

# Iron deficiency in regular blood donors in Enugu (Southeastern Nigeria)

Grace Ifeoma Amilo, Martin Ossy Ifeanyichukwu, Amauche Martina Ngwu, Godwin Okorie Obi

## ABSTRACT

**Aims:** Regular donors are often given some sort of non-monetary recognition. In Nigeria, about 92.9% of individuals donate blood because of the benefits they get from hospital. The aim was to study iron status of regular blood donors who had donated at least one or two units of blood in their life. **Methods:** The study was prospectively conducted on 290 regular blood donors. The blood donors were divided into four groups, according to the number of units of blood they had given. **Results:** The difference in serum ferritin concentration of first group ( $208.35 \pm 60.62$  ng/mL) was statistically significant ( $p < 0.05$ ) compared with donors in third group ( $34.20 \pm 21.89$  ng/mL) and fourth group ( $2.05 \pm 0.22$  ng/mL). None of the first group donors suffered from iron deficiency, whereas 11% of the donors who had donated between 11–15 units of blood within a 4-year period had iron deficiency. **Conclusion:** The results of this study

reveal the presence of iron deficiency in second group, third group and fourth group.

**Keywords:** Blood donors, Iron deficiency, Ferritin, Mean corpuscular volume (MCU)

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## INTRODUCTION

Blood donation results in a substantial (200–250 mg) loss of iron at each collection procedure, during which up to 425–475 mL of whole blood are withdrawn and subsequent mobilization of iron from body stores [1]. Chronic iron deficiency is a well-recognized complication of regular blood donation. A healthy individual can donate blood up to four times a year, i.e., at three months intervals as iron stores can be depleted if blood is donated more frequently [2]. In developing countries such as Nigeria, established blood supplies are limited and donors usually give blood when family or friends need a transfusion. About 92.9% of blood donors in Southeastern Nigeria receive incentives such as assurance that donors would have priority during shortages, free antenatal registration, free T-shirts, umbrellas, pens, towels, one bottle of malt, two raps of MoiMoi, excise books and face caps immediately after blood donation. This method of blood donation is being practiced only in government hospital

blood banks [3, 4]. Two of incentives such as assurance of blood donors having priority during shortage and free antenatal registration made most donors to donate whenever they are due, i.e, at intervals of three months. This act of given incentives after blood donation in this part of the country has made our blood donation practices not to meet up with the World Health Organization set goal in 1997 which demand that all blood donations should come from unpaid volunteer donors [5]. This study was, therefore, conducted to investigate the iron status of regular blood donors in blood bank laboratory of Enugu State University of Science and Technology Teaching Hospital Enugu (ESUTTH), Nigeria based on the number of units of blood each donor had donated.

## MATERIALS AND METHODS

**Subjects:** Two hundred and ninety regular blood donors aged between 18–50 years that donated blood in blood bank laboratory ESUTTH, Nigeria were recruited into the study after given informed consent. A total of 290 blood donors were included in this study in which 223 were males and 67 were females. All donors were screened using a HemoCueHb 301. Only donors whose hemoglobin was between 12.0 g/dL and 13.0 g/dL were eligible for the study. Each donor donated 450 mL of whole blood. Questionnaire classification of the donors into groups was applied. Regular blood donors in this work were defined as bloods donors that receive non-monetary remuneration after donation. In this study, iron stores were considered depleted when serum ferritin values were less than 12 ng/mL, and reduced when the values were between 13–20 ng/mL. Iron deficiency was considered present when the serum ferritin was less than 12 ng/mL and transferrin saturation percentage less than 15 [6].

**Study population:** Enugu State is in the Southeast geographical zone of Nigeria. According to the 2006 Nigerian census, the Enugu metropolitan area has an estimated population of 722,664.

**Methods:** Serum iron and total iron binding capacity (TIBC) were estimated using a ferrozine–based iron/TIBC reagent set (TECO DIAGNOSTICS, USA). Test procedures were conducted as described in the manufacturer's standard operating manual included with the kit. Transferrin saturation percentage was calculated from the serum iron concentration and TIBC values as follows: transferrin saturation percentage is equal to serum iron/TIBCx100 [6]. Serum ferritin was measured using a human ferritin enzyme immunoassay kit (BIOCHECK, INC, 323 Vintage Park Dr. Foster City, CA 94404). The ferritin quantitative test is based on a solid phase enzyme–linked immunosorbent assay (ELISA). The procedure was as described by the manufacturer of the human ferritin enzyme immunoassay kit. Twenty microliters of standard, specimens and controls were added into wells of microtiter plate. Hundred microliters

of enzyme conjugate reagent was dispensed into each well. Gently mixed for 30 seconds and incubated at room temperature for 45 minutes. The incubated mixture was removed by flicking the plate contents into sink. The microtiter wells were rinsed and flicked five times with deionized water. Hundred microliters of TMB reagent was added into each well and gently mixed for 10 seconds. Then the mixture was incubated at room temperature in the dark for 20 minutes. The reaction was stopped with addition of stop solution to each well which changed all the blue color to yellow. Absorbance was read at 450 nm with a microtiter plate reader within 15 minutes. Hemoglobin results were determined photometrically using the HemoCue meter (Hb 301). Packed cell volume (PCV) was determined using a microhematocrit centrifuge (DIN58933 of Germany). Mean corpuscular hemoglobin concentration (MCHC) was also calculated.

**Statistics:** The group comparisons were determined by one-way analysis of variance (ANOVA). Comparison between mean values of iron parameters were compared with student's t-test and 95% confidence interval were also applied. A 'p' value less than 0.05 was considered statistically significant.

## RESULTS

A total of 290 regular blood donors were included in this study. Only donors with hemoglobin levels of  $\geq 12.0$  g/dL for female and  $\geq 13.0$  g/dL for male were eligible for the study. The blood donors were grouped according to the number of units of blood they had given since they started donating blood. The first group (n = 40) were apparently healthy adult male and female Enugu state indigenes with no previous history of blood donation. Donors in second group (n = 211) had given between 1–5 units of blood within two years. Third group donors (n= 30) had donated between 6–10 units of blood within three years. Fourth group (n = 9) had donated between 11–15 units of blood within four years. Ferritin, serum iron concentration, TIBC and transferrin saturation percentage were evaluated in all four groups of blood donors. In first group, the mean serum iron concentration was 43.10  $\mu\text{mol/L}$  (SD = 2.27) with 95% CI of 43.10 $\pm$ 0.70. In second group, it was 26.25  $\mu\text{mol/L}$  (SD= 3.57) with 95% CI of 26.25 $\pm$ 0.48. In third and fourth group, the mean serum iron concentration were 34.20  $\mu\text{mol/L}$  (SD = 21.20) with 95% CI of 34.20 $\pm$ 8.15 and 10.35  $\mu\text{mol/L}$  (SD= 0.67) with 95% CI of 10.35 $\pm$ 2.26, respectively (Table 1) (Figure 1). The mean serum iron concentration was significantly higher in first group donors, who had no previous history of blood donation, than in donors in second, third and fourth group. The total iron binding capacity of donors in first group was significantly lower than those donors in second and fourth group. The percentage transferrin saturation of donors in first group was significantly higher than those donors in second, third and fourth group.

The mean ferritin concentration in first group donors 208.35 ng/mL (SD= 60.62); 95% CI of 208.35±18.79, was higher than that in donors in second, third and fourth groups: 63.05 ng/mL (SD= 23.48); 95% CI of 63.05±3.17, 34.20 ng/mL (SD= 21.89); 95% CI of 34±8.15 and 2.05 ng/mL (SD= 0.22); 95% CI of 2.05± 0.17, respectively (Table 1) (Figure 2). On comparing, the concentration of serum ferritin in first group with third group and fourth group, it was seen that ferritin levels decreased with increasing number of donation (Table 1). The serum ferritin concentration was statistically significantly different when comparing donors in third and fourth groups with first group.

Iron stores were reduced in 1.4% (3/211) in donors that donated 1-5 units of blood (second group), whereas 6.7% of third group donors who had donated between 6-10 units of blood had reduced iron stores (Table 2). None of the first group donors suffered from iron deficiency, while 4 out of 211 (1.9%), 1 out of 30 (3.3%) and 1 out 9 (11%) of donors who had donated 1-5 units, 6-10 units and 11-15 units of blood within two years, three and four years, respectively had ferritin concentrations below 12 ng/mL and percentage transferrin saturation below 15. There was no significant difference between hemoglobin, PCV, Mean corpuscular volume (MCV) and increasing instances of donation (p < 0.05) (Table 1).

Table 1: Mean values of iron, total iron binding capacity, percentage transferrin saturation and ferritin concentration, hemoglobin, packed cell volume and mean corpuscular hemoglobin concentration in donors grouped according to frequency of donation.

Groups	Number of donation	Serum iron (µmol/L)	TIBC (µmol/L)	Transferrin saturation (%)	Hb (g/dL)	PCV (%)	MCHC (g/dL)	Ferritin (ng/mL)	Median age of male	No. of M	% of male
1st group	0	43.10±2.27	73.05±10.30	29.85±11.59	14.58±1.24	43.73±3.73	33.33±0.50	208.35±60.62	23.50	19	47.50
2nd group	1-5	26.25±3.57	77.50±12.50	15.90±3.06	14.45±2.36	42.44±5.48	33.34±0.03	63.05±23.48	27.50	165	78.20
3rd group	6-10	34.20±21.89	76.20±0.62	10.80±5.49	14.48±1.31	40.78±6.23	33.32±0.02	34.20±21.89	25.50	30	100
4th group	11-15	10.35±0.67	82.50±7.90	13.25±0.44	14.89±0.52	44.66±1.57	33.33±0.50	2.05±0.22	27.50	9	100
1st:2nd group	0:1-5	0.00*	0.01*	0.00*	1.00	0.82	0.82	0.00*			
1st:3rd group	0:6-10	0.00*	0.44	0.00*	1.00	0.29	0.98	0.00*			
1st:4th group	0:11-15	0.00*	0.00*	0.00*	0.74	0.74	1.00	0.00*			

**Abbreviations**

TIBC: Total iron binding capacity, Hb: Hemoglobin, PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration  
No. of M: Number of male gender, % of male: Percentage of male gender

Table 2: Showed distribution of population under study according to iron status and frequency of donation

Groups	number of donation	number of donors	reduced iron stores (ferritin = 13- 20 ng/mL)	depleted iron (ferritin = 10-12ng/mL)	Iron deficiency (ferritin < 12ng/mL + %transferrin < 15)
1st group	0	40			
2nd group	1-5	211	1.4% (n=3)	0.95% (n=2)	1.9% (n=4)
3rd group	6-10	30	6.7% (n=2)	0% (n=0)	3.3% (n=1)
4th group	11-15	9	0% (n=0)	0% (n=0)	11% (n=1)

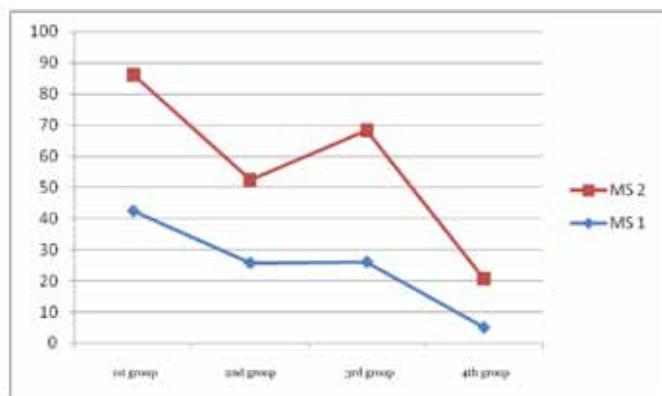


Figure 1: Mean serum iron values of 1st group to 4th group with 95% CI.

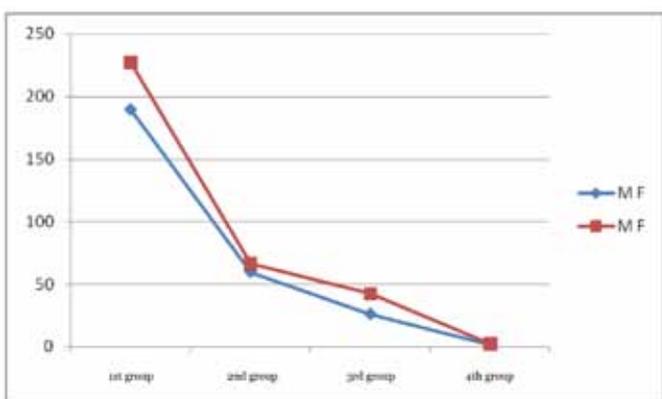


Figure 2: Mean ferritin values of 1st group to 4th group with 95% CI.

## DISCUSSION

In this study, 1.9%, 3.3% and 11% of regular blood donors in Enugu developed iron deficiency at interval of two years, three years and four years, respectively and defined as ferritin concentration < 12 ng/mL and TS (Transferrin saturation) < 15. In comparison with study from Iran which reported iron deficiency in 28% male donors who donated their blood about five to ten times in previous three years, our obtained figures are lower in the present study [1]. The reason behind our lower figure may be because of government effort to reduce poverty in Nigeria which now made our youth to have access to good medical care. Iron depletion was seen among 0.95% of regular blood donors that have donated 1–5 units of blood in two years. In comparable with study done in Poland that reported iron depletion of 49.7% in 10 instances of donation [7], our result had a lower figure. This lower figure in our study may be due to attitude of people to blood donation, i.e., they donate mainly when the recipient is their friend or relation. Reduced iron store was seen in 1.4% of donors that donated 1–5 units of blood in two years and 6.7% of donors that donated 6–10 units of blood in three years. In comparable with study

done in Iran that reported lack of iron stores in 4.66% of regular donors [8]. Our results have a higher figure than their result. This study has shown inverse relationship of serum iron, ferritin and transferrin saturation with increasing number of units of blood donated. Significant reduction in the levels of these three parameters was observed in the donors that have donated 11–15 units of blood. In the present study, the hemoglobin results among none donors 1st group, 2nd group, 3rd group, and 4th group were  $14.58 \pm 1.24$ ,  $14.45 \pm 2.36$ ,  $14.48 \pm 1.31$  and  $14.89 \pm 0.52$ , respectively. In comparison with study done in Malaysia which their hemoglobin results were  $15.56 \pm 1.48$ ,  $15.12 \pm 1.44$  and  $14.95 \pm 1.08$ , respectively our results are slightly lower than these results [9].

## CONCLUSION

This study showed that blood donors in Enugu metropolis develop iron deficiency irrespective of the number of units of blood they had given out. Based on these findings, it is suggested that ferritin test should be included in pre-screening test before blood donation in Nigeria.

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## Author Contributions

Grace Ifeoma Amilo – Drafting the article, Critical revision of the article, Final approval of the version to be published

Martin Ossy Ifeanyichukwu – Drafting the article, Critical revision of the article, Final approval of the version to be published

Amauche Martina Ngwu – Conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Critical revision of the article, Final approval of the version to be published

Godwin Okorie Obi – Drafting the article, Critical revision of the article, Final approval of the version to be published

## Guarantor

The corresponding author is the guarantor of submission.

## Conflict of Interest

Authors declare no conflict of interest.

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