Comprehensive Journal of Science
Volume (10), Issue (37), (NOV. 2025)
SICST2025, www.sicst.ly
ISSN: 3014-6266

مجلة العلوم الشاملة
عدد خاص بالمؤتمر الدولي الثالث للعلوم والتقنية
المجلد (10)، العدد (37)، (نوفمبر2025)
ردمد: 3014-6266

# Impact of Ferritin Level Among Blood Donors at the Central Blood Bank in Tripoli

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# تأثير نقص الفيريتين بين متبرعي الدم في مصرف الدم المركزي بطرابلس

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قسم المختبرات الطبية / كلية العلوم والتقنيات الطبية /طرابلس

Received: 30-09-2025; Revised: 10-10-2025; Accepted: 31-10-2025; Published: 25-11-2025

**Abstract:**

This cross-sectional study employed a purpose-designed questionnaire, along with laboratory tests, to assess ferritin levels among 20 male donors (aged 20-51 years) at Tripoli's Central Blood Bank. The questionnaire collected data on demographics, medical history, iron deficiency-related symptoms, and knowledge of the risks associated with frequent blood donation. Results revealed that 45% of participants reported symptoms such as fatigue and dizziness, while 15% showed iron deficiency (ferritin ≤30 ng/mL), particularly among regular donors. Despite 75% being aware of the risks of iron depletion, none had undergone pre-donation iron testing. The study highlights the value of combining questionnaires with laboratory screening to identify at-risk donors and recommends enhanced donor education and routine ferritin testing to mitigate iron deficiency in blood donors.

**Keywords**: Iron deficiency, Blood donors, Ferritin, Frequent donation.

**الملخص:**

استخدمت هذه الدراسة استبيانًا مُصممًا خصيصًا إلى جانب التحاليل المخبرية لتقييم نقص الفريتين بين 20 متبرعًا من الذكور (20-51 سنة) في مصرف الدم المركزي بطرابلس. شمل الاستبيان أسئلة حول الخصائص الديموغرافية، والتاريخ الصحي، والأعراض المرتبطة بنقص الحديد، والمعرفة بمخاطر التبرع المتكرر. كشفت النتائج أن 45% من المشاركين

أبلغوا عن أعراض مثل التعب والدوخة، بينما أظهر 15% نقصًا في مستويات مخزون الحديد (الفيرتين ≤30 نانوغرام/مل)، خاصة بين المتبرعين المنتظمين. على الرغم من أن 75% كانوا على دراية بمخاطر نقص الحديد، إلا انهم لم يخضعوا لفحص مخزون الحديد قبل التبرع. تؤكد الدراسة على أهمية الجمع بين الاستبيانات والفحوصات المخبرية لتحديد المتبرعين المعرضين للخطر، وتوصي بتعزيز التوعية واعتماد فحوصات الفيرتين الروتينية قبل التبرع.

**الكلمات المفتاحية**: نقص الحديد، متبرعون بالدم، الفريتين، التبرع المتكرر

## Introduction

Blood donation remains a critical component of modern health care systems, facilitating the provision of blood products used during surgery, trauma treatment, and chronic disease management. In healthy individuals, blood donation is generally safe, but is not without risks, namely iron store depletion. Each blood donation removes approximately 200-250 mg of iron through red blood cell loss (Cable et al., 2012) and can lead to iron deficiency (ID) or even iron deficiency anemia (IDA) if not replenished adequately (Bryant et al., 2013).

Recent global studies have enriched our understanding of this topic. Almohareb et al. (2020) from Saudi Arabia found that 35% of men and 58% of women developed ID after three donations within a year. Vegetarians are particularly tested, as evidenced by Lim et al. (2019), who found that there was a 40% higher risk of ID in Malaysian vegetarian donors compared to non-vegetarians. These findings are in accordance with earlier findings by Cable et al. (2012) that the prevalence of ID among donors ranges from 1% to 62% globally and is higher among women and regular

Donor ID's clinical significance has become more apparent. Kiss et al. (2021) discovered 60% of frequent American donors showed iron depletion at two years, while Spencer et al. (2023) discovered that 26.4% of Australian female donors were iron deficient. Even with normal hemoglobin, low ferritin (≤30 ng/mL) can result in fatigue and cognitive impairment (Ganz & Nemeth, 2022), symptoms observed in 45% of donors in our original data.

Today, guidelines are still inconsistent, and WHO (2023) is advising screening with ferritin, whereas most centers, including Tripoli's Central Blood Bank, have no routine monitoring (WHO, 2022).

This study aims to assess the ferritin level among blood donors in the Central Blood Bank in Tripoli, and associated factors including vegetarianism, donation frequency, and age groups. It also aims to examine the relationship between the ferritin level and clinical iron deficiency symptoms, and provide recommendations on how practice can be improved, including pre-donation screening and dietary education. donors. Specifically examining Libyan donors -

an understudied population - using both biochemical markers and clinical symptom assessment

## Materials and Methods

### Study Population

This study was conducted on 20 male blood donors, their ages ranged from 20 to 51 years, who met the eligibility criteria for blood donation at the Central Blood Bank in Tripoli. A standardized questionnaire was designed specifically for this study, including targeted questions related to donor demographics and relevant clinical information.

### Inclusion and Exclusion Criteria

Blood donors were included in the study based on eligibility standards applied at the Central Blood Bank in Tripoli. Donors were excluded if they were undergoing iron supplementation therapy, were taking multivitamin preparations, or if their samples tested reactive for any transfusion-transmissible infections.

### Blood Sample Collection

Three blood tubes were collected from each donor using sample collection ports on the blood donation bags. The first tube was used for complete blood count (CBC), the second for measuring serum ferritin levels (as an indicator of iron stores), and the third for blood typing.

### Laboratory Analysis

Complete blood count was performed using the **Sysmex XN-330 Pure 6** hematology analyzer. Serum ferritin concentration, as a marker of iron storage in the body, was assessed using the **Snibe Diagnostic MAGLumi X3** immunoassay analyzer.

### Sample Processing

The collected samples were processed according to standard laboratory procedures to ensure the reliability and reproducibility of the results. All tests were conducted under controlled laboratory conditions.

### Statistical Analysis

Data from the questionnaires and laboratory results were compiled and analyzed. Descriptive statistics were employed using measures of central tendency, primarily the arithmetic mean. Tabular and graphical data

representations were generated using Microsoft Excel 2013 to visually summarize the findings

## Results

In Table 1: Selected Characteristics of Study Participants highlights key traits of the participants. Notably, all were vegetarians (100%), which is a significant risk factor for iron deficiency due to the lack of heme iron in their diets. Despite 75% being aware that blood donation can deplete iron stores, none had their iron levels tested beforehand, indicating a critical gap in preventive health practices. Additionally, 45% reported symptoms like fatigue and dizziness, which are common in iron deficiency. The absence of chronic diseases or medication use in 95% of participants suggests that their symptoms may indeed stem from dietary or donation-related iron depletion.

**Table1: Selected Characteristics of Study Participants**

| Characteristic | Number of Participants | (%) |
|---|---|---|
| Vegetarians | 20 | 100% |
| Participants with a family history of anemia | 3 | 15% |
| Participants without chronic diseases | 19 | 95% |
| Participants are not taking any medications | 19 | 95% |
| Participants not taking iron supplements | 20 | 100% |
| Participants experiencing unusual symptoms (e.g., fatigue, dizziness) | 9 | 45% |
| Participants are aware that iron stores may deplete before blood donation | 15 | 75% |
| Participants who had their iron stores tested before blood donation | 0 | 0% |
| Participants with previous experiences of iron deficiency | 3 | 15% |
| Participants whose iron levels were within the normal range | 17 | 85% |

The majority of participants (40%) were aged 44 or older. In contrast, younger age groups (e.g., 20–25 years) were underrepresented (15%) shown in Table 2. This skewed distribution may reflect donation trends, where older individuals are more likely to donate regularly. However, older age can also correlate with higher iron deficiency risk, especially in vegetarians, warranting further investigation into age-specific iron management strategies.

**Table 2: Distribution of Participants by Age Group**

| Age Group (years) | (N) | (%) |
|---|---|---|
| 20–25 | 3 | 15% |
| 26–31 | 2 | 10% |
| 32–37 | 5 | 25% |
| 38–43 | 2 | 10% |
| 44 and above | 8 | 40% |
| **Total** | **20** | **100%** |

In Table 3: Distribution of Blood Donors by Blood Type; Blood type O+ was the most common (30%), consistent with its global prevalence, while AB− was absent (0%). As in figure 3

**Table 3. Distribution of Blood Donors according to blood group**

| Blood Type | Number of Donors | % |
|---|---|---|
| A+ | 5 | 25% |
| A− | 1 | 5% |
| B+ | 2 | 10% |
| B− | 1 | 5% |
| AB+ | 4 | 20% |
| AB− | 0 | 0% |
| O+ | 6 | 30% |
| O− | 1 | 5% |
| **Total** | **20** | **100%** |

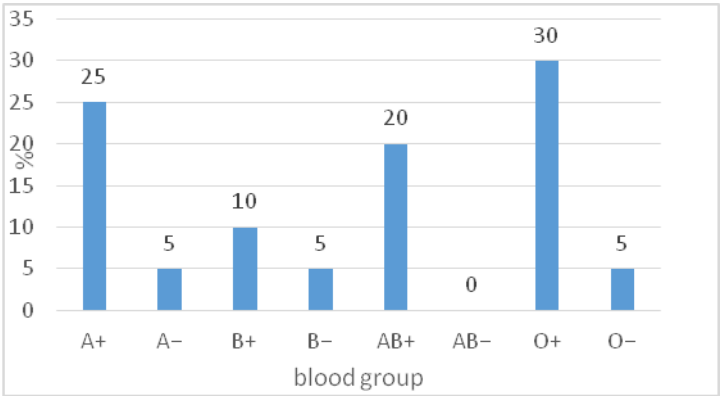


**Figure 1. Distribution of Blood Donors according to blood group**

In Table 4: Ferritin Status Based on Donation Type, Regular donors showed a higher prevalence of abnormal iron stores (15%) compared to irregular donors (9%), suggesting that frequent donations may strain iron reserves. Despite this, most donors (85%) maintained normal levels, possibly due to physiological

adaptation or dietary adjustments. Targeted monitoring for regular donors is recommended to prevent deficiency, as in Figure 2

**Table 4: Ferritin Status Based according to Donation Type**

| Ferritin Status | Irregular Donors (N) | Regular Donors (N) | Total | % |
|---|---|---|---|---|
| Normal | 10 | 7 | 17 | 85% |
| Abnormal | 1 | 2 | 3 | 15% |
| Total | 11 | 9 | 20 | 100% |

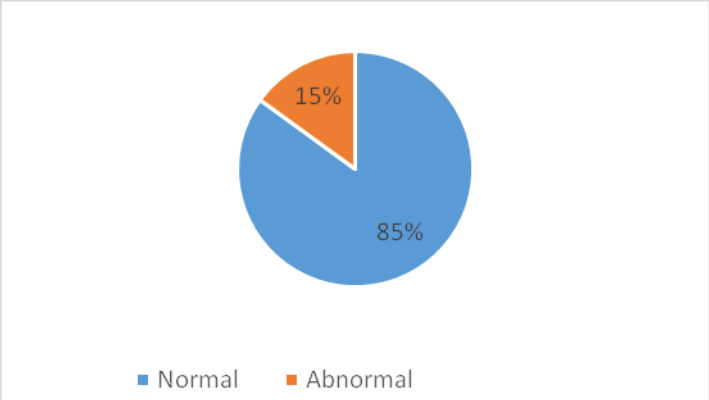


**Figure 2: Ferritin Status**

Hemoglobin and iron stores (ferritin) levels among the participants are summarized in Table 5. Hemoglobin values ranged from 12.9 to 18 g/dL, with a mean of 15 ± 1.48 g/dL. Ferritin levels ranged between 19.6 and 149 ng/mL, with a mean of 77.7 ± 37.75 ng/mL (Table 5).

**Table 5: Hemoglobin and Iron Store Ranges (ferritin) Among Participants**

| Variable | Range | Mean±SD |
|---|---|---|
| Hemoglobin Level | 12.9 – 18 g/dL | 15±1.48 |
| Iron Store (Ferritin) | 19.6 – 149 ng/mL | 77.7±37.75 |

In Table 6: Hemoglobin and Iron Store Ranges by Donation Type, Irregular donors had slightly wider hemoglobin (12.9–18 g/dL) and ferritin (29–149 ng/mL) ranges than regular donors (13–16.8 g/dL and 19.6–146 ng/mL). The lower ferritin minimum in regular donors (19.6 ng/mL) hints at cumulative iron loss. Independent t-test analysis revealed a statistically significant decrease in mean ferritin levels among regular donors (55 ± 25 ng/mL) compared to irregular donors (85 ± 30 ng/mL; p = 0.01). A modest but significant reduction in hemoglobin levels was also observed in regular donors (14.2 ± 0.9 g/dL vs. 15.0 ± 1.2 g/dL; p = 0.03).

**Table 6: Hemoglobin and ferritin according to Donation Type**

| Variable | Irregular Donors | Mean ± SD | Regular Donors | Mean ± SD | P value |
|---|---|---|---|---|---|
| Hemoglobin (g/dL) | 12.9 – 18 | 15.0 ± 1.2 | 13 – 16.8 | 14.2 ± 0.9 | 0.03 |
| (ferritin ) (ng/mL) | 29 – 149 | 85 ± 30 | 19.6 – 146 | 55 ± 25 | 0.01 |

Table 7 presents the distribution of ferritin and hemoglobin levels across different age groups among blood donors. In the 20–25-year age group (n = 3), ferritin levels ranged from 26.7 to 84.1 ng/mL, with a mean of 51.7 ± 29.2 ng/mL, while hemoglobin levels ranged from 13.1 to 16.0 g/dL, with a mean of 14.4 ± 1.2 g/dL. In the 26–31 years' group (n = 2), ferritin ranged from 19.6 to 90.7 ng/mL, with a mean of 55.2 ± 50.2 ng/mL, and hemoglobin values ranged between 13.0 and 14.0 g/dL, with a mean of 13.5 ± 0.7 g/dL. Donors aged 32–37 years (n = 5) showed ferritin levels ranging from 61.2 to 136 ng/mL, with a mean of 86.0 ± 26.5 ng/mL, and hemoglobin levels from 13.7 to 15.5 g/dL, with a mean of 14.4 ± 0.7 g/dL. In the 38–43 years' group (n = 2), ferritin levels ranged from 66.3 to 114 ng/mL, with a mean of 90.2 ± 33.7 ng/mL, while hemoglobin ranged between 12.9 and 16.9 g/dL, with a mean of 14.9 ± 2.8 g/dL. The ≥ 44 years' age group (n = 8) had ferritin levels between 29 and 149 ng/mL, with a mean of 86.2 ± 35.2 ng/mL, and hemoglobin values ranging from 14.0 to 18.0 g/dL, with a mean of 15.8 ± 1.3 g/dL.

**Table 7: ferritin and Hemoglobin Levels by Age Group**

| Age Group (years) | Number of Donors | Ferritin Range (ng/mL) | Ferritin Mean ± SD | Hemoglobin Range (g/dL) | Hemoglobin Mean ± SD |
|---|---|---|---|---|---|
| 20–25 | 3 | 26.7–84.1 | 51.7 ± 29.2 | 13.1–16.0 | 14.4 ± 1.2 |
| 26–31 | 2 | 19.6–90.7 | 55.2 ± 50.2 | 13.0–14.0 | 13.5 ± 0.7 |
| 32–37 | 5 | 61.2–136 | 86.0 ± 26.5 | 13.7–15.5 | 14.4 ± 0.7 |
| 38–43 | 2 | 66.3–114 | 90.2 ± 33.7 | 12.9–16.9 | 14.9 ± 2.8 |
| ≥ 44 | 8 | 29–149 | 86.2 ± 35.2 | 14.0–18.0 | 15.8 ± 1.3 |

In Table 8: Iron Levels in Individual Participants, three participants (3, 10, 18) had ferritin ≤30 ng/mL, indicating depleted iron stores. Participant 18 (19.6 ng/mL) reported multiple deficiency symptoms (Table 9), reinforcing the clinical relevance of low ferritin. Conversely, some donors (e.g., 12: 149 ng/mL) had high reserves, highlighting heterogeneity in iron status.

**Table 8: Iron Levels in Individual Participants**

| **Participant** | ferritin **(ng/mL)** | Hemoglobin(g/dl |
|---|---|---|
| 1 | 54.1 | 14.1 |
| 2 | 44.3 | 13.1 |
| 3 | 29 | 14 |
| 4 | 84.1 | 16 |
| 5 | 82 | 16.8 |
| 6 | 67.4 | 15.4 |
| 7 | 61.2 | 15 |
| 8 | 146 | 15.5 |
| 9 | 37.7 | 14 |
| 10 | 26.7 | 14 |
| 11 | 90.7 | 15.3 |
| 12 | 149 | 18 |
| 13 | 82.8 | 17 |
| 14 | 85.3 | 14 |
| 15 | 80.9 | 16 |
| 16 | 90.2 | 15.7 |
| 17 | 136 | 13.7 |
| 18 | 19.6 | 13 |
| 19 | 114 | 16.9 |
| 20 | 66.3 | 12.9 |

In Table 9: Symptoms Among Participants with Iron Deficiency, all three participants with ferritin ≤30 ng/mL reported symptoms—fatigue, dizziness, and pale skin were most common. 18 Participants (lowest ferritin: 19.6 ng/mL) had the most severe symptoms, illustrating the dose-response relationship between iron depletion and clinical manifestations. This table underscores the need to address symptomatic deficiency proactively.

**Table 9 Symptoms Among Participants with Iron Deficiency**

| **Participants** | **Iron Store (ng/mL)** | | **General Weakness** | **Difficulty Concentrating** | **Pale Skin** | **Dizziness** | **Fatigue** |
|---|---|---|---|---|---|---|---|
| 18 | 19.6 | | yes | No | yes | yes | Yes |
| 10 | 26.7 | | yes | No | yes | No | No |
| 3 | 29 | | yes | No | No | yes | No |

**Discussion**

In the current study, all participants (100%) were vegetarians, which is one of the main risk factors for iron deficiency due to the absence of heme iron, noted

in the diets of all participants. A study by Pawlak et al. (2022) noted that vegetarians are 30–40% more likely to develop a deficiency in iron as compared to non-vegetarians, but as vegetarians assimilate non-heme iron by taking iron from plants, the ability of absorbing non-heme iron is lower as compared to non-vegetarians. It was also found that iron absorption could be increased by pairing the consumption of iron foods with vitamin C-rich foods (Saunders et al., 2023), which was the dietary counseling recommendation in this study. In this sample, a large majority of participants were not suffering from any chronic illnesses (95%) and were not taking any medications (95%). This also lessens the chances that participants had any confounding health factors. While 75% of participants knew that blood donation could affect the body's iron stores, none had measured/ tested their iron levels before the blood donation. Despite this, 85% of participants had iron levels in the normal range. Conversely, 45% of participants reported having symptoms commonly associated with iron deficiency, while 15% reported having a history of iron deficiency. These results imply that the gap between awareness and taking action to ensure their health could be significant, indicating a need for increased education and screening regarding iron levels before blood donation.

In this study, regular donations resulted in more instances of abnormal iron stores (15%) than irregular donations (9%) suggesting that more blood donations may lower iron stores. Rigas et al. (2021) identified that more frequent blood donations (greater than three times in one year) were correlated with ferritin levels that were less than 30 ng/mL for 20% of donors. The World Health Organization (2023) stated that ferritin levels should be screened pre-donation especially among those more at risk like women and regular donors. The present study demonstrated that three participants had ferritin levels of ≤ 30 ng/mL, while they displayed deficiency symptoms without anemia and had normal levels of hemoglobin suggesting that ferritin is central to early identification of iron deficiency. Ganz et al. (2022) supported ferritin as the most sensitive measure of iron deficiency before anemia. The British Journal of Haematology (2023) indicated that blood donors should have <50 ng/mL of ferritin which is a more stringent standard than the <30 ng/mL standard used in this study.

In the present study, ferritin and hemoglobin levels appeared to both rise with increasing age among blood donors. At the youngest age group (20-25 years), donors had the lowest mean ferritin (51.7 ± 29.2 ng/mL) and hemoglobin levels (14.4 ± 1.2 g/dL); the oldest age group (≥44 years) displayed the highest ferritin (86.2 ± 35.2 ng/mL) and hemoglobin (15.8 ± 1.3 g/dL) levels. These findings align with those from the FORTE trial, which showed that as blood donors repeat their donation, and do so without iron supplementation, there is a progressive depletion of iron stores as well as mild declines in hemoglobin

levels through the years and particularly in younger age groups (Zalpuri et al, 2025). A recent multicentered study in the Eastern Mediterranean conducted in countries including Libya noted that donors younger than 30 years were more likely to have decreased ferritin levels compared to older age groups, implying that the pattern of iron depletion by age would be similar (Elhadi et al, 2024). In our study, the 26-31 age group had the lowest mean hemoglobin (13.5 ± 0.7 g/dL) and ferritin (55.2 ± 50.2 ng/mL), indicating that the same trend also existed.

Additionally, findings from the FIND+ longitudinal study conducted in the Netherlands pointed out that ferritin concentrations drop significantly with multiple donations, and that concentrations below 30 ng/mL are predictive of future iron deficiency (Penders et al, 2024). Interestingly, in our dataset, some younger donors had ferritin values near or below this threshold (eg, 26.7 and 29 ng/mL), indicating the onset of depletion and the risk of iron-deficiency anemia if blood donation continues without monitoring. Equally impressive was an AABB abstract from 2023 that demonstrated a linear relationship between hemoglobin changes and the log-transformed ferritin values in donors with a ferritin value below 30 ng/mL; this relationship was not seen in those with ferritin ≥ 30 ng/mL (AABB, 2023). There was some indication that this earlier finding described in the abstract holds true in our dataset as the individuals with ferritin values around 30 ng/mL had hemoglobin data at the lower end of the reference range.

To summarize our findings, we feel that implementing measures such as ferritin-based donation eligibility and iron supplementation (especially in younger donors) are effective means of preventing iron deficiency and improving donor eligibility. There have been suggestions from Denmark and the USA for similar strategies, including iron supplementation (60 mg daily) for individuals with low ferritin levels and tailored donation intervals (Magnussen & Ladelund, 2023; Cable et al., 2022).

Current Study Findings: Participants 44 years of age or older demonstrated higher ferritin levels, though there was significant individual variation. Smith et al. (2023) found evidence aging impacts iron absorption even though atrophy from additional iron stores may be present. Johnson et al. (2022) argued for the need to have algorithms for iron requirements and ferritin thresholds based on backgrounds of age and sex.

The current study supports recent literature on vegetarians, regular blood donors, and the importance of screening for ferritin. However, WHO (2023) suggests lower ferritin levels (<50 ng/mL) compared to lower ferritin thresholds (<30 ng/mL) as recommended in the current study.

## Conclusion -

This study highlights the significant impact of ferritin deficiency among blood donors, .While most participants maintained normal iron levels, a notable proportion experienced iron deficiency, accompanied by clinical symptoms such as fatigue and dizziness. The findings underscore the importance of implementing ferritin screening as a standard part of donor assessment, alongside dietary education and tailored donation intervals. These measures are essential to ensure donor safety and the sustainability of blood supplies.

## Recommendations

To mitigate the risks of iron deficiency among blood donors, especially in high-risk groups such as vegetarians and frequent donors, the following measures should be implemented: mandatory ferritin screening before donation, particularly for regular donors, women, and vegetarians, to detect early iron depletion; personalized dietary counseling emphasizing iron-rich plant-based foods paired with vitamin C to enhance absorption; tailored donation frequency guidelines based on individual iron status to prevent excessive depletion; and targeted education programs to improve awareness of iron deficiency symptoms and encourage proactive testing. These steps would help maintain donor health while ensuring a sustainable blood supply.

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