



Original article

Evaluation of Iron Stores in Blood Donors by Estimation of Serum Ferritin level

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ABSTRACT

Context: Regular blood donation can lead to iron deficiency as well as iron deficiency anaemia. Screening of voluntary blood donor's serum ferritin levels at the time of donation is very important to estimate the iron deficiency because they lose 236 mg of iron in each donation. **Aim:** To evaluate serum ferritin estimation in voluntary blood donors and to reflect the paucity of data in our country especially south India, regarding impact of regular voluntary blood donation on iron status of donors. **Material and Methods:** This study was conducted prospectively in which 100 voluntary blood donors were included. The blood donors were divided into four groups, according to the number of blood donations. Pre-donation haemoglobin assessment was done and serum ferritin was estimated by indirect ELISA. Statistical analysis used: The statistical analysis was done by using Student's 't' test and Z test. **Results:** The percentage of female donors with deficient iron stores was more as compared to male donors. The serum ferritin levels were significantly high in first time donors compared to regular donors. The serum ferritin levels gradually decreased depending upon the frequency of donations. Hence the number of donation per year was more predictive of decreased iron stores rather than the number of lifetime donations. The serum ferritin levels were significantly lower among the regular donors, compared to first time donors. The serum ferritin was <15 µg/L in 22.22% and 42.85% of male and female donors respectively who donated once a year, 27.77% and 28.57% in those who donated twice a year and 47.82% and 100% in those who donated thrice a year. **Conclusion:** Even though level of haemoglobin remained acceptable for blood donation but estimation of haemoglobin alone in regular blood donors may not be adequate for detection of iron deficiency. Hence, serum ferritin estimations may be needed to detect sub-clinical iron deficiency status. Iron supplementation and counselling needs to be considered in regular voluntary blood donors to minimise the risk of iron deficiency.

KEYWORDS: Blood donors, iron deficiency, iron stores, serum ferritin.

INTRODUCTION

Iron deficiency is the most common nutritional deficiency in both developing and developed countries. Regular blood donation may be an important cause of iron loss. Each 1.0 mL of blood contains approximately 0.5 mg of iron. A unit of donated blood therefore contains

approximately 250mg of iron and iron stores are approximately 30% lower in female observed in long-term blood donors. [1-5]

Chronic iron deficiency is a well-recognized complication of regular blood donation. With each

donation men lose 242 ± 17 mg and women lose 217 ± 11 mg of iron [6]. A healthy individual can donate blood up to four times a year, i.e., at three monthly intervals as iron stores get replete within this time period[7]. The donors must weigh at least 45 kg, as per Drugs and Cosmetics Act, Government of India and all are screened for anaemia prior to donation[8]. Cut-off value of haemoglobin of 12.5 g/dL is used.

In the majority of blood banks, haemoglobin has generally been used as a screening test for the suitability to donate blood. However, the use of this parameter has been reported to have poor sensitivity in the detection of early stages of iron deficiency. [4,9] The effect of blood donation on iron balance has been studied on changes in haemoglobin concentration, plasma iron concentration, total iron binding capacity, and iron stores. Initially haemoglobin concentration was the chief concern. Increasing number of donations is associated with a distinct fall in iron stores [9].

Since haemoglobin levels may be normal in the presence of reduced iron stores [10-12], the individuals potentially at risk for developing iron deficiency anaemia can be detected only by estimation of serum ferritin. Therefore iron status of the donors needs to be identified and necessary steps for iron supplementation need to be taken. This is especially relevant with the global and national drive to recruit and retain regular repeat voluntary blood donors [2].

To the best of our knowledge no systematic study has been conducted in south India to assess the iron stores in voluntary blood donors. The main objective of this study was to evaluate the effect of frequent blood donation on iron stores among regular voluntary blood donors at Yenepoya Medical College Hospital, blood bank, Mangalore and to correlate the serum ferritin levels with the number of donation.

MATERIALS AND METHODS

One hundred (100) voluntary blood donors were prospectively included in this study over a period of one year in our Blood bank. All selected donors were healthy according to their clinical histories, physical examination and fulfilled the suitability criteria for donation (haemoglobin >12.5 g/dL).

Donors were selected on the basis of the criteria laid down in the Technical Manual of the Directorate General of Health Services, Ministry of Health and Government of India for blood donation [13]. The selected donors were asked specific questions as per donor questionnaire, i.e., age at first donation, total number of life time donations, number of donations within previous one year, interval between donations, date of last donation/previous donation, dietary history; vegetarian and non-vegetarian food intake and its frequency.

The donors were divided into four groups according to the number of donations per year. The blood donors in group I (n=25) were first-time donors with no previous history of blood donation. Donors in group II (n=25), had previously donated once in the previous year and were donating for the second time. Group III donors (n=25), had donated twice in the previous year and were donating for the third time. Group IV donors (n=25) had donated thrice in the previous year and were donating for the fourth time. The study protocol was cleared by the Ethical Committee of the institute.

Informed consent was obtained from each donor who fulfilled the criteria for blood donation [13]. After blood donation of 450 ± 50 ml of whole blood and serum was separated from samples i.e 7.5 ml of blood collected from the pilot tubes from each blood bags (Thermopenpol company) after donation of blood. The ferritin was estimated in batches of samples by indirect solid phase (ELISA) enzyme immuno-metric assay using commercial ELISA kits available from Abbot AxSYM Ferritin 7k45-20. The test values were read from the standard curve.

Iron stores were considered depleted at serum ferritin values <15 μ g/L, reduced at values <20 μ g/L and normal at values from 50-200 μ g/L. In addition, iron deficiency anaemia was defined as serum haemoglobin and ferritin below 13g/dl and 15 μ g/L, respectively[14]. Data were analysed by dividing the donors in each group according to gender into male and female donors. Further categorization was also done age wise. For statistical analysis Student's 't' test and Z-test for percentage were performed by using SPSS computer software and p values less than 0.05 were considered statistically significant.

Expected values: Normal Range of serum ferritin values ($\mu\text{g/L}$)[15]

Adult Males (18-30 years of age)	-	18.7 - 323.0 ($\mu\text{g/L}$)
Adult Males (31-60 years of age)	-	16.4 - 293.9 ($\mu\text{g/L}$)
Adult Females (Premenopausal)	-	6.9 - 282.5 ($\mu\text{g/L}$)
Adult Females (Postmenopausal)	-	14.0 - 233.1 ($\mu\text{g/L}$)

RESULTS

A high number of blood donations may cause iron depletion. In order to evaluate iron stores in voluntary blood donors, a total 100 donors were included in this study, in which 75% were male and 25% female donors. All the donors had haemoglobin value >12.5 gm/dL. The donors were between 18 and 60 years of age and most of

the donors were between the ages of 21 to 30 years. In graph 1, of the total 100 donors, 17 were male and 8 were female in group I, 18 were male and 7 were female in group II, group III, 23 were male and 2 were female donors in group IV and the mean ages of donors were 28.20, 31.36, 33.04 and 33.68 years respectively.

Graph 1: Distribution of donors according to frequency of donation, age and sex.

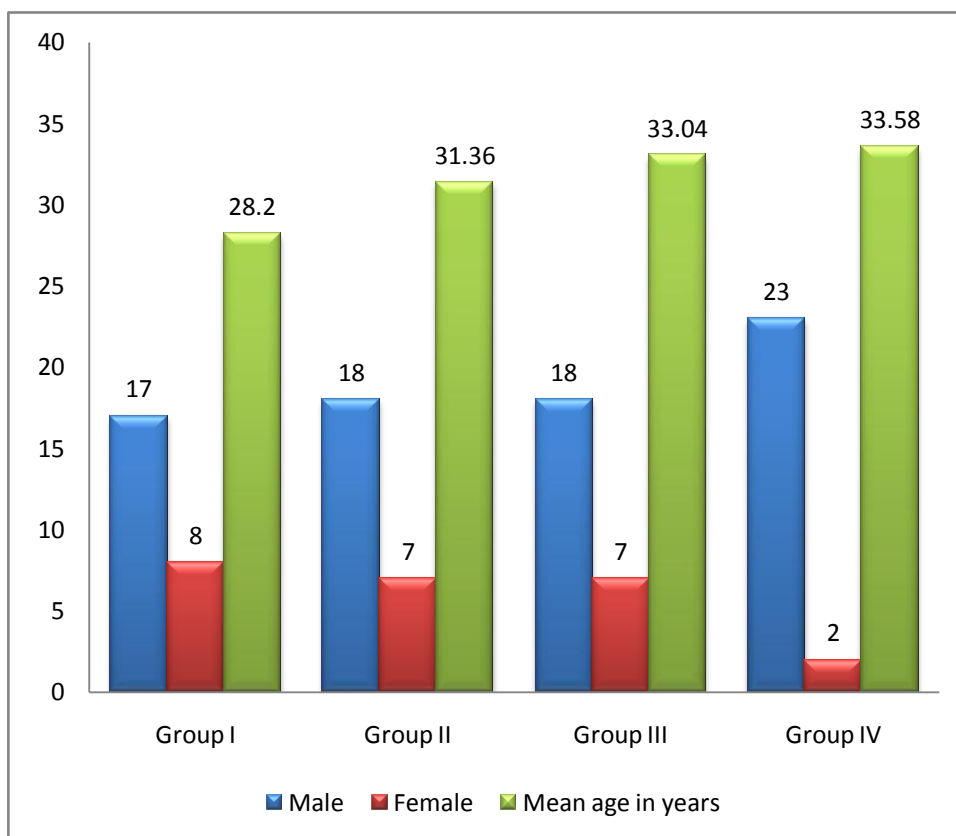


Table 1: Distribution of donors according to frequency of donation, age and sex.

Donor groups	Donor numbers			Mean age of donors (years)
	Male	Female	Total	
Group I	17	8	25	28.20
Group II	18	7	25	31.36
Group III	18	7	25	33.04
Group IV	23	2	25	33.58
Total	76	24	100	-

As shown in table 1, the mean serum ferritin in first-time donors was 49 μ g/L (SD=25.85) in men and 21.59 μ g/L (SD=2.06) in women, was higher than that in donors in groups II, III and IV: 45.74 μ g/L (SD=15.05) and 19.7 μ g/L (SD=4.06), 32.73 μ g/L (SD=19.06) and 18.35 μ g /L (SD=3.91) and 23.02 μ g/L (SD=12.05) and 8.5 μ g/L (SD=0.0), respectively. Comparing the concentration of serum ferritin in first-time and regular donors (groups II, III and IV), it was seen that ferritin levels decreased with increasing number of donations. The serum ferritin concentrations were statistically significantly different ($P<0.001$), when comparing regular

voluntary blood donors (groups III, IV and V) with first-time donors (group I) and the mean serum ferritin values of female donors were significantly less than those of males ($P<0.001$).

Comparison of ferritin levels in different age groups showed a downward trend in all ages except, the mean serum ferritin values in 18 -20 years female donors were significantly less as compared to age group 31-40 years ($P<0.001$) and also the younger male donors (<30 yr) had lower serum ferritin values than those beyond 50 years of age ($P<0.003$). These data illustrated that repeated blood donation had a significant effect on the iron balance in all donors.

Table 2: Inter-group and gender-wise comparison of serum ferritin status

Donor groups		Serum ferritin Mean and SD (range)	Frequency of deficiency No. Deficient / total (%)
Male donors	Group I	49 \pm 25.85(10-90)	2/17(11.11)
	Group II	45.74 \pm 15.05(10-75)	4/18(22.22)
	Group III	32.73 \pm 19.06(11-60.5)	5/18(27.77)
	Group IV	23.02 \pm 12.05(10-39)	11/23(47.82)
Female donors	Group I	21.59 \pm 2.06(8.5-35)	4/8(50)
	Group II	19.7 \pm 4.06(10-34.5)	3/7(42.85)
	Group III	18.35 \pm 3.91(12-32)	2/7(28.57)
	Group IV	8.5(5-12)	2/2(100)

The percentage of reduced serum ferritin (<15 µg/L) increased from 11.11% and 50%, 22.22% and 42.85%, 27.77% and 28.57 and 47.82% and 100% in group I to group IV (P<0.001) in male

DISCUSSION

Although several studies have indicated that repeated blood donation induces iron depletion and iron deficiency [2,3,13,16] and all blood centres still test only haemoglobin as an indicator for selecting the donors. Haemoglobin estimation is inadequate for detecting iron deficiency [2,3,16] as is also supported by our study. Therefore, we decided to show the importance of measuring the iron stores and then proposed a strategy to prevent severe iron depletion during frequent donations.

Several studies demonstrated that iron deficiency or iron stores depletion was present in those who had four or more blood donations during one year [11,17]. In addition Djalali et al[18] and Mozaheb Z et al[19] revealed that the frequency of blood donation per year was inversely correlated with haemoglobin, hematocrit, mean corpuscular haemoglobin concentration and serum ferritin. Mittal et al[2] also showed that an increase in donation frequency was accompanied by a significant decrease in serum ferritin; serum ferritin below 15 µg/L was found in 49% of male and 100% of female donors who donated thrice per year. Cancado et al[20] found that the frequency of iron deficiency was higher among male donors with three or more donations per year and among the women with two or more donations per year. The results of all these studies were similar to our findings and showed the importance of measuring iron stores as an indicator for being selected for blood donation.

In our study younger female donors had lower serum ferritin values compared to relatively older female donors. This difference can be explained by the fact that females in 31-40 years age group usually have completed their families and are aware of iron deficiency and its prevention [2].

and female voluntary blood donors respectively. Also the absolute serum ferritin values in female donors were significantly lower as compared to men as showed in table 2.

Most of the authors observed that the mean serum ferritin values in first time female donors were lower compared to male donors [2,3,11,16]. These results are similar to our study. These authors explained that in female donors with a basal iron requirement of 1.3 mg/day, iron stores were approximately 30 percent lower than in men giving one unit of blood yearly. Even though the iron requirements of the two groups were similar and the difference probably reflected the higher iron intake in male subjects due to their higher caloric intake.

The percentage of iron deficient female donors in our population was higher as compared to data from the developed countries [2,3,11] where 6 and 12 percent female donors were iron deficient. It may be due to low initial serum ferritin values in our donors and this could be due to the nutritional factors as most of our female donors were vegetarian.

There was significant inverse correlation of frequency of blood donations with the serum ferritin [2,3,16]. The reason for iron deficiency in donors with repeated donations is that the iron demands increase with number of annual blood donations [3]. Even though the absorption of nutritional iron among donors is much more efficient than non-donors, the donation frequency of units per year cannot be compensated by iron absorption and results in an iron deficiency [16,21,22].

The percentage of male donors with deficient iron stores increased with increased frequency of donations. Majority of male donors have adequate iron stores at the first donation; however these were less as compared to their Western

counterparts as was shown in a study done by histochemical quantitation of iron stores [23], which was explained by the lower mean serum ferritin value (49 µg/L) in our population as compared to the higher levels of 145.3 µg /L in the study of Ossirio et al[11] and 127.3 µg /L in the study of Finch et al[3]. In our study it was found that substantial number of persons had low iron stores, indicating their vulnerability to the development of anaemia. Hence, Iron-depleted and iron-deficient male donors need evaluation of serum ferritin; otherwise they are often annoyed and might become reluctant to donate again, even if they had been regular blood donors. On the other hand, we need a safe and effective donation; therefore, blood centres should consider consultation and iron replacement also for men in order to retain the volunteer donor base.

If iron deficiency was detected, it is necessary to start iron replacement. Since iron stores are reduced by about 200 mg iron per donation and with respect to an iron absorption rate of usually 10–20%, the recommended dosage of iron supplementation is roughly 100 mg/day for 10–20 days after the blood donation, except for those having multiple family members with cancer or a first-degree relative under the age of 60 years diagnosed with cancer.[24]

CONCLUSION

Reduction in iron stores after blood donation increases with number of blood donations and induces iron depletion and iron deficiency anaemia. Just determining the serum haemoglobin is not a good measure for the state of iron stores and it is not sufficient to ascertain the ability for donation. Measuring the ferritin level is the best test to evaluate the iron stores and can be used as a criterion to ascertain the donor's aptitude.

However, there is paucity of data in our country specially in South India regarding impact of regular voluntary blood donation on iron status of donors and also in our country, the iron stores in females are low especially in the reproductive age group. Hence, serum ferritin evaluation needs to

be included in the testing of blood donors. Measurement of serum ferritin is recommended in first time female donors for donor safety and if more than one donation is given per year in male voluntary donors. Furthermore, voluntary blood donors who donate more than once a year should receive iron supplement.

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