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A Study on the Frequency of Iron Deficiency and Thalassaemia in Blood Donors at Pusat Darah Negara, Kuala Lumpur

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ABSTRACT

Objective: This study was done to identify blood donors with thalassaemia and iron deficiency. A cross sectional study was carried out at Pusat Darah Negara (PDN), Kuala Lumpur in November 2003. **Methods:** Full blood counts were done on 242 blood donors (166 males and 76 females) Hb analysis and serum ferritin assay were done for all the samples. The first time donors were used as controls. **Results:** Only 20 (8.3%) donors had MCV <80 fl and MCH <26pg. Six of the 25 donors with iron deficiency had a low MCV (<80 fl) and low MCH (<26 pg) but all the 8 (40%) donors with thalassaemia or HbE had a low MCV and MCH! The mean ferritin levels were found to be lower among regular blood donors (95.3 μg/L) compared to first time blood donors (116.6 μg/L) but this was not statistically significant. There were 25 donors who were iron deficient: one was a first time donor and 24 were regular donors - 12 (50%) had donated 3 times a year in the last two years. Iron deficiency was seen in 12 Malays, and 9 Chinese, and 4 Indians. 13.3% of the males (22 out of 166 donors) and 4% (3 of 76) of female donors were iron deficient. Thalassaemia and HbE were found in 8 donors. HbE trait was identified in 5 Malay donors. One Malay and 1 Chinese donor had β thalassaemia trait. Another Chinese had alpha (α^0) thalassaemia trait. Neither HbE nor thalassaemia were seen in the Indian donors. **Conclusion:** In this study thalassaemia and HbE were seen in 3.3% and iron deficiency in 10.3% of the 242 blood donors at PDN. Iron deficiency was present in 3.2% of the first time donors and 12.8% of the regular donors. Regular donors should have the S.Ferritin done for their iron status and if their MCV and MCH are low, Hb analysis for thalassaemia or haemoglobinopathy.

Keywords: Blood donors, serum ferritin, iron deficiency, haemoglobinopathy

INTRODUCTION

Iron is a vitally important element in human cellular metabolism. It has a central role in erythropoiesis and is also involved in many other intracellular processes in all the tissues of the body.[2] Voluntary unpaid blood donation is a humanitarian act towards the sick by the healthy. The well-being and health of the blood donors is important.[1]

Blood donation is recognised as the most common iatrogenic cause for iron deficiency.[5] A donor generally donates approximately 450 ml (425 to 475 ml) of blood at the time of donation and this results in a substantial (200 to 250 mg) loss of iron.[2] Replenishment of this lost iron will take approximately 50 days based on a daily iron absorption rates of 2.8 -

6.0 mg/day.[7] An increase in the frequency of blood donations among the donor population is liable to result in iron loss with development of iron deficiency anemia, especially in women of childbearing age, if iron replacement is not adequate.

Iron deficiency starts with depletion of iron stores when the haemoglobin (Hb), level, mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) are still normal. This then progresses to iron deficiency with normal Hb level but decreasing MCV and MCH. When iron deficiency gets worse, the Hb, MCV and MCH become low; the person may be symptomatic which leads to the diagnosis of iron deficiency with the appropriate laboratory findings.[5]

In Malaysia, donors are allowed to donate up to 4 times a year, once in three months. Donors must weigh at least 45 kg and are screened for anaemia at the donation session, usually done by the 'copper sulphate specific gravity method' on a finger prick blood sample. A cut off value of 125 gm/dL of Hb is used to protect against the possibility of anemic donors donating blood. A study showed that hemoglobin or haematocrit measurement alone is not sufficient for detecting and excluding blood donors with iron deficiency without anemia.[2]

Thalassaemia and haemoglobinopathies are inherited conditions, which can be diagnosed easily from the haemogram and Hb analysis. About 3% of Malays and Chinese in Malaysia have thalassaemia. Full blood counts are done, but too often the low MCV and low MCH are not investigated further, and the donor is not aware that he has thalassaemia or HbE/ haemoglobinopathy. Persons with thalassaemia or HbE may have a normal haemoglobin and so are able to donate blood.

This study was designed to assess the development of anemia and frequency of iron deficiency and thalassaemia and haemoglobinopathy among blood donors at PDN population.

METHODS

Two hundred and forty-two unselected whole blood donors (54 first-time donors and 188 regular donors) donating blood at the Pusat Darah Negara, Kuala Lumpur were recruited into the study after obtaining informed consent. The blood donors in this study filled a questionnaire. Based upon the number of donations in the previous two years, the donors were grouped into five categories. The group of 54 'first-time' donors was taken as "controls". Regular donors were defined as those who had donated at least twice before. They were divided into 4 groups. Group A comprised those who had donated 2-5 times (77 donors), Group B 6-10 times (39 donors), Group C 11-19 times (40 donors), and in Group D were those who had donated more than 19 times (32 donors).

Iron deficiency is defined as serum ferritin levels of less than 12.0 μg/L in females and less than 34.0 μg/L in males. All donors were screened for anaemia by measuring their Hb using the copper sulphate method. This method does not measure the Hb directly, but uses the specific gravity (S.G.) to identify those with a low Hb of less than 12.5gm/dl The red blood cells are heavier when the Hb is more than 12.5gm/dl and will sink when a drop of blood is dropped into the copper sulphate solution. If the Hb is less than 12.4g/dl, the drop of blood will float and the person cannot donate blood. This method is simple, cheap and quick to differentiate the anaemic from those who have a normal Hb of more than 12.5g/dl. Only donors who passed the copper sulphate test were eligible for the study. Those with low

Hb would be anaemic and were excluded from the study. Each donor donated 300mls or 450mls of whole blood depending on his/her body weight.

Five ml each of venous blood was taken into EDTA and plain tubes at the end of donation from each donor. Full blood counts were performed using an automated hematology analyzer (Beckman Coulter). Serum ferritin assays were performed on the Hitachi 920 using immunoturbidimetric assay.

The diagnosis of thalassaemia trait in the routine haematology laboratory includes the Hb electrophoresis, Hb A_2 quantitation and investigation for the presence of 'H' inclusion bodies in the reticulocyte smear.

For statistical analysis, differences were evaluated by the Student "t" test and correlation using Spearman's rank correlation coefficient. A "P" value less than 0.05 was considered statistically significant. All the analyses were performed on the software SPSS, version 11.0.

RESULTS

The characteristics studied in the 242 blood donors are summarised in Table 1. No significant demographic differences were observed among the groups. There were fewer females in groups C&D because female donors have become more regular donors only in the last 5 years.

Overall, statistically the 5 groups did not show any significant differences in haematology indices and serum ferritin level, except Group D where the MCH was significantly lower than in the control group. RDW (Red Cell Distribution Width) was significantly higher among regular donors in Group C and Group D. There was no significant difference demonstrated in the male and female donors' proportion of developing iron deficiency following repeated blood donations as compared to first time donation *(Fig. 1)*.

Table 1. Demographics and laboratory data among first time and regular blood donors

Groups		CONTROL	A	B	C	D
AGE		33.2 ± 9.6	31.1 ± 8.3	32.2 ± 7.8	36.2 ± 7.6	37.0 ± 7.7
SEX	Male	31	48	27	33	27
	Female	23	29	12	7	5
RACE	Malay	15	40	19	11	8
	Chinese	24	31	17	29	22
	Indian	15	6	3	0	2
Hb (gm/dl)		14.2 ± 1.7	14.2 ± 1.4	14.4 ± 1.6	14.7 ± 1.5	14.6 ± 1.3
Hct (L/L)		42.5 ± 5.2	42.8 ± 4.2	43.3 ± 4.7	44.2 ± 4.4	44.2 ± 3.7
MCV (fL)		88.3 ± 4.1	85.9 ± 7.0	86.4 ± 5.2	87.5 ± 6.2	85.4 ± 6.2
MCH (pg)		29.5 ± 1.4	28.7 ± 2.6	28.8 ± 1.7	29.1 ± 2.3	28.2 ± 2.4*
MCHC (g/L)		33.4 ± 0.5	33.4 ± 0.9	33.3 ± 0.7	33.2 ± 0.8	33.0 ± 1.0
RDW		13.1 ± 0.6	13.5 ± 1.1	13.4 ± 1.3	14.0 ± 1.7*	14.4 ± 2.1*
RBC (x 10^{12}/L)		4.8 ± 0.6	5.1 ± 1.3	5.0 ± 0.6	5.3 ± 1.6	5.2 ± 0.5
Ferritin (µg/L)		109.4 ± 77.9	97.2 ± 74.3	72.9 ± 63.1	101.5 ± 65.5	91.3 ± 80.1

**P value < 0.05 when compared with controls*

Among the 25 donors with iron deficiency, there were 12 Malays (12.9%), 9 Chinese (7.3%) and 4 Indians (15.4%). Iron deficiency in regular donors was seen in all the 4 groups (Table 2). There were 12 donors with iron deficiency who had donated 3 times in a year in the last two years, 4 donors who had donated twice a year and 8 who had donated only once a year.

Iron deficiency was seen in 24 (9.9%) regular donors and in only one first-time (0.4%) donor out of the 242 blood donors studied. There were 22 (13.3%) male and 3 (3.9%) female donors. All the iron deficient female donors were regular donors (two of them donated 3 times and one 18 times). The frequency of iron deficiency was higher in regular blood donors than in first-time blood donors, for male blood donors 15.6% versus 3.2% and for female 5.7% versus 0% (Table 3).

There were 19 donors who had normal Hb, MCV and MCH but low serum ferritin levels. There were 6 cases with normal Hb but low MCV and MCH with low serum ferritin (Table 4). All the cases in this study had normal Hb concentration. This was not statistically significant.

Table 2. Distribution of iron deficiency in twenty-five blood donors according to number of donation

GROUP	CONTROL First time donors	A 2-5 donations	B 6-10 donations	C 11-19 donations	D >20 donations
Male	1	4	6	3	8
Female	0	2	0	1	0
TOTAL	1 (4.0%)	6 (24.0%)	6 (24.0%)	4 (16.0%)	8 (32.0%)

Table 3. Frequency of iron deficiency in blood donors according to sex and type of donor

SEX	Male n = 166 (68.6%)		Female n = 76 (31.4%)	
Type of Donor	First Time n = 31 (18.7%)	Regular n = 135 (81.3%)	First Time n = 23 (30.3%)	Regular n = 53 (69.7%)
Iron deficiency n (%)	1 (3.2%)	21 (15.6%)	0	3 (5.7%)

**P value < 0.05 when compared with controls*

Table 4. Iron deficiency in donors relating to Hb, MCV and MCH

Status of the indices	Number of cases	Serum Ferritin range (μg/L)
Normal Hb, MCV, MCH	19	2.3-23.9
Normal Hb but low MCV, MCH	6	4.9-17.1
Total	25	

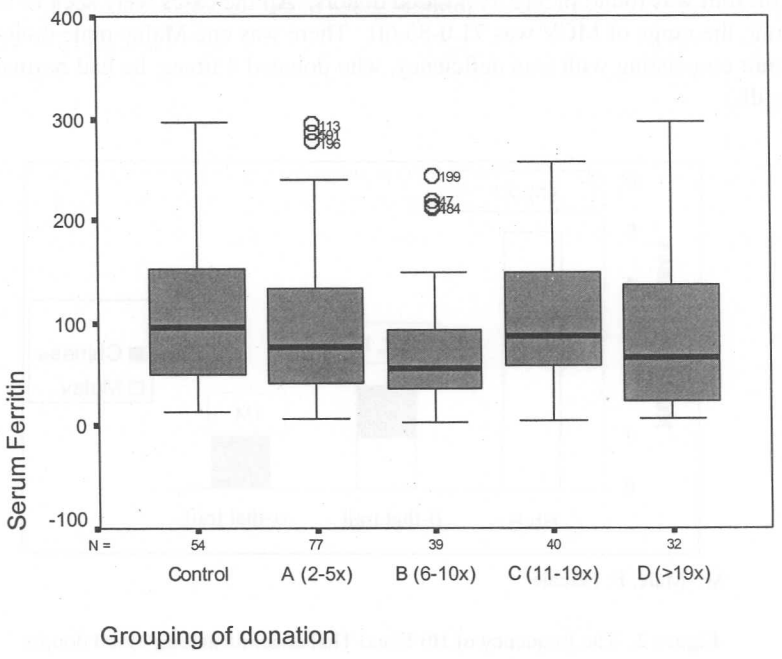


Figure 1. Serum ferritin levels among first time and regular blood donors

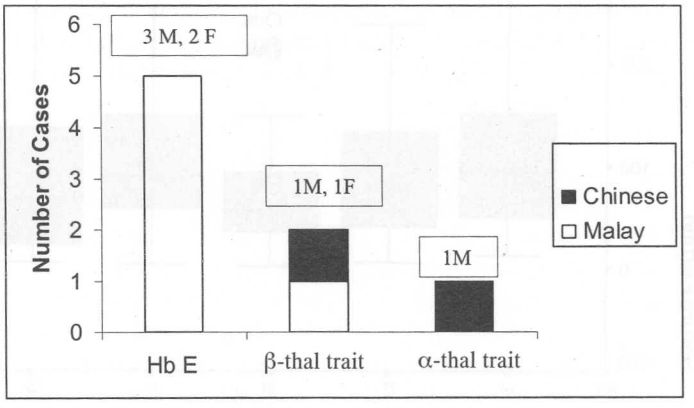
This study found that 8 donors had thalassaemia and HbE trait (Table 5). Two had β thalassaemia trait and one had α^0 thalassaemia trait *(Fig. 2)*. HbE was found in 5 (2.1%) of the donors, who were all Malays. There was one Malay male donor who had HbE and iron deficiency who had donated 4 times; he had a normal Hb level of 13.8g/dl.

Twenty donors had a low MCV (<80 fl) and MCH (<26 pg). Six of them had iron deficiency and 7 donors had thalassaemia and HbE trait. Two had β-thalassaemia trait and only one α^0-thalassaemia trait. The MCV range for the three thalassaemia trait was 61.5fl-66.4fl. The MCH range for thalassaemia trait was 19.6-21.8pg. Four Hb E trait had MCV between 71.0-79.3fl and MCH between 24.3- 26.8pg One HbE had a MCV of 85.6fl and MCH of 28.1pg.

Table 5. Distribution of iron deficiency, thalassaemia and HbE in blood donors according to number of donation

Group	A	B	C	D	Controls
Total	77	39	40	32	54
Iron deficiency	6(8%)	6(15%)	4(10%)	8(25%)	1(1.9%)
Thalassaemia		3(4%)			
HbE	4(5%)	1(2.5%)			

HbE trait was found in 5 (2.1%) blood donors. All the cases were seen in Malays. In HbE trait, the range of MCV was 71.0-85.6fl. There was one Malay male donor who had Hb E trait co-existing with iron deficiency, who donated 4 times; he had normal Hb level (13.8 g/dL).



M: Male, F: Female

Figure 2. The frequency of Hb E and Thalassaemia among blood donors

DISCUSSION

All blood donors with iron deficiency had a normal hemoglobin level and were allowed to donate (Table 4). This shows that measuring the Hb concentration alone would not identify the population with iron deficiency. All the donors with iron deficiency did not have a low Hb or a low MCV (<80 fl) and low MCH (<26 pg) either since 19 iron deficient donors in this study had normal MCV and MCH. Therefore MCV and MCH are also not useful to identify those donors with iron deficiency whose iron stores have been depleted after regular blood donation. Only 6 donors had iron deficiency with low MCV (<80 fl) and low MCH (<26 pg). The sole iron deficient donor in the first time donor group had a normal MCV (84.2 fl) and MCH (28.6 pg).

In this study all cases of thalassaemia trait had MCV less than 76.0fl and MCH less than 26.0pg. Therefore, a low MCV of less than 76.0fl and MCH less than 26.0pg can be used as a cut off value to screen for thalassaemia.

This study shows that the prevalence of iron deficiency increases with frequent blood donations. Finch *et al.* reported that frequent donation was associated with a high incidence of iron deficiency and donor dropout.[4] Cancado *et al.* observed similar result in 1999.[2] The frequency of iron deficiency was higher in multi-time blood donors than in first-time donors, for both male blood donors (7.6% versus 0%, $P<0.05$) and female donors (41.5% versus 18.5%, $P<0.05$).

Another study conducted in Karachi by Ahmed *et al.* (1996) again showed absence of the iron stores in many of their non-anaemic donors who had donated six or seven times in two years. Ergen *et al.* demonstrated that decreased serum ferritin levels were directly related to the frequency of blood donation and lower ferritin levels were found especially in those who had donated 6-10 times.[3]

In this study, there were 12 donors with iron deficiency who had donated 3 times a year in the last two years, 5 with iron deficiency donated twice a year and 8 iron deficient donors had donated only once a year. Thus those with more frequent donations tended to develop iron deficiency.

A recent study at the University Malaya Medical Centre, Malaysia by Nadarajan *et al.* reported that 15.7% of male regular donors and 22.7% of female regular donors exhibited iron deficiency.[6] At PDN, there was much less iron deficiency in female (5.7%) regular blood donors but a similar incidence in males regular donors (15.6%) was seen when compared with the finding of Nadarajan *et al.* At PDN, only 3.2% of male "control" (first-time) donors exhibited iron deficiency with normal Hb, MCV and MCH.

Nadarajan *et al.* in their study at the University Malaya Medical Centre also showed that increasing frequency of donation is associated with iron deficiency. However, this study showed a statistically insignificant relationship between the serum ferritin level and the frequency of blood donation.[6] Both studies were done in the blood donor population in the Klang Valley and is assumed to have similar environmental factors. Every donor is given iron tablets and encouraged to take them. Further studies should be done to develop better methods e.g. educating / counseling regular blood donors to reduce iron deficiency after frequent blood donations.

In 5 cases of Hb E trait, one had a MCV of 85.6 fl, while the other 4 had MCV ranging from 71.0-79.3 fl. The MCH range for 4 of the donors with HbE was 24.3-26.8 pg; but there was one donor with an MCH of 28.1 pg. Although he had a normal MCH he was identified since in this study all the 242 donors had the Hb analysis done. Therefore, using MCV and MCH is not effective in identifying Hb E trait.

Hb E trait and thalassaemia were found only among Malays and Chinese in this study. It is cost effective to screen Malays and Chinese who present with low MCV and low MCH for thalassaemia trait by doing Hb analysis. Since thalassaemia and HbE are inherited disorders, it is not necessary to repeat the investigation if the donor is confirmed to have thalassaemia or Hb E trait.

CONCLUSION

The number of iron deficient donors in the regular blood donor population studied was 12.8% and 3.2% in the first time donor population It reflects higher prevalence of iron deficiency among the regular donors. Thalassaemia and HbE were seen in 3.3% of the blood donor population showing that persons with thalassaemia or HbE may donate blood.

Regular blood donors who donate frequently should be tested for iron deficiency and those Chinese and Malay regular donors who have a low MCV and MCH should be screened for thalassaemia and HbE.

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