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The Effect of Repeated Blood Donations on the Iron Status of Male Blood Donors in Enugu State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors IMO and NAM designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AGI, OGO and OCO managed the analyses of the study. Authors OCJ and INC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: One of the biggest challenges in blood donation particularly in Nigeria is the recruitment and retention of voluntary non-remunerated, low cost blood donors.
Aims: The aim of this study is to determine the effect of repeated blood donations on iron stores and the prevalence of iron deficiency anaemia among the male blood donors in the Enugu State, Nigeria.

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Study Design: In this case-control study, two hundred and twenty three randomly selected male blood donors, were grouped into six categories according to the number of units of blood donated in one year, two years, three years and the last group were on their 4th year.
Place and Duration of Study: Haematology and blood bank laboratory unit, Enugu State University of Science and Technology Teaching Hospital, Enugu, Enugu State, Nigeria: April 2012 to December 2012.
Methodology: Prior to blood donation, blood samples of 202 directed/regular male blood donors and twenty one apparently healthy men with no previous history of blood donation (aged 18-40years) were collected. Donors were grouped into 0, ≤ 3, 4-6, 7-9, 10-12 and > 13 categories based on the number of units of blood donated.
Results: Iron depletion was seen in 1.3% in group 2 (1-3 times) and also in 13.3% of group 4 (7-9 times), iron deficiency was present in 4.4% of group 3 (4-6 times) and in 20% of group 6 (13-15 times) and iron deficiency anaemia was discovered in 4.4% of group 3 (4-6 times). Blood donors with more than seven times instances of blood donation (*P<0.05)* showed a significant relationship between iron depletion and iron deficiency.
Conclusion: This study showed that iron deficiency anaemia in blood donors can occur as a result of increase in number of units of blood donated and also based on iron status of individual at time of donation. Based on findings of this study ferritin test should be done on all male blood donors in Enugu before donating any unit of blood to find out the appropriate time to start iron supplement.

Keywords: Blood donors; Enugu; iron deficiency anaemia; iron deficiency; ferritin.

1. INTRODUCTION

Since 1980s great effort has been made by blood collectors worldwide, which yielded two positive results. The first one is blood product safety, followed by an adequate blood supply. In the area of safety, specifically the reduction of transfusion-transmitted diseases, the achievements over the past quarter century are remarkable. Then for adequacy of the blood supply, the past decade has witnessed major gains in some countries of Canada, US and Europe and less than had been expected in other developing countries of the world, which Nigeria is one of them [1]. In the 124 countries surveyed by world health organization in 1997, about 75 countries are still having the challenge of a more stable blood supply, in which supply and demand are in better balance, which still remains an important issue [2]. Meanwhile, the aforementioned achievement has come at a price, which is iron depletion and iron deficiency of the repeat blood donors. Different blood collection centers have shown that it is less expensive to collect blood from existing donors than to recruit new donors. While first-time donors, particularly adult male have been more successfully recruited. 92.9% of Enugu blood donors are repeat directed/regular blood donors, while the remaining 7.1% are voluntary and paid blood donors [3,4]. Iron accumulation is one of the consequences of chronic red blood cell transfusion, knowing very well that whole blood transfusion is still being practiced in Nigeria [5].

The safety of blood donors and recipients as well is source of concern to the people of Nigeria because majority of blood banks in different parts of Nigeria uses haemoglobin measurements alone as screening tests for the ability to donate blood even when iron stores may be depleted in donors with haemoglobin values above the arbitrarily defined limit for anaemia [6]. Studies have shown that individuals at risk of developing iron deficiency which will be immediately followed by iron deficiency anaemia can only be detected by estimating serum ferritin levels [7,8]. Therefore, this study was carried out with the aim to assess the effect of repeated blood donation on iron stores and the prevalence of iron deficiency anemia among the directed/regular male blood donors in Enugu state, Nigeria.

2. MATERIALS AND METHODS

2.1 Subjects

Two hundred and two directed/regular male blood donors aged 18-40 years that donated blood in blood bank laboratory of Enugu State University of Science and Technology Teaching Hospital Enugu, between April and December 2012 were recruited into the study after given informed consent. Before carrying out the research ethical clearance approval was given by the Enugu State University of Science and Technology Teaching Hospital Ethics Committee. Twenty one apparently healthy men with no previous history of blood transfusion served as

control (group1). The donors were 223 and divided into six groups according to the number of donation one had made in three years; group 1 (n=21) were those with no previous history of donation, group 2 (n=150) had donated one to three units of blood, group 3 had donated 4 – 6 units, group 4 had donated 7 – 9 times, group 5 had donated 10-12 units and group 6 had donated above 13 units. Questionnaire classification of the donors into groups was applied. In this study, iron depletion, iron deficiency, and iron deficiency anemia are defined below.

Iron depletion: Serum ferritin less than 20 ng/mL.

Iron deficiency: Serum ferritin less than 12 ng/mL and transferrin saturation percentage less than 15.

Iron deficiency anemia: Serum ferritin less than 12ng/mL, transferrin saturation percentage less than 15, and Hb less than 13 g/dL [9]. Also in this work "directed" donors are those that donated blood for their family member and friends. While "regular" donors are those that received non monetary incentives such as free T-shirts, umbrellas, face caps and polo after donation. But for the purpose of this work the two different types of the blood donors were analyzed together.

2.2 Sample Collection

Under aseptic condition, 400-450mililiters of venous blood was collected from 202 subjects through plastic blood bag, followed by 2ml in EDTA bottle and 5ml in plain plastic test tube. The median cubital vein was used. The collected 5ml of blood was put into a well labeled acid-washed plastic test tube, allowed to clot, centrifuged at a speed of 5,000 rotations per minute for 10 mins. The serum obtained was dispensed into another acid-washed test tube. The serum and the RBCs were stored at 4℃ until ready for analysis. (NB only the 7ml were used for the analysis of this work, 400-450ml were stored in blood bank, which was latter used for transfusion).

2.3 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. Percentage transferrin saturation was calculated from the serum iron concentration and total iron binding capacity (TIBC): Percentage transferrin saturation = serum iron/TIBC x 100. 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. 20µl of standard, specimens and controls were added into wells of microtiter plate. 100µl 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 5 times with deionised water. 100µl of TMB reagent was added into each well and gently mixed for 10 seconds. 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 color. Absorbance was read at 450nm with a microtiter plate reader within 15 minutes.

Haemoglobin concentration was determined photometrically using the HemoCue Hb 301 (ÄNGELHOLM SWEDEN).

2.4 Statistical Analysis

Data generated from the study were analyzed using computer package SPSS (version 17.0.1) [10]. Mean ±SD was used to analyze the age. The group comparisons were determined by ANOVA and student's t-tests. 5% ($P<0.05$) was regarded as an acceptable level of significance.

3. RESULTS

A total of 223 Enugu male blood donors participated in this study. All donors had haemoglobin concentration greater than 12.5g/dL. The population under study was divided into six groups according to the number of donation the subjects had made in one year, two years, three years and last group on the 4th year. Table 1 showed the mean age, percentage and their numbers in each group. Ferritin, Serum iron concentration, TIBC, percentage transferrin saturation and haemoglobin were evaluated in all the groups of blood donors. The mean serum

iron concentration was significantly higher in group 1; who had no previous history of blood donation, than donors in group 4, 5, 6 who had given more than 7 units of blood in three years. The percentage transferrin saturation of donors in group 1 was significantly higher than those donors in group 3, 4, 5 and 6 (*P<0.05*) as shown in Table 2.

The mean ferritin concentration in group 1 donors 154.61 ng/mL (SD= 39.99), was significantly higher than that in donors in groups 3, 4, 5 and 6: 51.50 ng/mL (SD=37.07), 23.46 ng/mL (SD= 9.96), 22.73 ng/mL (SD= 0.47) and 2.80 ng/mL (SD= 1.17) respectively. Iron depletion was seen in 1.3% in group two and also in 13.3% of group 4. Iron deficiency was seen in 20% of group 6 and 4.4% of group 3. Iron deficiency anaemia was present in 4.4% of group 3.

4. DISCUSSION

The result of this work showed that the age of the donors increases with the increase in the number of units of blood donated. The age range in this work is slightly below the age reported of [3]. Comparing the ferritin mean among control blood donors and blood donors in group 3, 4, 5 and 6 in our study with studies performed in Thailand [11] and Malaysia [12], indicates iron reserves decrease among blood donors in our country as shown in Table 2. In this study there was a significant decrease in serum ferritin, serum iron, percentage transferrin saturation, and rising instances of blood donation especially from 4th donation (*P<0.05*). This slightly differs with the results of studies done in Malaysia [12], Tehran University of Medical Sciences [7] and Javadzadeh and colleagues [13]. Therefore it seems very important that direct/regular male blood donors in Enugu from the fourth donation upwards should take iron supplement before another donation. Iron depletion was seen in 1.3% in group two and also in 13.3% of group 4. Iron deficiency was seen in 20 % of group 6 and 4.4% of group 3.

Table 1. Percentage representation of each group with their mean age

Groups	Number of units of blood donated per yr	Number of donors	Age (years) mean (SD)	Percentage (%)
Group 1	0	21	24.3 (SD = 1.2)	9.4
Group 2	1-3 units (1 yr)	150	25.2 (SD= 2.6)	67.3
Group 3	4-6 units (2 yrs)	23	26.0 (SD = 3.3)	10.3
Group 4	7-9 units (3 yrs)	15	27.8 (SD = 2.1)	6.7
Group 5	10-12 units (3 yrs)	9	28.8 (SD = 2.1)	4.0
Group 6	13-15 units (4 yrs)	5	29.0 (SD = 0.4)	2.2

Table 2. Mean ±SD values of ferritin, serum iron, total iron binding capacity, percentage transferrin saturation and haemoglobin

Groups	No of units blood donated per yr	ferritin ng/ml	serum iron umol/L	TIBC umol/L	%TS	Hb (g/dL)
Group 1	0	154.61±39.00	25.45±9.33	78.09±12.36	31.55±9.20	14.51±1.68
Group 2	1-3 units (1 yr)	127.64±31.43	23.63±5.78	84.00±6.31	29.91±6.80	15.72±2.83
Group 3	4-6 units (2 yrs)	51.55±37.05	13.72±7.84	75.18±12.05	14.45±6.99	14.82±2.13
Group 4	7-9 units (3 yrs)	23.46±9.96	4.48±0.95	61.73±12.55	6.73±1.27	14.63±1.63
Group 5	10-12 units (3 yrs)	22.73±0.47	5.14±0.14	67.09±1.04	8.18±0.40	15.16±0.16
Group 6	13-15 units (4 yrs)	2.80±1.17	9.64±0.92	75.91±1.04	12.45±1.12	15.11±0.76
Gp 1: Gp 2; 0: 1-3 p values		0.51	0.99	0.72	0.10	0.82
Gp 1: Gp 3; 0: 4-6 p values		0.00*	0.05	0.99	0.00*	0.10
Gp 1: Gp 4; 0: 7-9 p values		0.00*	0.00*	0.60	0.00*	1.00
Gp 1: Gp 5; 0: 10-12 p values		0.00*	0.00*	0.11	0.00*	0.79
Gp 1: Gp 6; 0: 13-15 p values		0.00*	0.00*	0.99	0.00*	0.88

Key: Statistically significant (P<0.05)
Gp = Group, yr= year, yrs= years

In this study, our result had lower figures compared with study done in Thailand [11] that reported 21.21% iron depletion among samples and also a study in Poland [4] that reported iron depletion in 49.7%. However, in comparison with a study in India [14] that reported ferritin less than 15 in 21% of samples, our result has a lower figures. Reason for lower figure in this study when compared with other studies may be due to high consumption of local foods that are rich in iron by some blood donors residing in Enugu. Study done in Brazil [14] that reported 5.5% iron deficiency among samples differs completely from our result. Iron deficiency anaemia was seen in 4.4% of blood donors in this study, which differ with study done in Iran that observed iron deficiency anaemia among 16% of regular male donors [13]. The result of our study is different when compared to a survey in Denmark that reported 0.26% and 0.5% iron deficiency anaemia among male blood donors respectively [1]. In conclusion the rates of iron depletion and iron deficiency were significantly higher among donors that have donated more than seven units of blood.

5. CONCLUSION

This study concluded that iron deficiency in blood donors can occur as a result of increase in number of units of blood donated and also based on iron status of individual at time of donation. Based on findings of this study ferritin test should be done on all male blood donors in Enugu before donating any unit of blood to find out the appropriate time to start iron supplement.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Milman N, Kirchhoff M. Influence of blood donation on iron stores assessed by serum ferritin and haemoglobin in a population survey of 1433 Danish males. Eur J Haematol. 1991;47:134-139.
2. Brecher ME. AABB Technical Manual, 15th edition. Bethesda, MD; 2005.
3. Zacheaus AJ, Baribefe BK. Reference percentiles of hematological and biochemical iron values of blood donors in Portharcourt Nigeria. Haematology. 2009;14(6):366-37.
4. Szymczyk-Nuzka M, Wo owiec D. Iron stores in regular blood donors. Pol Arch Med Wewn. 2003;110:1415-1421.
5. Blumberg N, Heal J, Murphy P. Association between transfusion of whole blood and cancer recurrence. Br Med J. 1986;293:530–532.
6. Badar A, Ahmed A, Ayub M, Ansari AK. Effect of frequent blood donations on iron stores of stores of non anaemic male blood donors. J Ayub Med Coll Abbottabad. 2002;14:24-27.
7. Djalali M, Neyestani TR, Bateni J, Siassi F. The effect of repeated blood donations on the iron status of Iranian blood donors attending the Iranian blood transfusion organization. Int J Vitam Nutr Res. 2006;76:132-137.
8. O'Meara A, Infanti L, Stebler C, Ruesch M, Sigle JP, Stern M, et al. The value of routine ferritin measurement in blood donors. Transfusion. 2011;51(10):2183-2188.
9. Yousefinejad V, Darvishi N, Arabzadeh M, Soori M, Magsudlu M, Shafiayan M. The evaluation of iron deficiency and anemia in male blood donors with other related factors. Asian J Transfus Sci. 2010;4:123-127.
10. Statistical Package for Social Sciences, SPSS. Computer Package for Windows, version 17.0.1; 2008.
    Available: http:www.spss.com.
11. Tardtong P, Sthabunswadigarn S, Atamasirikul K, Chaunsumrit A, Suwannuruk R. Iron stores in Thai blood donors. J Med Assoc Thai. 2000;83:146-151.
12. Norashikin J, Roshan TM, Rosline H, Zaidah AW, Suhair AA, Rapiaah MA. Study of serum ferritin levels among male blood donors in Hospital Universiti sains Malaysia. Southeast Asian J Trop Med Public Health. 2006;37:370-373.

13. Javadzadeh SH, Attar M, Taher YM. A study of the prevalence of iron deficiency and its related factors in blood donors of Yazd, Iran, 2003. Transfus Med. 2005;15:287-293.

14. Mittal R, Marwaha N, Basu S, Mohan H, Ravi Kumar A. Evaluation of iron stores in blood donors by serum ferritin. Indian J Med Res. 2006;124:641-646.

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