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Effect Of Regular Voluntary Blood Donation On Iron Stores In Males

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Abstract:
Background*: Blood donation results in a loss of 200 to 250 mg of iron stores for every donation. Voluntary blood donation camps are conducted regularly to improve the availability of blood components. Donors who donate blood in these camps are mostly the existing pool of voluntary donors. Repeated donation might lead to a decrease in the donors' haemoglobin and iron store levels. Haemoglobin measurement is the only method for estimating iron levels in blood donors. This study is taken with the health of precious voluntary regular donors in mind. The study aimed to evaluate the iron status of regular voluntary blood donors by measuring their total iron profile. The study also compared the total iron profile between first-time and regular voluntary blood donors who had donated five or more times.*
Materials and Methods*: In this cross-sectional study, 126 blood donors who passed the pre-donation screening were divided into first-time and regular donors. Regular donors are those who have donated blood five or more times voluntarily and made their last donation within one year. Haemoglobin, red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and red cell distribution width were estimated. Serum ferritin, serum iron, total iron-binding capacity and unsaturated iron-binding capacity were estimated to evaluate the donors' total iron profile. The association of these parameters between the two donor groups was studied.*
Results*: The first-time donors had significantly higher serum ferritin levels than the regular donors, suggesting that the repeated donation might lead to decreased iron stores. Other parameters were within the normal range, and no notable correlation was observed.*
Conclusion: *Haemoglobin estimation as a sole criterion for detecting anaemia before blood donation does not accurately reflect body iron stores and may not be adequate in preventing iron deficiency among blood donors. Review of the screening criteria for blood donation could be conducted by adding the serum ferritin measurement to it, so that adequate iron stores in the donor can be ensured. Steps may also be taken to protect donors by raising awareness of iron supplementation and dietary changes.*
Key Word*: Blood donation, Haemoglobin, regular blood donors, serum iron, serum ferritin*

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I. Introduction

The voluntary unpaid blood donation is a humanitarian act towards the sick by the healthy. No transfusion service can survive without blood donors. The well-being and health of blood donors are of prime importance to the medical profession.[1] The general impact of blood donation on iron status has been studied since the late 1970's. Iron deficiency anaemia is a common finding in regular blood donors. According to current guidelines, haemoglobin (Hb) is used to screen donors in blood centres. Hb measurement alone may not detect donors with iron deficiency, thus accepting many donors with depleted iron stores but normal Hb values.[2]

Iron is present in the human body in haemoglobin, myoglobin, and several irons containing mitochondrial respiratory enzymes. It serves as a carrier for oxygen and electrons and acts as a catalyst for various oxygenation reactions. So, this micronutrient is essential for every cell.

Iron deficiency is one of the most important problems in the world today, especially in developing countries. Almost one-third of the world's population suffers from iron deficiency and its complications due to inadequate dietary iron intake, ineffective absorption, excessive loss, or increased iron requirements. Since each blood donation reduces between 200 to 250 mg of iron stores, blood donation significantly reduces serum ferritin levels more than other iron parameters.[3]

Iron deficiency is also reflected in the haematological parameters by low haemoglobin, low pack cell volume, low mean cell volume, low mean cell haemoglobin and low mean cell haemoglobin concentration, whereas the red cell distribution width is increased.

In India, the annual blood units required are more than those collected in our government and private blood centres. So, to meet this additional requirement, several voluntary blood donation camps are conducted. However, the donors are often from the existing pool of voluntary blood donors. So, these repeated voluntary blood donations can affect their haemoglobin and iron store levels.[4]

This study is taken up keeping in mind the health of precious voluntary regular donors to protect them from iron depletion, iron deficiency, iron deficiency anaemia and its consequences and, most importantly, retain them as a healthy voluntary donor as long as possible without any adverse effects on their health. The study aimed to evaluate the iron status of regular voluntary blood donors by measuring their total iron profile. The study also compared the total iron profile between first-time and regular voluntary blood donors who had donated five or more times.

II. Material And Methods

This cross-sectional study was conducted in the Department of Transfusion Medicine of a tertiary care centre in Imphal, Manipur, between August 2019 and September 2021 after getting due approval from the Institutional Research Ethics Board. Voluntary blood donors who passed the pre-donation screening as stipulated by the Drugs and Cosmetics Act were recruited after obtaining informed written consent and divided into two groups: first-time donors and regular donors. First-time donors are those who have donated blood voluntarily for the first time, and regular donors are those who have donated blood five or more times voluntarily and made their last donation within one year.

A complete blood count, serum ferritin, serum iron, total iron-binding capacity (TIBC), and unsaturated iron-binding capacity (UIBC) were estimated to evaluate the donors' total iron profile.

Blood sample collected in a 2 mL ethylenediamine tetraacetic acid (EDTA) tube was analysed using an automated cell count analyser to measure haemoglobin (Hb), red blood cell count, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW). Serum obtained after centrifuging the 2 mL clotted sample was analysed to measure serum ferritin by enzyme-linked immunosorbent assay (ELISA), serum iron, TIBC, and UIBC by the ferrozine method.

The following values were taken for the study as normal values.[5]

Haemoglobin in adult males: 13.5 – 18.0 g/dL
Red cell count in adult males: 4.20 – 6.00 million/mcL
Packed cell volume (PCV): 40 – 50%
Mean corpuscular volume (MCV): 80 – 100 fL
Mean corpuscular haemoglobin (MCH): 26 – 34 pg
Mean corpuscular haemoglobin concentration (MCHC): 32 – 36 g/dL
Red cell distribution width (RDW): 11.5 – 14.5%
Serum ferritin in males: 40 – 400 ng/mL
Serum iron: 50 – 160 mcg/dL
Total iron binding capacity (TIBC): 250 – 400 mcg/dL
Unsaturated iron binding capacity (UIBC): TIBC in mcg/dL – Serum iron in mcg/dL

Descriptive statistics like mean, standard deviation and percentages were used. Chi-square test, independent 't' test and ANOVA were used to determine the level of significance. Post-hoc test was also used to find the association between the groups. A p-value of <0.05 was taken as statistically significant.

III. Result

A total of 126 donors donated blood voluntarily during the study period, and all of them were males. The mean age of the donors was 33.62 ± 8.89 years. Fifty-five donors (43.65%) were in the first-time donors group, and 71 donors (56.35%) were in the regular donors group. The distribution of donors in terms of the number of donations is shown in Table no 1.

Table no 1: Number of blood donations by the donors

Number of donations	No. of donors
First-time	55 (43.65%)
5 to 10	39 (30.95%)
11 to 20	22 (17.46%)
21 to 30	4 (3.18%)
More than 30	6 (4.76%)
Total	126 (100%)

The age (in years) of first-time donors ranged from 20 to 48, and regular donors ranged from 21 to 58. The mean age of first-time donors was 30.53±6.81 (mean±SD), and that of regular donors was 36.02±9.6 (mean±SD). There was a significant association between the age group of the blood donors and the number of donations. Table no 2 illustrates the distribution of the two donor groups based on age.

Table no 2: Age of two donor groups

Age (in years)	First Time Donors (n = 55)	Regular donors (n = 71)	p-value
18 – 30	37	25	0.001
31 – 40	13	20	
41 – 50	5	21	
51 - 60	0	5	

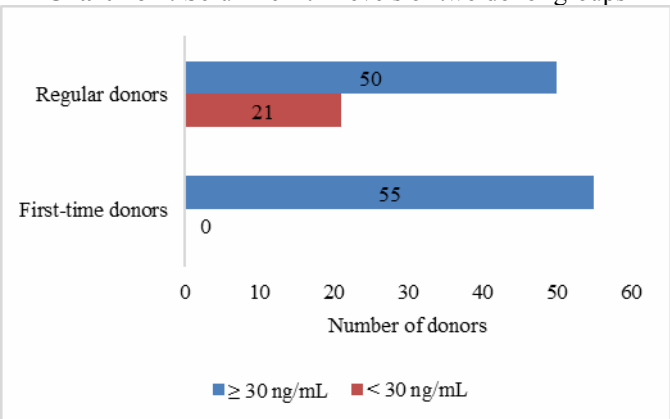
Haemoglobin, red blood cell count, PCV, MCV, MCH, MCHC, and RDW were within acceptable limits, and their mean values are given in Table no 3. The association of haemoglobin, red blood cell count, PCV, MCV, MCH, MCHC, and RDW between the two donor groups were studied and was not significant.

Table no 3: Various parameters of two donor groups

Parameter	First Time Donors (Mean ± SD)	Regular donors (Mean ± SD)	p-value
Hb (g/dL)	14.63±1.24	14.35±1.37	0.243
RBC count (million/mcL)	4.86±0.52	4.9±0.58	0.686
PCV (%)	41.22±3.91	40.57±4.32	0.381
MCV (fL/cell)	85.04±6.39	83.31±7.43	0.172
MCH (pg)	30.26±2.7	29.56±2.83	0.160
MCHC (g/dL)	35.54±2.36	35.53±2.36	0.978
RDW (%)	13.44±1.22	13.72±1.89	0.346

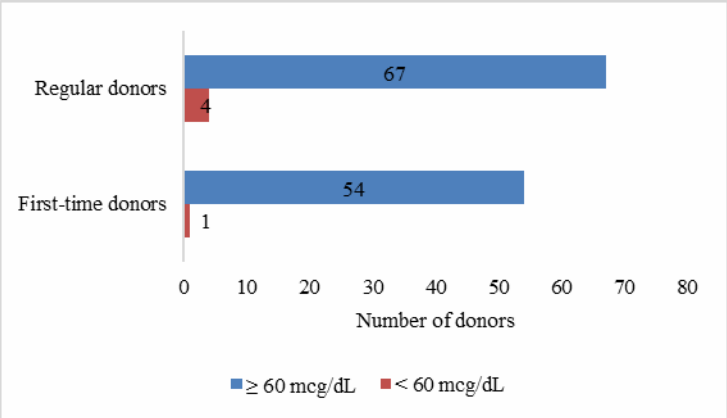
The mean serum ferritin of all the donors was 94.90±72.17 ng/mL (mean±SD). The serum ferritin value of less than 30 ng/mL was considered as low ferritin as per the study conducted by Dijkstra A. et al.[6]. Serum ferritin level was ≥ 30 ng/mL in 105 donors (83.33%) and < 30 in 21 donors (16.67%). All the first-time donors had a serum ferritin level of ≥ 30 ng/mL, whereas, among the regular donors, 50 had ≥ 30 ng/mL, and 21 had < 30 ng/mL, as shown in Chart no 1. First-time donors had significantly higher serum ferritin levels than regular donors (p-value - < 0.001).

Chart no 1: Serum ferritin levels of two donor groups



The mean serum iron of all the donors was 117.46 ± 41.95 mcg/dL (mean±SD). Serum iron was ≥ 60 mcg/dL in 121 donors (96.03%) and < 60 mcg/dL in 5 donors (3.97%). Among the first-time donors, 54 had a serum iron level of ≥ 60 mcg/dL and one donor < 60 mcg/dL. Whereas among regular donors, 67 had ≥ 60 mcg/dL, and 4 donors had < 60 mcg/dL, as shown in Chart no 2. The correlation was statistically not significant (p-value – 0.386).

Chart no 2: Serum iron levels of two donor groups



Among the first-time donors, 54 had TIBC of ≥ 250 mcg/dL and 1 had < 250 mcg/dL. Among the regular donors, 69 had TIBC of ≥ 250 mcg/dL and 2 had < 250 mcg/dL, and was not statistically significant (p-value – 1.00). Unsaturated Iron Binding Capacity (UIBC) values were within acceptable limits, and mean values of TIBC and UIBC are given in Table no 4.

Table no 4: TIBC and UIBC of two donor groups

Parameter	First Time Donors (Mean ± SD)	Regular donors (Mean ± SD)	p-value
TIBC (mcg/dL)	322.57±28.15	323.1±37.39	1.000
UIBC (mcg/dL)	200.02±49.31	210.23±61.12	0.315

IV. Discussion

The present study included 126 male blood donors who donated blood at the Department of Transfusion Medicine of a tertiary care centre in Imphal, Manipur, between the ages of 20 and 58. Donor selection criteria were based on the basic eligibility guidelines for blood donation in India. The study only included male blood donors, as done by Thomas et al.[2], Sujatha B et al.[4], Norashikin et al.[7], Abdullah SM[8], Akpotuzor et al.[9] and Mackintosh and Jacob.[10] Researchers[11,12] also studied both genders and concluded that iron depletion in females is more caused by factors such as menstrual iron loss, diet, and BMI. The study found that the donor's age was statistically significant to the number of donations, which can be justified by the fact that as the age of the donor increases, he tends to donate more blood compared to the younger donors.

Many factors influence an individual donor's ability to donate blood without developing iron deficiency anaemia, including differences in nutritional iron intake, the prevalence of iron deficiency in the specific population, menstrual iron loss in females, worm infections, blood loss, frequency of blood donation, use of supplemental iron, and the capacity to absorb iron.[11]

As the demand for blood products grows and only humans can meet the massive demand for blood, more and more donors are needed to accomplish the requirement.[13] In many countries, recruiting a sufficient number of new blood donors is a huge challenge.[14,15] One of the most common reasons for donor rejection, particularly among young women, was the failure to meet the Hb criteria.[16] Greater pressure is placed on the established donors to ensure an adequate blood supply because it is easier to collect blood from known or existing donors than to recruit new donors. Donors with a high frequency of donations are at risk for iron deficiency[2].

This study was carried out considering the health of regular volunteer donors who are valuable, to protect them from iron depletion, iron deficiency, iron deficiency anaemia or its consequences and, most importantly, to retain them as healthy volunteer donors for as long as possible without any adverse effects on their health.

In the present study, the haemoglobin of all the donors was within acceptable limits. However, studies show that haemoglobin measurement alone is inadequate to detect donors with iron deficiency as they may be in

the first or second stage of iron deficiency[17]. This results in accepting many iron-depleted donors with normal haemoglobin values[18]. For blood donation, all blood centres have a minimum haemoglobin requirement. It is usually estimated by measuring the haemoglobin concentration indirectly through finger-prick blood sampling. Although measuring haemoglobin is simple, quick, and inexpensive, it may not be the accurate criterion for estimating body iron stores.

Parameters such as red cell count, PCV, MCV, MCH, MCHC, and MCHC were in the normal ranges and were not statistically significant to the number of donations. Other studies also show no correlation between these parameters and the number of donations.[2,8,19]

Total body iron is 3 to 5 grams, out of which 60% to 70% is within haemoglobin in the red blood cells. A unit of blood contains 230 to 250 milligrams of iron, about 8% to 10% of that present in the red blood cells.[20,21] So, blood donations cause a significant loss of iron, which will be replenished in an average adult within 12 to 16 weeks.[21]

There was a significant association between the serum ferritin levels of the blood donors and the number of donations. This exhibited that the iron store was depleted in the regular donor group, suggesting that serum ferritin level decreases as the blood donation number increases. Other studies also showed a decrease in serum ferritin levels when the frequency of blood donation increased[7,21], which was consistent with this study.

In the study, serum iron levels, TIBC, and UIBC were normal; no significance was found with the number of donations.

V. Conclusion

Blood donation has a profound effect on iron stores. It is a significant factor for iron deficiency in blood donors, especially in repeat donors, despite their eligibility to donate blood according to the guidelines.

As all the donors who participated in the study had passed the haemoglobin screening test before blood donation, the present study suggests that haemoglobin estimation as a sole criterion for the detection of anaemia before blood donation does not accurately reflect body iron stores and may not be adequate in the prevention of iron deficiency among blood donors.

Review of the screening criteria for blood donation could be conducted by adding the serum ferritin measurement to it, so that adequate iron stores in the donor can be ensured.

We also recommend that necessary steps be taken to protect donors by raising awareness of iron supplementation and dietary changes.

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