Body iron status in blood donors in Erbil

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ABSTRACT

Background and Objectives: Blood donation is a process by which an individual voluntarily donates blood for humanitarian reasons, for storage in blood bank. The aim of this study is evaluation of iron status of blood donors in Erbil city

Methods: Over six months period ,489 healthy looking adult male attending Nanakaly hospital for blood disease in Erbil city north of Iraq, those divided into 1st time donors, multiple donors (2-4times/2year) and frequent donors(>4times/2year), blood samples for complete blood picture, serum iron parameters &serum ferritin level were performed.

Results: Ninety one donor(18.6%)were found to have *laboratory* evidence of iron deficiency, all were repeated donors, (20.5%) among multiple donors increased to (26.7%)among frequent donors. iron deficiency was positively related to the frequency of blood donations(p<0.001).the frequency of early stages of iron deficiency was higher among multiple donors (store depletion 47.9%, iron deficient erythropoiesis (IDE) 47.9% compared to 37.2% store depletion &44.2% iron deficient erythropoiesis (IDE) among frequent donor iron deficiency anemia (IDA) was higher among frequent donors(18.6%V4.2%p=0.01).mean cell volume (MCV) was inversely related to frequency of donation, hemoglobin and Hematocrit (HB& PCV) showed no association with serum ferritin or with frequency of donations, however serum iron& transferrin saturation were positively associated with serum ferritin level.

Conclusion: iron deficiency is common among repeated donors and worsens with increasing frequency of donations ,iron supplementation may be needed.

Key words: Body iron , blood donors

INTRODUCTION:

Blood donation involves the removal of approximately225mg iron with each donated pint [1]. Blood loss is a major cause of iron deficiency. Frequent blood loss can result in negative iron balance.[2] The stages of developing iron deficiency is depletion of body iron stores followed by impairment of erythropoiesis and iron dependant enzymes and only at a later stage does the Hb level fall with the development of microcytic hypochromic anemia.[3] In most blood banks, (Hb) concentration, is the only index of donor iron status which is insensitive determination.[2] As assessed by serum were reduced in 8% of male and 23% of female blood donors, the prevalence of iron deficiency increases with the frequency of donation.[4]

Aim of Study:

This study is an attempt to evaluate the iron status of blood donors in Erbil ,to assesses the degree of blood donation and body iron status as measured by serum ferritin, serum iron parameters, Hb and other red cell indices& to asses the efficiency of Hb, red cell indices and serum iron parameters as indicators of body iron status.

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PATIENTS   AND METHODS:

From November 2007 to June 2008, four hundred eighty nine male donors, aged between 18-54 years, attended blood bank department in Nanakaly hospital for blood donation were randomly selected.

Group I

• First time donors: this group included (94) males who were donating for the first time in their life, as a control group.

Group II

• Multiple donors: This group included (234) males who had donated 2-4 times within the last 2 years.

Group III

• Frequent donors: This group included (161) males who had donated more than 4 times within the last 2 years. From each donor a sample of 9 ml of blood collected was taken via the bleed line after completion of the donation, 3 ml were into EDTA-tubes for the performance of routine hematological tests (Hb, PCV, Platelet counts,, MCV, MCH, MCHC and blood film) and 6 ml were collected into plain tubes, the serum was separated, stored at -20˚C for the later estimation of serum iron, TIBC and serum ferritin.

A smear of blood was stained by Leishmann stain for red cell morphology assessment. Serum iron and TIBC were measured using commercial kits (BIOLAB).

For each iron deficient donor, the stage of iron deficiency was specified as follows.[5]

• Stage of iron store depletion; where low serum ferritin was the only abnormal finding.

• Stage of iron deficient erythropoiesis (IDE); in this stage, low serum ferritin was associated with a transferrin saturation of less than 16%.

• Stage of iron deficiency anemia (IDA); in this stage, in addition to the previous changes the Hb concentration dropped to less than 13 g/dl with low red cell indices and the appearance of hypochromic microcytic red cells on stained blood

• The cut off value of serum Ferritin was 20 μg/l.

Statistical analysis:

Data were evaluated statistically, analyzed and organized in tables and graphs. SPSS (statistical package for social sciences), version (15) was used to analyze the data. Student t-test was used to make comparison between two variables. Association between two variables was studied using the chi-square test. A p-value of less than 0.05 was considered as statistically significant. Microsoft Excel was used for arranging tables and figures.

RESULT:

Figure (1) shows the age distribution of four hundred Eighty Nine male studied donors. All from Erbil Governorate Their ages ranged between (18-54) years, were all in a good heath and none of them had any significant complains. The frequency of blood groups of studied donors is given in (Figure 2). The frequency of Rh^{+ve} donors was (97%) while only (3%) was Rh^{-ve}. In order of frequency the commonest ABO types were: O, B, A & AB. Donors were divided into 3 groups according to the frequency of donations, group I was considered as control. Table (1) presents a statistical summary of various hematological and biochemical parameters of the studied subjects . Among studied donors (91) 18.6% showed evidences of iron deficiency, there were 48 in group II, 43 in group III and none in group I. The percentage within each group was (48) 20.5% in group II and (43) 26.7% in group III).   The frequency of iron deficiency increased significantly with increasing frequency of donations (P<0.001). Twenty three percent (91) of repeated donors (multiple and frequent donors) had iron deficiency. According to the stages of deficiency; (39) 42.8% of cases were in the stage of iron store depletion, (42) 46.1% of cases were in the stage of IDE and (10) 11% of cases were in the stage of IDA. In group II, (23) 47.9% of cases

23) 47.9% of cases were in the stage of IDE and (2) 4.2% of cases were in the stage of IDA. In group III there were (16) 37.2% of cases in the stage of store depletion, (19) 44.2% of cases were in the stage of IDE and (8) 18.6% of cases were in the stage of IDA, figure (4) shows the distribution of iron deficient donors according to the stages of deficiency. Table (2) compares the hematological and biochemical parameters of repeated donors with the control group. In group II donors, the MCV, platelets and serum ferritin were all significantly reduced, the rest of the parameters showed no significant differences. In group III; The MCV, the platelets, serum ferritin and transferrin saturation were all significantly reduced as compared to the controls. TIBC was increased, other parameters, including Hb from the control. Serum ferritin levels were strongly associated with the frequency of donations, figure (5) shows the progressive reduction of serum ferritin with increasing frequency of donations. Serum ferritin was also significantly associated with serum iron level and transferrin saturation, other parameters showed no significant association. The MCV was significantly associated with the frequency of donations but not with serum ferritin levels. Among iron deficient donors, regardless of the frequency of donations, serum ferritin levels were significantly associated with Hb, PCV, MCV, MCH, serum iron and transferrin saturation. These associations were stronger among group III donors. Table (4) summarizes the degree and level of these associations.
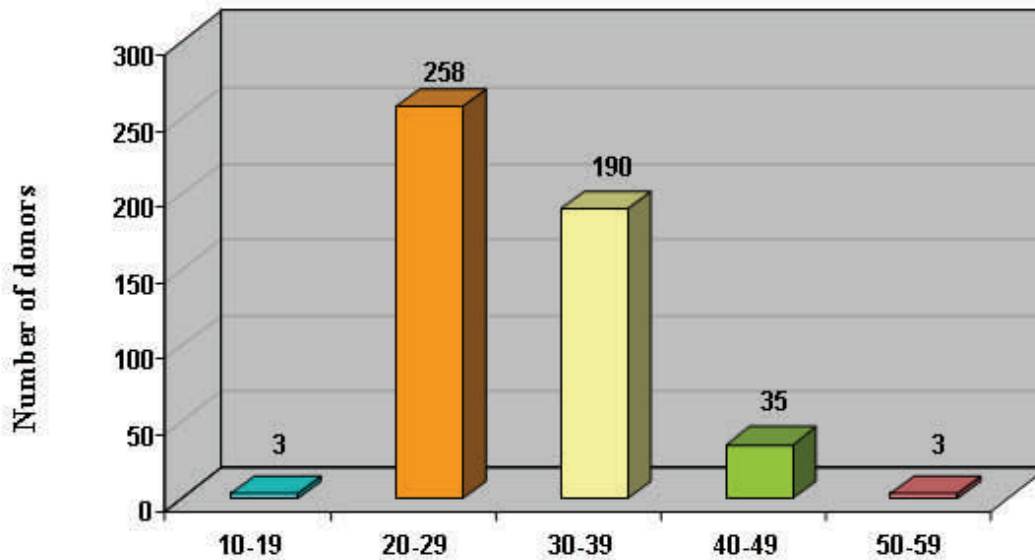

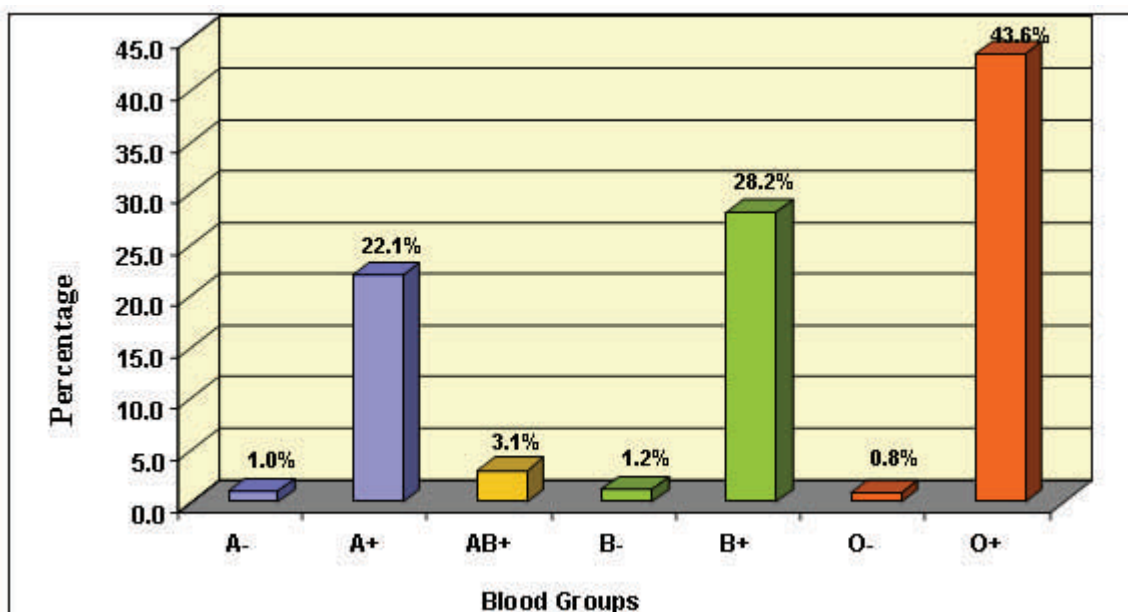**Figure 1:** age distribution of studied donors

Figure 2: Distribution of blood groups among studied donors.

Table 1 : Statistical summary of the hematological and biochemical parameters of the studied donors

| Parameters (mean ± SD) (Range)	Group I (n=94)	Group II (n=234)	Group III (n=161)
Hemoglobin (g/dl)	15.2 ± 1.2 (13.1-18.8)	15.4 ± 1.2 (11.8-18.6)	15.4 ± 1.6 (9-18.6)
Hematocrit (%)	46.2 ± 3.4 (40.1-56.7)	45.4 ± 3.3 (36.6-55.7)	45.4 ± 3.9 (28.7-54.1)
MCV (fl)	87.5 ± 4.2 (79.1-98.3)	86.3 ± 5.7 (46.8-99.2)	85.4 ± 7.8 (38.8-98.5)
MCH (pg)	28.8 ± 2.1 (25.5-33.6)	29.4 ± 2.3 (20.9-34.3)	29.0 ± 3.0 (17.9-34.2)
Platelets (x10^9/l)	279.3 ± 57.5 (150-442)	257.3 ± 60.5 (108-514)	262.8 ± 69.4 (126-491)
Serum Ferritin (µg/l)	102.2 ± 68.1 (21.8-341.3)	73.5 ± 63.0 (0.8-294.3)	62.0 ± 56.6 (0.5-226.8)
Serum Iron (µg/dl)	105.8 ± 30.3 (63.07-196.9)	103.7 ± 36.8 (10.8-195.1)	100.3 ± 40.5 (13.6-198.4)
TIBC (µg/dl)	360.8 ± 71.1 (202.9-486)	377.8 ± 83.2 (173.7-620.6)	381.6 ± 87.4 (179.1-668.4)
T. Sat (%)	30.9 ± 11.8 (16.1-57.9)	28.9 ± 12.3 (2.6-60.4)	27.7 ± 12.7 (3.6-59.1)
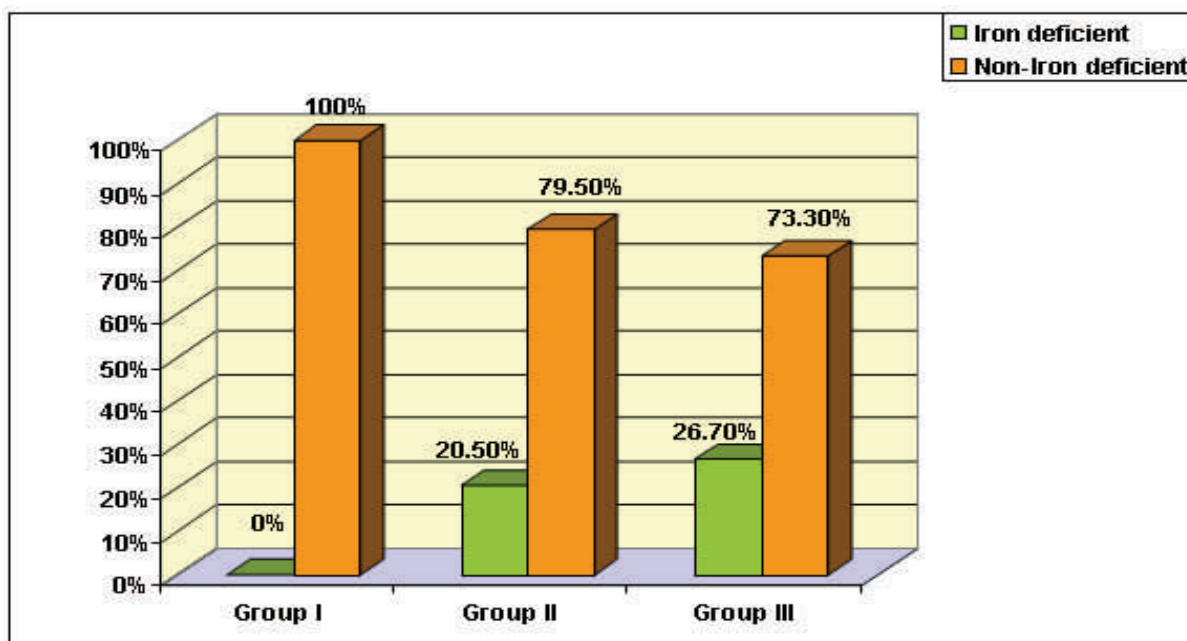
Figure 3: Distribution of cases of iron deficiency among studied groups
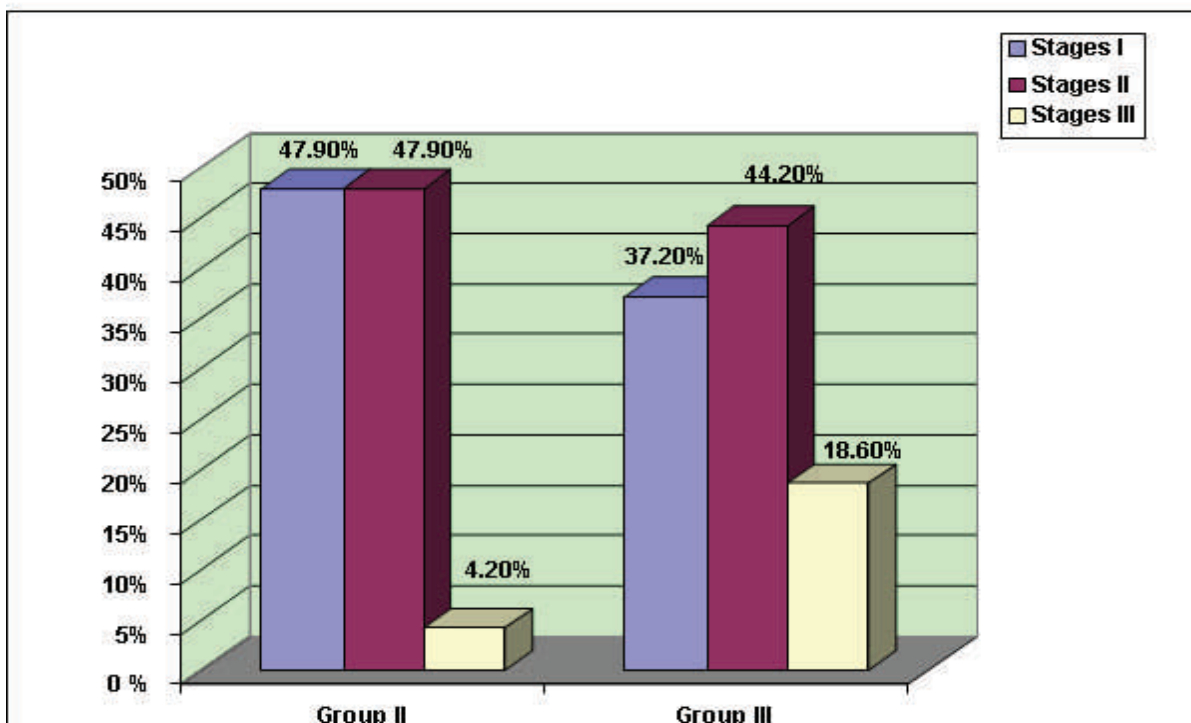
Figure 4: Distribution of iron deficient donors according to the stage of iron deficiency

Table 2: Comparison between hematological and biochemical parameters of group I, group II and group III.

Parameters	Group I (Mean)	Group II		Group III	
		(Mean)	P-Value	(Mean)	P-Value
Hemoglobin (g/dl)	15.2	15.4	0.1	15.4	0.3
Hematocrit (%)	46.2	45.4	0.05	45.4	0.08
MCV(fl)	87.5	86.3	0.04*	85.4	0.007*
MCH(pg)	28.8	29.4	0. 4	29.0	0.5
Platelets (x10^9/l)	279.3	257.3	0.002*	262.8	0.04*
Serum Ferritin (µg/l)	102.2	73.5	0.001*	62.0	<0.001*
Serum Iron(µg/dl)	105.8	103.7	0.6	100.3	0.2
TIBC (µg/dl)	360.8	377.8	0.06	381.6	0.04*
T. Saturation (%)	30.9	28.9	0.2	27.7	0.04*

* Significant.

Table 3: summarizes the level of significance of association between frequency of donations and serum ferritin with various parameters.

Parameters	Frequency of Donations	Serum Ferritin
	p-value	p-value
Ferritin (µg/l)	<0.001*	
Hemoglobin(g/dl)	0.39	0.05
Hematocrit (%)	0.14	0.074
MCV(fl)	0.034*	0.073
MCH(pg)	0.54	0.11
Serum Iron(µg/dl)	0.53	<0.001*
TIBC (µg/dl)	0.13	0.1
T. Saturation (%)	0.18	<0.001*

Table 4: Degree of association between serum ferritin and various parameters in iron deficient donors using chi-square test.

Parameters	Iron deficient cases		
	All (n=91)	Group II (n=48)	Group III (n=43)
	P-Value	P-Value	P-Value
Hemoglobin(g/dl)	<0.001*	0.20	<0.001*
Hematocrit (%)	<0.001*	0.11	<0.001*
MCV(fl)	<0.001*	0.16	0.001*
MCH(pg)	0.001*	0.43	0.002*
Serum Iron(µg/dl)	<0.001*	0.01*	<0.001*
TIBC (µg/dl)	0.23	0.25	0.64
T. Saturation (%)	<0.001*	0.004*	0.002*

DISCUSSION :

Blood donation is the most vital part of any successful blood transfusion service. The frequency of iron deficiency was positively associated with the frequency of donations (p< 0.001). In Germany, Alvarez-Ossorio et al, (2000)[6]have reported a frequency of 24% among multiple donors and none among first time donors. Nadarajan et al, (2002)[7] reported in Malaysia a frequency of 17.4% among multiple donors. Cancado et al, (2001)[8] have reported a frequency of 7.6% among multiple donors in Brazil. In Iran Shahshahani et al, (2005) [9]have reported a frequency of 7.5% among studied donors. In India Mittal et al, (2006),[10]have shown that 8% of first time donors were iron deficient but the percentage rose to 49% in multiple donors. In Karachi similar results were reported by Badar et al, (2002)[1], they noted that the frequency of iron deficiency ranged between 5%-50% among those who were donating (3-7) times within two years. In this study, 42.8% of the cases belonged to the stage of store depletion, 46.1% to the stage of IDE and only 11% were anemic. The frequencies of the first two stages of iron deficiency were higher among multiple donors compared to frequent donors (47.9% store depletion, 47.9% IDE versus 37.2% store depletion and 44.2% IDE respectively), a reversed pattern was noted in cases of overt IDA (4.2% versus 18.6% ; p= 0.01). Most of the workers have shown a progressive deepening of the negative iron balance with increasing frequency of donations (Shahshahani et al, 2005[9]; Djalali et al, 2006[11]; Mahida et al, 2008)[12].In this work, serum ferritin was considered as the prime indicator of body iron status, it was significantly decreased with increasing frequency of donations (P < 0.01 in group II & < 0.001 in group III compared to group I). The mean value among first time donors was 102.2 µg/l compared to a mean value of 73.5µg/l and 62 µg/l in groups II and III respectively. Similar finding were repeatedly reported by other workers

2001; [8]Badar et al, 2002[1]; Nadarajan et al,[7] 2002; Shahshahani et al, 2005[9]; Djalali et al, 2006[11]). Hemoglobin and hematocrit had shown no significant changes among different groups and showed no association with serum ferritin levels, similar results were reported by Norashikin et al, (2006)[13]. Among iron deficient donors in group III a significant association was found between Hb, PCV and serum ferritin, this was because of the higher frequency of iron deficiency anemia in this group. These findings indicate that the so commonly used Hb estimations as screening for iron deficiency will fail to detect iron deficiency in most instances, all it can, is to exclude donors with overt anemia, a relatively late development in the sequence of events of iron deficiency. These findings agree with the results of other authors (Alvarez-Ossorio et al, 2000; Cancado et al, 2001; Nadarajan et al, 2002; Norashikin et al, 2006; Mittal et al, 2006); however, Djalali et al, (2006) had found a significant association between the Hb level and the frequency of donations. In this study the association between frequency of donations and other red cell indices was interesting; the MCV progressively decreased with increasing frequency of donations (p<0.05 in group II &< 0.01 in group III compared to group I). The MCH did not differ significantly when different groups were compared and it showed no association with the frequency of donations; it became significantly different in cases of iron deficiency anemia only. These findings suggest that MCV may be superior to Hb in detecting early iron deficiency . Regarding serum iron parameters; the mean serum iron and transferrin saturation showed progressive decrease with increasing donation frequency. Likewise the TIBC progressively increased, but these changes did not reach a significant level among group II donors. In group III donors TIBC and transferrin saturation differed significantly from group I (p<0.05 & <0.05 respectively). High TIBC and low transferrin saturation are

Hoffbrand, 2005)[14]. Serum iron and transferrin saturation were positively associated with serum ferritin level (p<0.0001 &p<0.0001 respectively). This association was stronger in those cases belonging to group III compared to group II iron deficient donors.

CONCLUSION:

Iron deficiency is rare among first time blood donors but it is a common complication of repeated donations, majority of iron deficient donors belong to the stages of store depletion and iron deficient erythropoiesis measurements or by serum iron parameters .

REFERENCES:

1. Badar A, Ahmed A, Ayub M, Ansari AK . Effect of frequent blood donations on iron stores of non anemic male blood donors. Ayub Med Coll Abbotabad 2002; 14(2): 24-27.

2. Andrews NC . Iron deficiency and related disorders. In : Greer JP, Foerster J, Lukens JN, Rodgers GM, Paraskevas F, Glader B. Wintrobe's Clinical Hematology. 11th Edition. Philadelphia: Lippincott Williams & Wilkins. 2004:980-1009.

3. Alexander HD, Sherlock JP, Bharucha C . Red cell indices as predictors of iron depletion in blood donors. Clin Lab Heme 2000; 22: 253-258.

4. Simon TL, Garry PJ, Hooper EM . Iron stores in blood donors.JAMA 1981; 245: 2038-2043 (Abstract)

5. LewisSM,Bain BJ, Bates I. Dacie and Lewis Practical Hematology.10th Edition, Philladelphia:Elsevier. 2006: PP26-27.

6. Alvarez-Ossorio L, Kirchner H, Klüter H, Schlenke P . Low ferritin levels indicate the need for iron supplementation: strategy to minimize iron-depletion in regular blood donors. Transfuse Med; 2000;10: 107-112.

7. Nadarajan VS and Eow GI . Anemia and iron status among blood donors in a blood transfusion unit in Malaysia. Malaysian J Pathol 2002; 24: 99-102.

8. Cancado RD, Chiaton CS, Alonso FF, Junior D.M.L, Alves R.C.S . Iron deficiency in blood donors. Sao Paulo Med J 2001; 119: 32-34.

9. Shahshahani HJ, Attar M, Yavari MT. A study of the prevalence of iron deficiency and its related factors in blood donors of Yazd, Iran, 2003. Transfus Med 2005; 15(4): 287-293.

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

11. 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 (3): 132-137.

12. Mahida VI, Bahatti A, Gupte SC. Iron status of regular voluntary blood donors. Asian J Transfus Sci 2008; 2: 9-12.

13. Norashikin J, Roshan TM, Rosline H, Zaidah AW, Suhair AA, Rapiaah M . A study of serum ferritin levels among male blood donors in hospital university sains Malaysia. South east Asian J Trop Med Pub Health 2006; 37: 370-373.

14. Workwood M and Hoffbrand VA . Iron metabolism, Iron deficiency and disorder of heme synthesis. In: Hoffbrand AV, Catovsky D, Tuddenham EGD, Editors. Postgraduate Hematology. 5th Edition. Oxford: Blackwell. 2005.PP 26-43.