd quartile (Q3) and 1st quartile (Q1), representing the middle 50 % of the data. Notably, all donor categories except Repeat Donor 2 show MCH values that lie outside the general distribution pattern, highlighting the presence of outliers in those groups.

Also, with regards to Mean Cell Hemoglobin Concentration (MCHC), the box plot distribution for repeat donor > 3 and Hb-deferred are positively skewed. The box plot for repeat donor 1 is also positively skewed. The single point values within the MCHC dataset are outliers that vary greatly from others by being much smaller or significantly larger (Fig. 4).

Fig. 4 shows the distribution of Mean Cell Hemoglobin (MCH) across donor categories. Each boxplot illustrates the interquartile range (Q1 to Q3), with a solid line marking the median and a dotted line indicating the overall mean. Points beyond 1.5 times the IQR are plotted as outliers. All donor categories except Repeat Donor 2 exhibit MCH values outside the overall distribution, indicating outliers.

Again, with RDW, the box plot distribution for repeat donor > 3 and Hb-deferred are negatively skewed. A longer box length of repeat donor > 3 shows a more dispersed RDW data compared to the smaller box of repeat donor 1 (Fig. 5).

From the figure, each box represents the interquartile range (IQR), with the lower and upper edges corresponding to the first (Q1) and third (Q3) quartiles. The solid horizontal line within each box denotes the median MCV value for that donor group, while the dotted horizontal line indicates the overall mean MCV across all donor categories. Points beyond the whiskers represent outliers. The MCV values of Repeat Donor 1, Repeat Donor ≥ 3, and Hb Deferred groups deviate from the overall pattern and are identified as outliers.

According to Fig. 6, the mean serum ferritin for all the donor groups is shown as a dotted line in their respective boxes. The single points for the repeat donor > 3 box plot distribution are outliers and represent the maximum value and the minimum mark for repeat donor > 3.

The figure presents the distribution of Mean Corpuscular Hemoglobin Concentration (MCHC) across donor categories. Each boxplot shows the interquartile range (Q1–Q3), with the median marked by a solid line and the overall mean by a dotted line. Data points beyond the whiskers indicate outliers. All categories, except First Donor, show MCHC values outside the overall distribution, indicating outlier status.

A bar chart analysis was done representing the prevalence of iron depletion and iron-deficient erythropoiesis among the participants. From the bar chart, it was seen that, out of the total participants, 16.7 % of them had iron depletion (ID) with 8.3 % having Iron-Deficient Erythropoesis (IDE). Using the cut off limits of < 30 ng/mL and $30 \leq x \leq 60$ ng/mL respectively. The greater part (75 %) of the donors in the study had normal serum ferritin levels and were classified as

Table 1
Demographic data of the study participants.

Demographics		Frequency (N = 350)	Percentage (100 %)
Sex	Male	256	73.1 %
	Female	94	26.9 %
Age (years)	< 20	18	5.0 %
	20–29	93	26.7 %
	30–39	192	55.0 %
	≥ 40	47	13.3 %
Donation History	First time donor	146	41.7 %
	Repeat donor 1	64	18.3 %
	Repeat donor 2	29	8.3 %
	Repeat donor > /= 3	53	15.0 %
	Hb deferred	58	16.7 %

Table 2
Descriptive statistics of the red cell indices and Ferritin levels among the participants.

	Mean	Standard Deviation	Minimum	Maximum	Percentile 25	Median	Percentile 75
Hb	12.57	1.64	9.50	16.80	11.50	12.40	14.00
MCV	84.73	5.35	73.00	94.70	81.65	84.20	88.30
MCH	28.47	3.35	16.70	39.00	26.55	27.85	30.65
MCHC	31.35	4.54	19.50	44.60	29.20	32.00	32.90
RDW	16.73	2.38	12.30	22.40	15.10	16.40	18.50
Ferritin	106.64	78.94	11.80	500.10	59.50	97.80	161.70

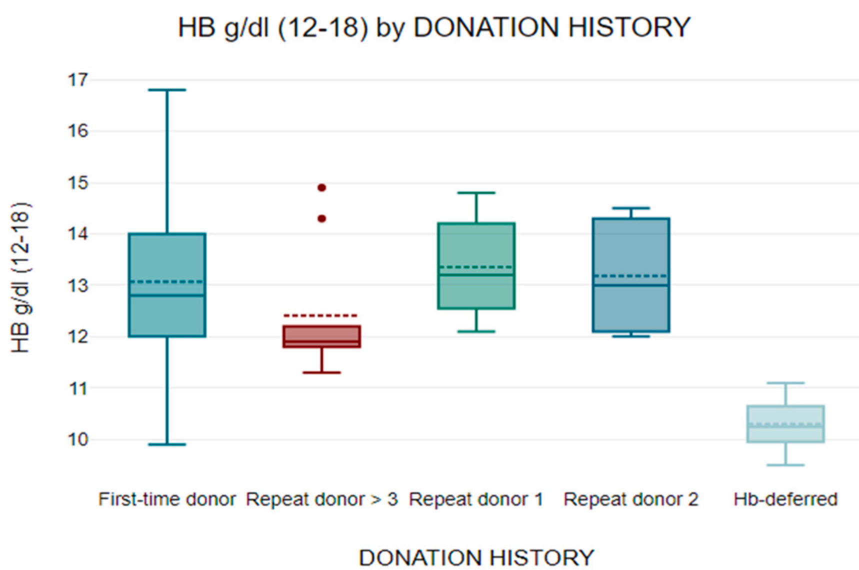

Fig. 1. A Box and whisker diagram showing a summary of hemoglobin concentration among the donor groups.

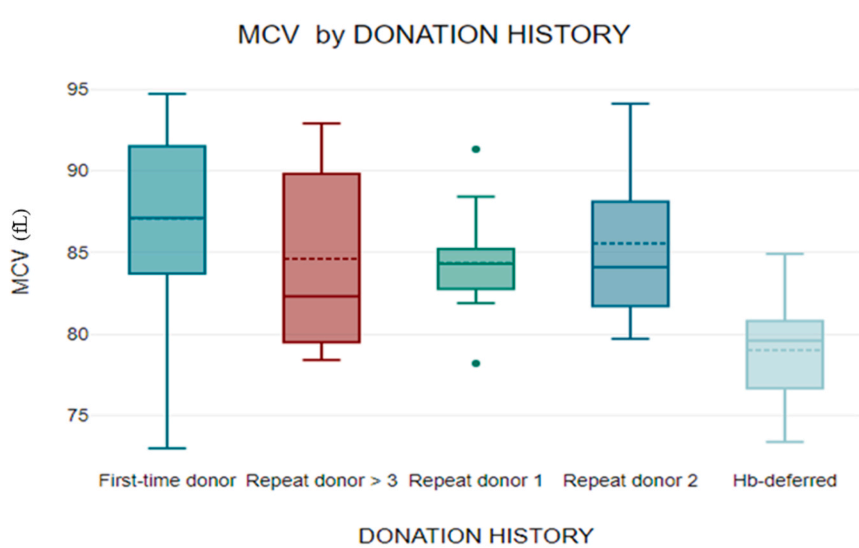

Fig. 2. A Boxplot showing a summary of the mean cell volume of red blood cells of the donor groups.

having normal iron stores (Fig. 7).

This figure illustrates the rising prevalence of iron deficiency (ID) and iron-deficient erythropoiesis (IDE) with increasing frequency of blood donations. ID is defined as low serum ferritin levels (<30 ng/mL) indicating depleted iron stores, while IDE refers to a state of insufficient iron for red blood cell production, often characterized by low ferritin levels in combination with abnormal red cell indices (IDE was classified within the range of $30 \leq$ ferritin ≤ 60 ng/mL). The data from the figure show a clear upward trend in both ID and IDE among repeat donors, with the highest prevalence observed among those who have donated three or more times. This pattern underscores the cumulative impact of repeated blood donations on iron status and suggests the need for more robust donor monitoring and iron management strategies.

3.4. *Inferential statistics*

From One way ANOVA comparing red cell indices among the donor groups, there was a significant difference in Hb (F 10.039, $p < 0.001$)

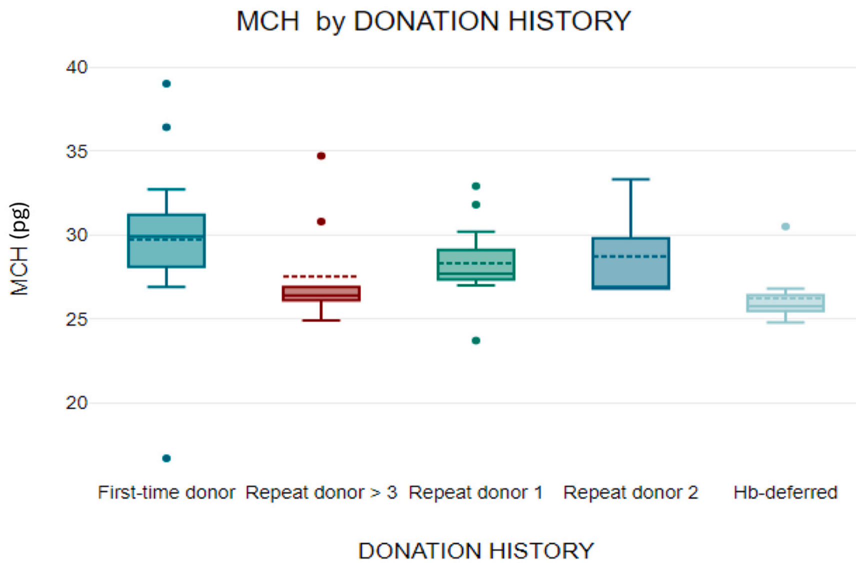

Fig. 3. A Box and whisker plot showing a summary of the mean cell hemoglobin of red blood cells of the donor groups.

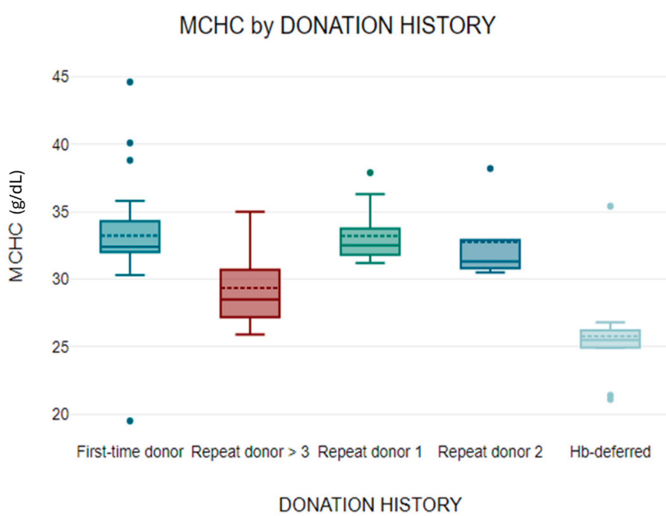

Fig. 4. A Box and whisker plot showing a summary of the mean cell hemoglobin concentration of red blood cells of the donor groups.

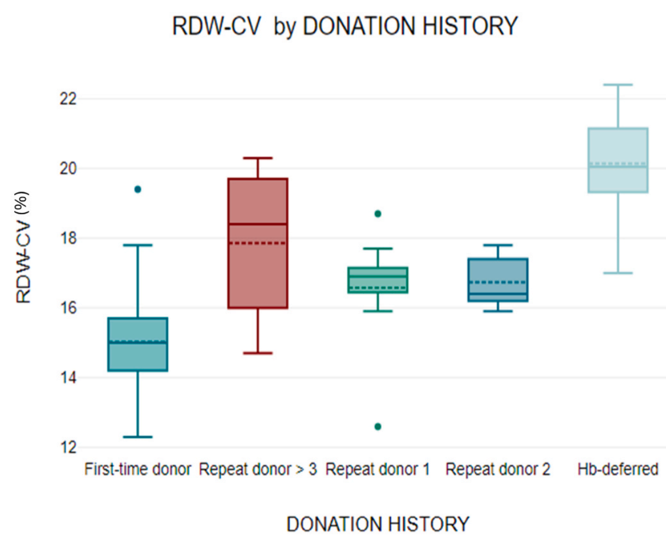

Fig. 5. A Box and whisker plot showing a summary of the red cell distribution width of red blood cells of the donor groups.

among first time donors, repeat donors and hemoglobin-deferred donors, considering p value of < 0.05. MCV also showed a significant difference among first time, repeat and Hb-deferred donors (F 5.294, $p = 0.001$). There was also significant difference between MCHC among the three donor groups (F 8.997, $p < 0.001$). Likewise, RDW also showed a significant difference (F 20.464, $p < 0.001$) among donor group. There was, however, no statistically significant difference in MCH among the groups (F 2.390, $p = 0.062$).

Again, from One way ANOVA comparing Ferritin concentration among the donor groups, Serum Ferritin levels of first-time donors, repeat donors and hemoglobin-deferred donors showed a statistically significant difference (F 9.066, $p < 0.001$).

4. Discussion

This study had three hundred and fifty (350) participants in total and based on age distribution, the largest (55 %) group was found to be in the 30–39 years category, followed by the 20–29 years age group (26.7 %). According to donation history, first-time donors and repeat donors were the same in number as against Hb-deferred donors. Also, the majority of the participants were males, a trend observed also in a study by Adu et al., (2020) where the male donors were 89.0 % of the study population [8].

Red Cell Distribution Width (RDW), Mean Corpuscular Volume (MCV), and Mean Corpuscular Hemoglobin (MCH) are valuable hematologic indices in the early detection of iron deficiency. RDW, which reflects the variation in red blood cell size (anisocytosis), tends to increase early in iron deficiency due to the presence of both microcytic and normocytic cells. Several studies confirm RDW as a sensitive early marker, often rising before changes in MCV or hemoglobin are observed [9,10].

MCV, indicating the average size of red blood cells, decreases progressively as iron deficiency worsens. In early stages, MCV may still be within normal range but tends to drop as microcytosis becomes more prominent [11]. Similarly, MCH—representing the average hemoglobin content per red cell—also declines as iron becomes insufficient for adequate hemoglobin synthesis, making it a useful parameter alongside MCV and RDW in screening and diagnosis [12]. Together, these indices provide a cost-effective, readily available means of identifying early iron

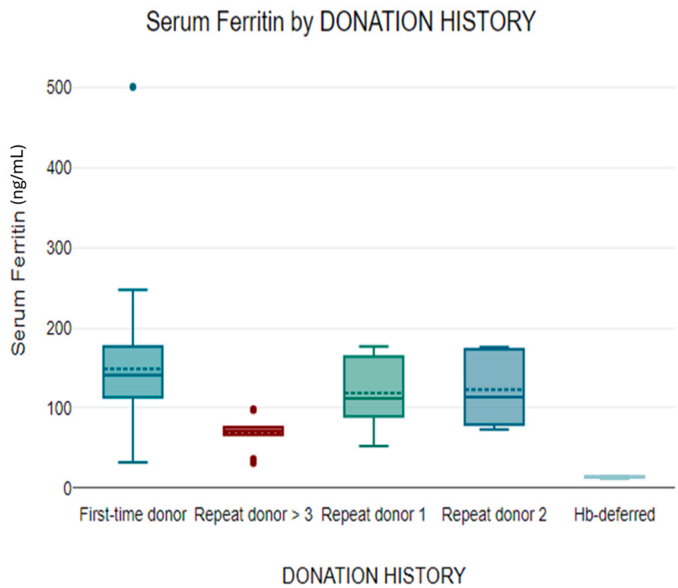

Fig. 6. A Box and whisker plot showing a summary of serum ferritin concentration among the donor groups.

deficiency before overt anemia develops, particularly in populations with limited access to serum ferritin testing.

To evaluate the study's aim, serum ferritin concentration was measured as well as the red blood cell indices - Hb, MCV, MCH, MCHC and RDW for each donor. These indices/parameters were evaluated between the donor groupings. Significant differences were seen in the levels of the serum ferritin measurement and majority of the red cell indices among the three groups. An Analysis of variance using boxplot showed a significant difference in the MCV of the donor groups where the MCV appeared low in repeat donors and Hb-deferred donors compared to first time donors. This is in line with a study in Indian where MCV and MCH were shown to be potential indicators of iron deficiency in repeat blood donors [13,14]. However, there was no significant difference in MCH among the participants in this study.

Compared to MCV or MCH, RDW has been proposed as a more accurate marker for the early detection of iron deficiency [15]. The current study discovered significant variations in RDW among the different donor categories. This was however in contrast to a previous study by Jain et al., (2018) where no notable difference was found in the RDW among the donor groups [13]. Again, in the current study, significant difference among the donor groups was found in MCHC. This finding is in line with the findings in a study which recorded a statistically significant difference in MCHC, where MCHC was reduced in regular donors than first time donors [14,15].

Furthermore, in the current study, Hb showed a statistically significant difference among first time donors, repeat donors and hemoglobin-deferred donors. This finding is comparable to findings in a study by Waheed et al., (2018) where Hb was statistically significantly different between regular donors – repeat and Hb-deferred donors (lower) and first-time donors (higher) [14]. However, these findings are in contrast with a study conducted by Fateen et al., (2022) where there was a slight or no difference between the Hb of first-time donors and frequent donors [3].

With regards to serum ferritin, there was relatively very low serum ferritin concentration in Hb-deferred donors and repeat donors as compare with first time donors and the difference was significant. Further, using serum ferritin evaluations, 8.3 % and 16.7 % of the participants in this study exhibited iron-deficient erythropoiesis (ferritin $30 \leq x \leq 60$ ng/mL) or were iron depleted (ferritin < 30 ng/mL), respectively. According to Adu et al., (2020), voluntary donors in a state of negative iron balance could be made worse by donating blood [8]. Also, a previous study done in Nigeria showed that 20.6 % of blood donors had depleted iron stores, using a cutoff value for serum ferritin concentration of 12 ng/mL [16]. Also, prior research from the RISE project in the USA revealed that iron stores were depleted in 15 % of blood donors and that 41.7 % of donors had iron-deficient erythropoiesis [17].

According to the current study's findings, evaluating serum ferritin levels may be a crucial prerequisite for blood donor recruitment. Even if their hemoglobin levels were adequate at the time of donation, blood donors may still have insufficient iron stores. The method of hemoglobin estimation employed by blood centers where copper sulfate solution is used may not be able to identify such persons during the donor screening. Given that, the present study identified some donors with Hb below 12 g/dL by the analyzer method, but the copper sulfate density method of assessment passed them to donate blood. Studies conducted by Anju et al., 2022) support the assertion that methods of preventing iron deficiency in donors should be based on ferritin screening [18]. Subsequently, numerous blood services in the US and Europe have recently begun employing routine ferritin testing as an additional tool to help detect and manage donors who may be at risk of developing iron deficiency [19,20].

Still, findings from other studies indicate that ferritin testing is not currently accessible as a point-of-care test and so employing it as a screening test for donors may not be possible in many blood centers particularly in deprived areas. But the outcome of this study shows that

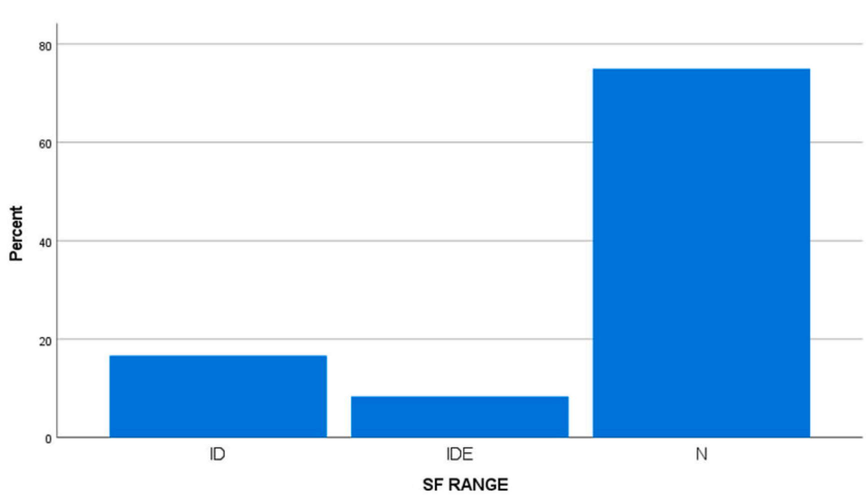

Fig. 7. A bar chart classifying blood donors into normal, iron-deficient erythropoiesis and iron depletion based on their serum ferritin levels.

regular/repeat donors demonstrate lower ferritin levels, suggesting higher risk for iron deficiency [18].

A noteworthy observation from this study is the hemoglobin profile of individuals who had previously been deferred due to low hemoglobin levels but were later deemed eligible to donate. Despite their qualification, all recorded hemoglobin values for this group fell below the recommended Ghanaian cutoff for females. This suggests that these donors may have passed the hemoglobin screening via the copper sulfate ($CuSO_4$) method but subsequently failed the more precise cell counter hemoglobin measurement. This discrepancy raises critical concerns about the reliability of the $CuSO_4$ method, which may be compromised due to inadequate quality control or, more plausibly, the overuse of the solution without timely replacement.

Furthermore, across all other donor categories, a substantial proportion of recorded hemoglobin values also fell below the expected male cutoff of 13.0 g/dL. In Fig. 1, over 50 % of donors in each category excluding one-time donors, exhibited values below this threshold, despite males comprising approximately 75 % of the donor pool. This pattern strongly suggests systemic issues in donor hemoglobin screening, with potential implications for donor safety and the quality of the collected blood. It is therefore imperative that the national blood service conduct a thorough review of its current hemoglobin screening procedures, particularly the continued reliance on $CuSO_4$, and prioritize the implementation of more accurate, standardized testing methods.

4.1. Limitation

A limitation worthy of mentioned is the fact that tests for Erythrocyte Sedimentation Rate (ESR) and C-Reactive proteins were not performed to rule out inflammation. Also, baseline ferritin of > 300Ug/L was not checked to exclude individuals with hemochromatosis. Again, confounding variables such as dietary iron intake, menstrual status and parasitic infections were not assessed. Furthermore, demographic data collected was solely based on response of donors and some donors may not have disclosed all relevant information.

5. Conclusion

Among the three groups studied, repeat and hemoglobin-deferred blood donors exhibited relatively lower serum ferritin concentrations and red cell indices, along with elevated RDW values. These findings support the evidence that repeated blood donations can deplete iron stores and may lead to post-donation iron deficiency anemia (IDA). The results of this study, along with consistent findings from previous research in the U.S. and Europe, highlight the urgent need for comprehensive donor iron management strategies. These should include donor education materials, adjusted donation intervals or frequency, ferritin-based monitoring, and targeted iron supplementation programs. To safeguard donor health, it is recommended that blood donation centers revise their screening protocols to incorporate the above listed processes.

Funding information

The authors received no financial support for the research, authorship, and/or publication of this article.

CRediT authorship contribution statement

Lawrence Annison: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Data curation, Conceptualization. **Hannah Nana Amene Asiedu:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Conceptualization. **Samuel Antwi-Baffour:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Conceptualization. **Benjamin Tetteh Mensah:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Conceptualization. **Dorinda Naa Okailey Armah:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis, Data curation.

Declaration of Competing Interest

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Acknowledgments

We are grateful to the directors and managers of the Accra area blood centre and the Liberty Diagnostics Centre for their assistance in carrying out this study.

Disclaimer

The views and opinions expressed in this article are those of the authors and are the product of professional research. They do not necessarily reflect the official policy or position of any affiliated institution, funder, agency, or that of the publisher. The authors are responsible for this article's results, findings, and content.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

References

[1] Dorle A, Gajbe U, Singh BR, Noman O, Dawande P. A review of amelioration of awareness about blood donation through various effective and practical strategies. Cureus 2023 Oct 12;15(10):e46892. https://doi.org/10.7759/cureus.46892. PMID: 37954754; PMCID: PMC10638672.

[2] World Health Organization. Who can give blood [Internet]. 2018. Available from: ⟨https://www.who.int/campaigns/world-blood-donor-day/2018/who-can-give-blood⟩.

[3] Fateen T, Ali SS, Saqlain N, Shafqat F, Khalid A, Ali KS, et al. To assess the iron reserves in blood donors by measuring serum ferritin and hemoglobin in the Children Hospital Lahore. Pak J Med Health Sci 2022;16(10):265. https://doi.org/10.53350/pjmhs221610265.

[4] Dev S, Babitt JL. Overview of iron metabolism in health and disease. Hemodial Int 2017;21(S1):S6–20. https://doi.org/10.1111/hdi.12542.

[5] Kiss JE. Laboratory and genetic assessment of iron deficiency in blood donors. Clin Lab Med 2015;35(1):73–91. https://doi.org/10.1016/j.cll.2014.10.011.

[6] Baart AM, van Noord PAH, Vergouwe Y, Moons KGM, Swinkels DW, Wiegerinck ET, et al. High prevalence of subclinical iron deficiency in whole blood donors not deferred for low hemoglobin. Transfusion 2012;53(8):1670–7. https://doi.org/10.1111/j.1537-2995.2012.03956.x.

[7] World Health Organization. Anemia [Internet]. 2022. Available from: ⟨https://www.who.int/health-topics/anemia#tab=tab_1⟩.

[8] Adu P, Bennin D, Edzie R, Owusu-Poku A, Hakeem T, Baba G, et al. Depleted iron stores in voluntary blood donors: a three-center cross-sectional study in Ghana. Asian J Transfus Sci 2020;14(2):149. https://doi.org/10.4103/ajts.ajts_112_18.

[9] Balci YI, et al. Diagnostic value of MCV and RDW in detecting iron deficiency anemia in adolescents. Turk J Med Sci 2019;49(2):423–9. https://doi.org/10.3906/sag-1807-6.

[10] Kumar H, et al. RDW as a simple marker of nutritional deficiency in children. J Clin Diagn Res 2019;13(1):EC10–2. https://doi.org/10.7860/JCDR/2019/38771.12488.

[11] Hoffmann JJML, et al. Red cell distribution width as early marker in iron deficiency anemia. Clin Chem Lab Med 2021;59(3):509–16. https://doi.org/10.1515/cclm-2020-0995.

[12] Chowdhury S, et al. Role of complete blood count indices in the early detection of iron deficiency. Hematol Rep 2022;14(1):47–52. https://doi.org/10.3390/hematolrep14010006.

[13] Jain A, Chowdhury N, Jain S, Uttam N, Meinia SK. Altered red cell indices in repeat blood donors: experience of a North Indian blood bank. Indian J Hematol Blood Transfus 2018;34(4):666–70. https://doi.org/10.1007/s12288-018-0954-9.

[14] Waheed U, Arshad M, Sultan S, Saeed M, Arshad A, Irfan S, et al. Iron deficiency and iron deficiency anemia in blood donors at a tertiary care hospital in Islamabad, Pakistan. Glob J Transfus Med 2018;3(1):17. https://doi.org/10.4103/gjtm.gjtm_55_17.

[15] Sultana GS, Haque SA, Sultana T, Ahmed AN. Value of red cell distribution width (RDW) and RBC indices in the detection of iron deficiency anemia. Mymensingh Med J 2013;22(2):370–6. PMID: 23715364.

[16] Jeremiah ZA, Koate BB. Anemia, iron deficiency and iron deficiency anemia among blood donors in Port Harcourt, Nigeria. Blood Transfus 2010;8(2):113–7. https://doi.org/10.2450/2009.0113-09.

[17] Cable RG, Glynn SA, Kiss JE, Mast AE, Steele WR, Murphy EL, et al. Iron deficiency in blood donors: analysis of enrollment data from the REDS-II Donor Iron Status Evaluation (RISE) study. Transfusion 2010;51(3):511–22. https://doi.org/10.1111/j.1537-2995.2010.02865.x.

[18] Anju J, Abhishekh B, Debdatta B, Bobby Z, Sharan M. Assessment of iron status in regular blood donors in a tertiary care hospital in Southern India. Asian J Transfus Sci 2022 Jul-Dec;16(2):186–93. https://doi.org/10.4103/ajts.ajts_119_21. Epub 2022 Sep 28. PMID: 36687540; PMCID: PMC9855216.

[19] Zalpuri MG, Quee FA, Huis In 't Veld EMJ, Prinsze FJ, Hoogendijk EO, Twisk JWR, van Weert AWM, de Kort WLAM, van den Hurk K. Ferritin measurement in donors: effectiveness of iron monitoring to diminish iron deficiency and low hemoglobin in whole blood donors (FIND'EM): study protocol for a stepped wedge cluster randomised trial. Trials 2020;21(1):823. https://doi.org/10.1186/s13063-020-04648-w. PMID: 32998766; PMCID: PMC7528293.

[20] Petersen P, Hakimjavadi H, Chamala S, Mathur G. Evaluating utility of routine ferritin testing in blood donors: a hospital-based blood donor centre experience. Transfus Med 2024 Dec;34(6):491–8. https://doi.org/10.1111/tme.13081. Epub 2024 Aug 25. PMID: 39183386; PMCID: PMC11653056.