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A Study of Iron Status and Total Serum Protein Levels in Blood Donors in Owerri, Imo State

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Abstract
Haemoglobin level, Serum Ferritin, Serum Iron, Total Iron-binding Capacity (TIBC), Percentage Transferrin Saturation and Total Serum Protein levels were measured in three groups of individuals. A total of 138 subjects were recruited for this study. These subjects were grouped into three based on the number of donations done in the last one year: Group A were individuals with a history of 1-3 donation, Group B 4-6 donations and Group C, 7-9 donations. The mean haemoglobin levels in group A, group B, and group C were 13.30±2.10g/dl, 9.76±1.83 g/dl, and 8.03±0.68g/dl respectively. The mean serum ferritin levels of group A were 76.87±108.59 ng/ml, group B 1.56±2.73 ng/ml and group C 0.92±2.05 ng/ml. The mean serum iron in group A, B and C were 92.64±24.63µg/dl 47.86±23.06µg/dl and 30.64±18.93µg/dl respectively. The mean total serum protein was group A 7.02±1.34g/dl, group B 6.90±0.57g/dl and group C 6.67±0.72g/dl. The WHO reference range for each parameter was obtained as Hb = 12.0 – 18.0g/dl, Serum ferritin = 8-385 ng/ml, serum iron = 60-150µg/dl, TIBC = 250-400 µg/dl, percentage transferrin saturation = 20-55% and serum protein = 6.2-8.5g/dl. The iron status level decreased according to the number of donations. All the iron profile parameters and Hb levels were found to be have a significant difference ($P<0.05$) as frequency of blood donation increases. The total serum protein had no significant difference ($P>0.05$) with increase in frequency of donation. However, from this study it was observed that iron deficiency was high in donors donating above the stipulated 2-3 donation per year. The implications of unregulated blood donations become apparent from the result of the study.

Keywords*: iron status, protein, blood donors*

Introduction
Iron is an essential element involved in a broad range of biologically important reactions critical for cellular function and also plays fundamental role in oxygen transport. It is the most abundant

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of all essential elements in animal tissues and participates in many biochemical processes including redox reactions. It is a universal cofactor for mitochondrial energy generation and support the growth and differentiation of all cell types. Disorders of iron homeostasis are among the most common human disorders. Although it is the fourth most abundant element in Earth´s crust, iron bioavailability is very low and despite a low daily requirements iron deficiency is the most common nutritional disorder in the world. Iron is an essential component in the synthesis of haemoglobin, myoglobin, and several haem and metalloflavoproteins and its turnover in the human body is dominated by the synthesis and breakdown of haemoglobin. Every day about 30mg of iron is used to make new haemoglobin, and most of this is obtained from the breakdown of old red blood cells.[1-10]

A donor generally donates approximately 450ml of blood at the time of donation. One gram of haemoglobin contains 3.4mg of iron.[9] In a normal individual with 15g of haemoglobin per dl, 100 ml of blood contains approximately 50 mg of iron. Thus, removal of only 2 ml of blood results in the loss of 1 mg of iron.[11] If 450 ml of blood is taken in a donation, approximately 225 mg of iron will be lost. If the donor has no iron deficiency, the erythrocytes and the haemoglobin level will generally return to normal within 3-4 weeks. The physiological importance of the storage iron is that it provides a rapidly available supply of iron in the event of blood loss.[12]

Materials and Method

Study Area

The study was conducted in Owerri Municipal in Imo State.

Study Population and Recruitment

A total of 138 subjects (121 males and 17 females) aged 18-45 years were recruited for this study. The subjects were sub-divided into three groups of study (group A, B and C) based on number of blood donations in the last one year. The group A (81 donors), B (35 donors) and C (22 donors) consisted of individuals who have donated between 1-3times, 4-6times and 7-9times respectively in the last one year. The samples for study (voluntary blood donors group A) were collected from blood donors attending NBTS, Owerri for blood donation, while the commercial blood donors (group B and C) were recruited from private laboratory within Owerri metropolis operating blood banking services. With the use of questionnaire, their medical histories were noted.

Selection Criteria

Prospective blood donors who have donated blood at least ones in the last one year.

Exclusion Criteria

Pregnant women, menstruating women, individuals who are medically ill, people below or above the age limit of 18 – 40 years respectively and individuals who refuse to give their consent were all excluded in the study.

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Sample Collection and Preparation

Using a 5ml sterile syringe, 5mls of fresh venous blood was drawn from each subject by a clean vein puncture from the antecubital vein and delivered into two different containers; 2mls was delivered into an EDTA container and the other was delivered into a plain container to obtain serum. The EDTA specimens were used for the estimation of haemoglobin. The sample in plain test tubes were allowed to clot at room temperature and centrifuged to separate the serum. The serum was transferred into clean test tubes for the determination of iron and protein profile. The samples were then taken to a Links Diagnostic and Research Laboratory Owerri where the laboratory analysis was carried out.

Laboratory Methods and Procedures

The reagents for the research were commercially purchased and manufacturer's standard operating procedures were strictly followed.

Haemoglobin Estimation

The Cyanmethaemoglobin method was used for the haemoglobin estimation.

Procedure

1 in 201 dilutions of blood were made by adding 20 µl of blood to 4 ml of diluent (Drapkin's solution) into a test tube. The test tubes were stoppered and inverted several times and were then poured into a cuvette and the absorbances were read in a colorimeter at 540 nm against the reagent blank. Haemoglobin level was read off from the calibration graph prepared.

B Serum Ferritin Estimation

The serum ferritin was estimated by Enzyme-Immunoassay method. Reagent kit was purchased from BIOTEC Laboratories Ltd. Catalog No 7/352.

Procedure

Into different microplates, 20µl of the test samples and standard solution were added. An anti-ferritin monoclonal antibody conjugate of 100 µl was added into each standard and test microplate. The microplates were sealed using plate sealer and were shaken for 30 seconds to allow proper mixing of the solution. The mixtures were in an incubator at 37^0C for 30 minutes. Using microplate washer, the test and standard plates were washed with washing solution to remove unbounded antibodies. 200 µl chromogen / substrate solution was added into each microplate and sealed with plate sealer. The solution was incubated for 10 minutes at room temperature in the dark. 100 µl of stop solution was added after 10 minutes to terminate the enzyme reaction and a coloured solution was obtained. The concentration of ferritin in each sample was measured using automatic microplate reader. The colour intensity is proportional to the concentration of the ferritin present in each sample.

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CSerum Iron and TIBC estimation

Procedure

(i) Serum Iron

The tubes were labeled blank, standard, control and test accordingly. Into each tube, 2.5ml Iron buffer reagent was added. 0.5ml (500µl) sample was added to each tube, while 500µl iron-free water was added to blank. The spectrophotometer was zero with the blank and read at 560 nm wavelength. The absorbance of all tubes (A_1 reading) was read and recorded. After recording A_1 reading, 0.05ml (50µl) of Iron colour reagent was added to all tubes. The solution was mixed and placed in water bath at 37^0C for 10 minutes. The spectrophotometer was zeroed using the blank at 560 nm wavelength. The absorbance of all tubes was read (A_2 reading) and recorded.

Calculation:

A= Absorbance

Std= Standard

$$\frac{A_2 \text{ Test} - A_1 \text{ Test}}{A_2 \text{ Std} - A_1 \text{ Std}} \times \text{Conc. Of std} = \text{Total Iron (µg/dl)}$$

(i) UIBC (Unsaturated Iron-binding Capacity)

The tubes were labeled, blank, standard, control and test accordingly. Into each tube, 2.0 ml UIBC buffer reagent was added. 0.5ml (500µl) iron-free water and 0.5ml (500µl) of standard was added to the tube labeled "standard", while 0.5ml (500µl) sample plus 0.5ml (500µl) Iron Standard was added to the tube labeled "Test". 1.0 ml iron-free water was added to blank. The spectrophotometer was zero with the blank and read at 560 nm wavelength. The absorbance of all tubes (A_1 reading) was read and recorded. 0.05ml (50µl) of Iron colour reagent was added to all tubes. The solution was mixed and placed in water bath at 37^0C for 10 minutes. The spectrophotometer was zeroed using the blank at 560 nm wavelength. The absorbance of all tubes was read (A_2 reading) and recorded.

UIBC Calculation:

$$\text{Conc. Of Std} - \frac{[A_2 \text{ Test} - A_1 \text{ Test}]}{[A_2 \text{ Std} - A_1 \text{ Std}]} \times \text{Conc. Of std} = \text{UIBC (µg/dl)}$$

TIBC (Total Iron-binding Capacity) Calculation:

$$\text{Iron Level} + \text{UIBC} = \text{TIBC (µg/dl)}$$

(ii) Transferrin percentage Saturation Calculation:

$$\frac{\text{Serum Iron}}{\text{TIBC}} \times 100 = \%\text{Transferrin Saturation}$$

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DTotal Protein Estimation

The reagent kit was obtained from Teco diagnostic Industry, USA.

Procedure

The tubes were labeled, Blank, Standard, Control, and test accordingly. 3.0 ml of reagent was added into each tube. 50µl of standard was added to the tube labeled "standard", while 50µl sample was added to the tube labeled "Test". The solution was mixed by inversion and was allowed to stand at room temperature (15-30^{0}C) for 10 minutes. The spectrophotometer was zeroed using the blank at 540 nm wavelength. The absorbance of all tubes was read and recorded.

Calculations:

$$\frac{\text{Abs. of Unknown}}{\text{Abs. of Standard}} \times \text{Conc. Of Standard}$$

Reference Range:

6.2 – 8.5 g/dl

Statistical Analysis

The values were expressed as mean, standard deviation, bar chart, pie chart and the test of significance was carried out using the Chi-square

Results

Table 1: Age and Gender Distribution of Subjects

Age group (years)	Gender		Total
	Male(%)	Female(%)	
18-25	38 (90.5)	4(9.5)	42(100)
26-35	56(83.6)	11(16.4)	67(100)
36-45	27(93.1)	2(6.9)	29(100)
	121(87.7)	17(12.3)	138(100)

Of the 138 blood donors studied 121(87.7%) were males and 17 (12.3%) were females giving a male to female ratio of 7.1:1. The subjects ranged from 18 to 45years with mean age of 28.61±5.47.

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In both the male and female donors, the age group 26-35years had the highest number of donors 56 (83.6%) and 11 (16.4%) respectively. The least number of donors was seen in the age group 36-45years, male 27(93.1%) while female had 2(6.9%).

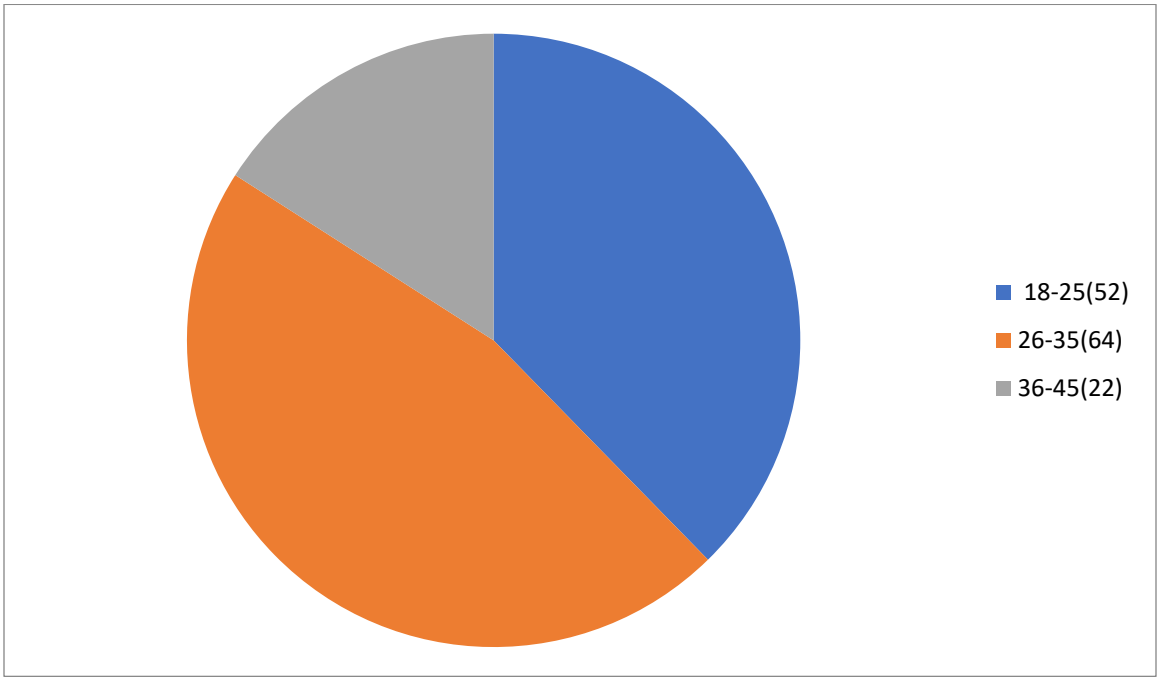

Figure 1: Age distribution of Study Population

Figure 1 shows the age distribution of the blood donors studied. Of the 138 blood donors studied, the age group 26-35 years 64(46.4%) had the highest number of donors with the least number 22(15.9%) seen in age group 36-45years. In age group 18-25years, there were 52 (37.7%) donors.

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Table 2: Socio-demographic Characteristics of Study Subjects

	A N=(%)	B N=(%)	C N=(%)	X^2	Df	P-value
Age group						
18-25	35(43.2)	9(25.7)	8(36.4)	3.383	4	0.496
26-35	34(42.0)	20(57.1)	10(45.5)			
36-45	12(14.8)	6(7.1)	4(18.2)			
Mean age±SD	27.90±5.82	29.11±4.69	30.05±5.16			
Sex						
Female	17(21.0)	0(0)	0(0)	13.643	2	0.00109
Male	64(79.0)	35(100)	22(100)			
Tribe						
Igbo	78(96.3)	34(97.1)	22(100)	0.844	2	0.655
Others	3(3.7)	1(2.9)	0(0)			
Place of Resisdence						
Urban						
Rural	66(81.5)	28(80)	19(86.4)	0.390	2	0.8228
	15(18.5)	7(20)	3(13.6)			
Occupation						
Civil servant						
Traders	23(28.4)	0	0			

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Unskilledworkers	17(21.0)	9(25.7)	6(27.3)
Student	11(13.6)	17(48.6)	9(40.9)
Unemployed	19(23.4)	2(5.7)	0
Others	5(6.2)	2(5.7)	3(13.6)
	6(7.4)	5(14.3)	4(18.2)

Table 2 shows the socio-demographic data of the studied subject. Of the 138 blood donors under study majority belong to the age group 26-30years (group A 34(42.0%), group B 20(57.1%), while group C was 10(45.5%). This was not significant statistically (x^2=3.383, df= 4, p-value=0.496). The number of males to female donors in the entire studied group was significant statistically (x^2 = 13.643, df= 2, p-value=0.001). Majority of the blood donors are of Igbo tribe in each group of study while minority belongs to other tribe. This was not significant statistically (x^2=0.844, df=2, p-value=0.6559).
Among the group A blood donors 66(81.5%) lived in urban area of the state while 15 (18.5%) lived in rural area of the state. In group B and C 28(80%) and 19(86.4%) respectively lived in Urban area, while 7(20%) and 3(13.6%) respectively lived in rural area. This was significant statistically (x^2=0.390, df=2, p-value=0.8228).

In group A, 23 (28.4%) were civil servants while in group B and C non were civil servants. The majority of the occupation in group B, 17 (48.6%) and C, 9 (40.9%) were unskilled workers. Traders were 17 (21.0%), 9(25.7%) and 6(27.3%) in group A, B and C respectively. Student donors were seen in group A, 19(23.4%) and B, 2(5.7%) while non was seen in group C. 5 (6.2%) unemployed blood donors were seen in group A, group B had 2(5.7%) while non was seen in group C.

Table 3: Mean and Standard Deviation of Iron status in blood donors

Group	Frequency of donation	Serum Ferritin (ng/ml)	Serum Iron (µg/dl)	TIBC (µg/dl)	%Transferrin Saturation (%)
A	1-3	76.87±108.59	92.64±24.63	324.73±50.14	29.41±9.91
B	4-6	1.56±2.73	47.86±23.06	426.41±117.63	11.07±5.53

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C	7-9	0.92±2.05	30.64±18.93	470.55±67.92	8.27±7.41

Table 3 shows the mean ±S.D values for serum ferritin level, serum iron, TIBC, and Iron saturation tested for in group A, B, and C. In group A, the mean ±S.D values of serum ferritin, serum iron, TIBC, and % transferrin Saturation were 76.87±108.59, 92.64±24.63, 324.73±50.14, and 29.41±9.91respectively. In group B, the mean ±S.D of serum ferritin, serum iron, TIBC, and % transferrin Saturation were 1.56±2.73, 47.86±23.06, 426.41±117.63 and 11.07±5.53 respectively. The mean ±S.D of serum ferritin, serum iron , TIBC, and % transferrin Saturation were 0.92±2.05, 30.64±18.93, 470.55±67.92, and 8.27±7.41 respectively.

Figure 4.2: Subjects with normal Serum Ferritin, Serum Iron, TIBC and Percentage Transferrin Saturation in the study population.

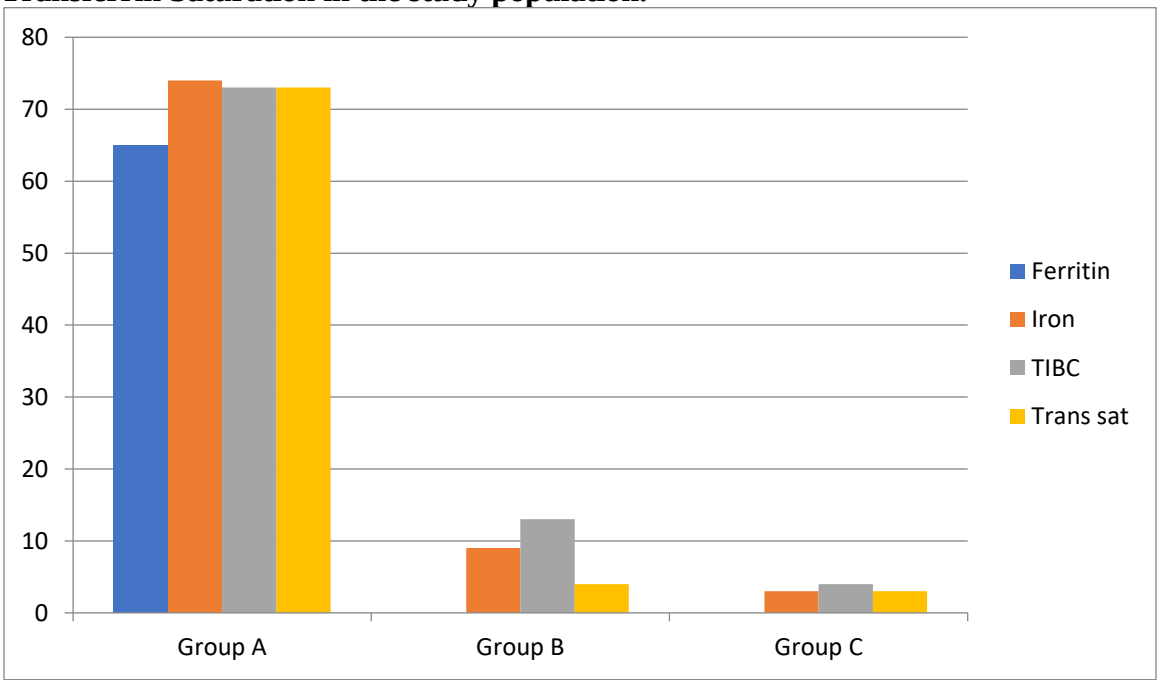

Figure 2 shows the number of blood donors in each group with normal Serum Ferritin, Serum Iron, TIBC and %Transferrin Saturation level. Of the 81 donors in group A, 65 (100%), 74 (86.1%), 73 (81.1%) and 73 (91.3) had normal serum ferritin, serum iron, TIBC and % transferrin Saturation level respectively. In group B and C, all the blood donors studied had abnormal serum ferritin level. They are completely iron depleted. Of the 35 blood donors in group B, 9(10.5%), 13(14.4%), and 4(5.0%) had normal serum iron, TIBC and %transferrin saturation level respectively. In group

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C, the number of blood donors with normal serum iron, TIBC and % transferrin Saturation level were 3(3.4%), 4(4.5%), and 3(3.7%) respectively.

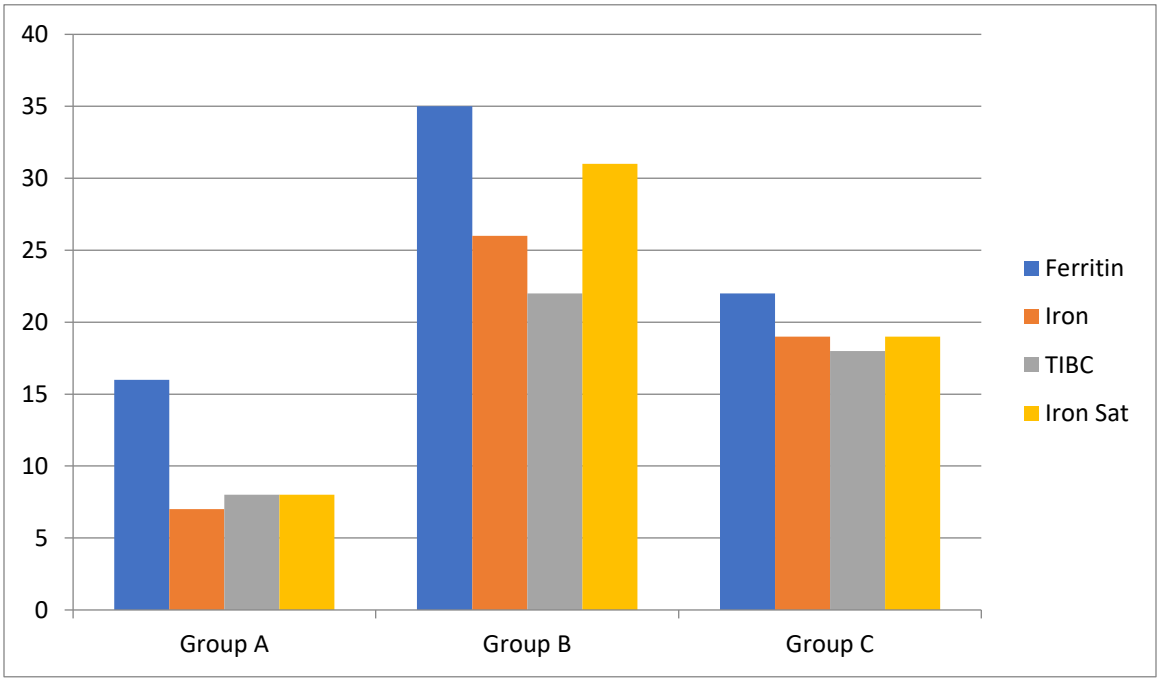

Figure 3: Subjects with abnormal Serum Ferritin, Serum Iron, TIBC and % Transferrin Saturation level in the study population

Figure 3 shows the number of blood donors in each group with abnormal Serum Ferritin, Serum Iron, TIBC and % Transferrin Saturation level. Of the 138 donors under study, group A had 16 (21.9%) , 7 (13.5%), 8 (16.7%) and 8 (13.8%) with abnormal serum ferritin, serum iron, TIBC and % Transferrin Saturation level respectively. In group B, 35(47.9%), 26(50.0%), 22(45.8%) and 31(53.5%) had abnormal serum ferritin, serum iron, TIBC and iron saturation level respectively. In group C, the number of blood donors with abnormal serum ferritin, serum iron, TIBC and % Transferrin Saturation level were 22 (30.2%), 19(36.5%), 18(37.5%), and 19(32.7%) respectively.

Table 4: Relationship between frequency of blood donation and serum ferritin

Serum Ferritin	A	B	C	Test

		N=(%)	N=(%)	N=(%)	Total	X^2	Df	p-value
Normal Ferritin	Serum	65(100)	0(0)	0(0)	65(100)	86.46	2	<0.00001
Abnormal Ferritin	Serum	16(21.9)	35(47.9)	22(30.2)	73(100)			
					138			

Table 4 shows the relationship between the frequency of blood donation and serum Ferritin. In group A, 65(100%) had normal serum ferritin while 16 (21.9%) had abnormal serum ferritin. All the studied subjects in group B and C, 35 (47.9%) and 22(30.2%) had abnormal serum ferritin respectively. The relationship was significant statistically (x^2=86.46, df=2, p-value=<0.00001)

Table 5: Relationship between frequency of blood donation and Serum Iron

Serum Iron		A N=(%)	B N=(%)	C N=(%)	Total	Test X^2	Df	p-value
Normal Serum Iron		74(86.1)	9(10.5)	3(3.4)	86(100)	71.262	2	<0.00001
Abnormal Iron	Serum	7(13.5)	26(50.0)	19(36.5)	52(100)			
					138			

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Table 5 shows the relationship between frequency of blood donation and Serum iron. Of the 81 blood donors in group A, 74 (86.1%) had a normal level of serum iron while group B had 9(10.5%) normal serum iron. In group C, only 3(3.4%) had normal serum iron level. Abnormal serum iron level were 7(13.5%), 26 (50.0%), 19(36.5%) in group A, B, and C respectively. The result was significant statistically (x^2=71.262, df=2, p-value= <0.00001).

Table 6: Relationship between frequency of blood donation and TIBC

TIBC	A N=(%)	B N=(%)	C N=(%)	Total	Test X^2	Df	p-value
Normal TIBC	73(81.10)	13(14.4)	4(4.5)	90(100)	86.46	2	<0.00001
Abnormal TIBC	8(16.7)	22(45.8)	18(37.5)	48(100)			
				138			

Table 6 shows the relationship between blood donation and TIBC. The number of blood donors with normal TIBC level in group A were 73(81.1%), 13 (14.4%) in group B and 4(4.5%) in group C. 8 (16.7%) of blood donors in group A had abnormal level of TIBC, 22(45.8%) in group B while 18(37.5%) abnormal value were seen in group C.
The result was significant statistically (x^2=55.767, df= 2, p-value= <0.00001).

Table 7: Relationship between frequency of blood donation and Percentage Transferrin Saturation

Iron Saturation	A N=(%)	B N=(%)	C N=(%)	Total	Test X^2	Df	p-value

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Normal Saturation	Iron	73(91.30)	4(5.0)	3(3.7)	80(100)	83.234	2	<0.00001
Abnormal Saturation	Iron	8(13.8)	31(53.5)	19(32.7)	58(100)			
				138				

Table 7 shows the relationship between blood donation and % Transferrin Saturation. The number of normal levels of iron saturation in blood donors in group A were 73(91.3%). Group B and C were 4(5.0%) and 3(3.7%) respectively. The abnormal levels were 8(13.8%), 31(53.5%), and 19(32.7%) in group A, B and C respectively. The result was significant statistically (x^2=83.234, df= 2, p-value= <0.00001)

Table 8: Mean ±S.D of Total Serum Protein in Blood Donors

Group	Frequency of blood donation	Mean Serum Protein (g/dl)
A	1-3	7.02±1.34
B	4-6	6.90±0.57
C	7-9	6.67±0.72

Table 8 shows mean ±S.D of serum protein in group A, B, and C. The mean ±S.D of total serum protein in group A was 7.02±1.34, while mean ±S.D of total serum protein in group B was 6.90±0.57. In group C mean ±S.D of total serum protein was 6.67±0.72.

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Table 9: Relationship between frequency of blood donation and Total Serum Protein

Serum Protein	A N=(%)	B N=(%)	C N=(%)	Total	Test X^2	Df	p-value
Normal Serum Protein	75(58.6)	32(25.0)	21(16.4)	128(100)	0.3332	2	0.8465
Abnormal Serum Protein	6(60.0)	3(30.0)	1(10.0)	10(100)			
				138			

Table 9 shows the relationship between frequency of blood donation and Serum protein. Of the 81 blood donors under study in group A, 75(58.6%) had normal serum protein while 6(60.0%) had abnormal serum protein. Out of 35 blood donors under study in group B, 32(25.0%) had normal serum protein while 3(30.0%) had abnormal serum protein. Normal serum protein was seen in 21(16.4%) of group C while abnormal was 1(10.0%).
The result was not significant statistically (x^2=71.262, df=2, p-value= 0.8465

Table 10: Mean ±S.D of Haemoglobin in Blood Donors

Group	Frequency of Blood donation	Mean Hb (g/dl)
A	1-3	13.30±2.10

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B	4-6	9.76±1.83
C	7-9	8.03±0.68

Table 10 shows mean ±S.D of Hb in group A, B, and C. The mean ±S.D of Hb in group A was 13.03±2.10, while mean ±S.D of Hb in group B was 9.07±1.83. In group C mean ±S.D of Hb was 8.03±0.68.

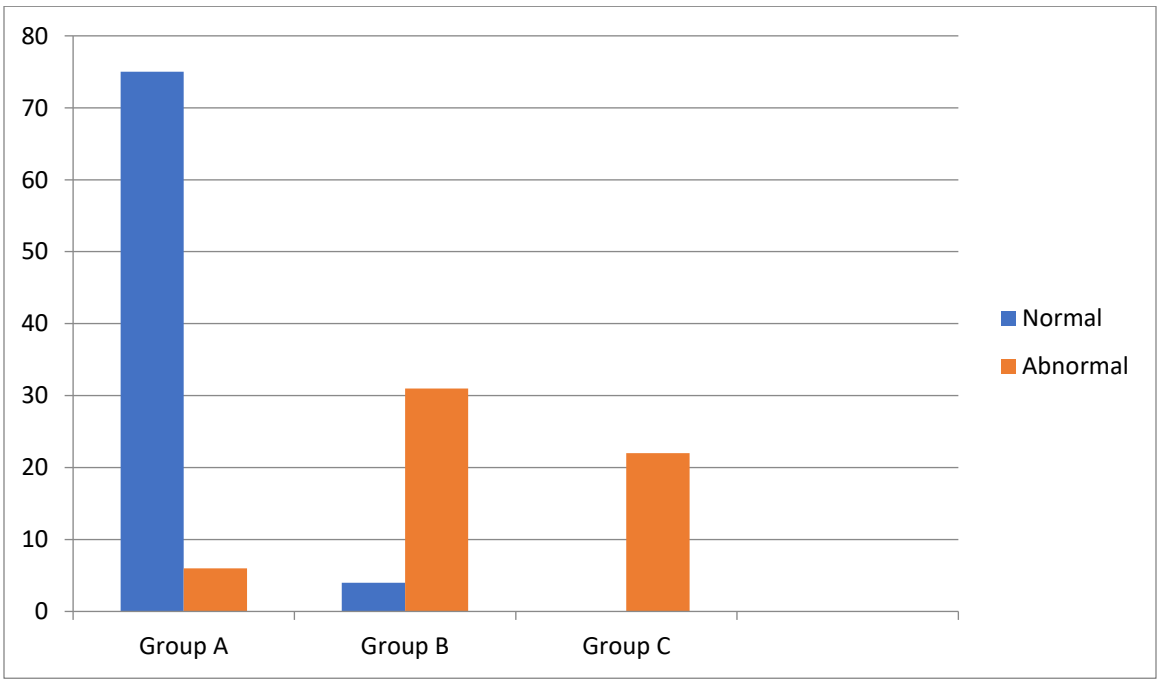

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Figure 4: Normal and Abnormal Haemoglobin value of the Study population

Figure4 shows the Hb levels of the blood donors. In group A 75 (94.9%) had normal Hb while 6(10.2%) had abnormal Hb. Group B had 4(5.1%) normal Hb while 31(52.5%) had abnormal Hb. In group C all the blood donors 22 (37.3%) had abnormal Hb.

Table 11: Relationship between frequency of blood donation and Hb

Hb	A N=(%)	B N=(%)	C N=(%)	Total	Test X^2	Df	p-value
Normal Hb	75(94.9)	4(5.1)	0(0)	79(100)	100.825	2	<0.00001
Abnormal Hb	6(10.2)	31(52.5)	22(37.3)	59(100)			
				138			

Table 11 shows the relationship between blood donation and Hb. Of the 138 blood donors studied, the Hb level of group C all had low Hb 22 (37.3%). Group A has the highest number 75 (94.9%) with normal Hb level. Of the 81 blood donors in group A only 6 (10.2%) had low Hb. Out of the 35 blood donors studied in group B, 4 (5.1%) had normal Hb, 31 (52.5%) had low Hb.
The result was significant statistically (x^2=100.825, df= 2, p-value= <0.00001).

Discussion

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The socio-demographic data obtained from the study subjects shows that the majority of the donors are within the age group of 26-35 years in all the study groups. In group B and C, this may be attributed to the fact that the commercial blood donors are not gainfully employed and so they come occasionally to donate blood when they have needs to raise money for their upkeep. In group A, their occupations were mostly civil service while unskilled workers dominated the majority of the blood donors studied in group B and C. The rest were distributed among other occupations. No civil servant was seen in group B and C.

From the result obtained in this study, the mean serum ferritin level in group A was 76.89±108.59ng/ml, group B was 1.56±2.73 while group C was 0.92±2.05. The mean ± S.D of serum iron was 92.64±24.63ug/dl in group A, 47.86±23.06 in group B and 30.64±18.93 in group C. The result obtained in TIBC in group A was 324.73±50.14 ug/l, while group B and C were 426.41±117.63 and 470.55±67.92 respectively. The values of percentage transferrin saturation in the three groups A, B and C were 29.41±9.91 %, 11.07±5.53 and 8.27±7.41 respectively.

From the findings in this study, there was a significant decrease ($p<0.05$) in serum ferritin as the frequency of donations increase. The result obtained is in line with other studies in Nigeria on serum ferritin in blood donors.[13]

There was a significant decrease ($p<0.05$) in serum iron and percentage transferrin in this finding as the frequency of blood donation increase. This was in line with the works done by Okpokam *et al* 1[4]. Serum Iron and percentage transferrin saturation were found to be significantly lower in regular blood donors and higher in individuals with no history of blood donation. It was observed from this study that TIBC significantly increase ($p>0.05$) as the frequency of donation increases. This is also similar to the study conducted by Akputuzor *et al*.[15]

From the findings of this study, the values of iron profile parameters obtained from the group A (voluntary donors) shows that at normal donation interval (1-3 times per year) the iron status remained within normal range. The values obtained from group B and C give a confirmatory high loss of body's iron stores through regular blood donation. A falling trend in all the iron profile parameters was seen in established iron deficiency anaemia (Hb≤7.0g/dl). After a single donation, a person needs approximately 3 months to replenish iron stores. With continued bleeding below the 3 months interval, an individual either reaches equilibrium at a lower level of iron stores or becomes anaemic.

This means that as donation increases, the iron stores of these donors are completely depleted leaving such donors in a state of anaemia. This is shown in the mean Hb of these donors. The mean Hb of group A (13.03±2.10) when compared to the Hb of group B (Hb=9.76±2.78) and group C (8.03±0.68) showed that there was a significant decrease ($P<0.05$) in Hb with increase in number of donations. The results also show that all the donors in group C and 85.7% of group B have developed iron-deficiency anaemia (Hb<12.0). Of the 81 blood donors studied in group A, 23 (28.4%) individuals have normal Hb but with completely reduced iron stores, hence are iron store deficient. Several studies indicate that haemoglobin is not a sensitive indicator to detect iron deficiency at an early stage, but is useful in detecting the majority of blood donors with established

iron deficiency.[16] Considering this observation, I may suggest that at 4th and 5th time, donation should be discouraged as the quality of such blood may not be satisfactory for use. Again, this will also help to prevent the donors from developing anaemia due to blood donation. There was no significant relationship ($p>0.05$) in the total serum protein level with frequency of donation. This may be due to the fact that plasma proteins take only two weeks to replenish the lost one contrary to iron that takes 3months to replenish. Also, dietary absorption of protein in the villi is not tightly controlled unlike absorption of iron which is tightly controlled due to its toxic effect to the body when in excess.

Conclusion

A high prevalence of iron deficiency and iron deficiency anaemia was present among the remunerated blood donors. The iron status levels gradually decrease according to the number of donations and there was a significant relationship between frequency of donations and iron status. Haemoglobin estimation should not only be used as the sole criterion for donating blood as the association between Hb and iron deficiency is poor. The result obtained from this study may indicate the need to review the guidelines on acceptance of donors. Some donors in this study presented a normal haemoglobin value, passing the screening test and donate blood despite being iron deficient. While conventional screening programmes based on the haemoglobin are adequate to prevent the development of progressive iron deficiency anaemia, they provide no indication of the development of tissue iron depletion. While it would be desirable to avoid iron depletion in regular blood donors only a minority of the eligible population have been willing to provide the blood resources in Nigeria based on altruism, the rest are commercial blood donors who donates blood on financial gain hence subjecting themselves to iron deficiency anaemia due to increase frequency of blood donation.

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