EFFECT OF FREQUENT BLOOD DONATIONS ON IRON STORES OF NON ANAEMIC MALE BLOOD DONORS

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Background: A healthy blood donor loses about 225 mg of iron per donation. This loss is made up very quickly by mobilizing the iron stores in form of ferritin, followed by replenishing the iron stores if diet is adequate. The situation, however, is different for donors with high frequency of blood donations. Their iron stores are under a constant pressure. In the absence of iron replacement this can lead to emptying of iron stores. We undertook this study to evaluate the effect of frequent blood donations on iron stores of regular male blood donors in Karachi. **Methods:** This study was carried out at Department of Physiology, BMSI, JPMC, Karachi. Our subjects were 8 groups each with 20 non-anaemic male donors, of 20–40 years age (total=160). The first group was 'control group' that comprised of first time donors, while the rest 7 groups comprised of donors who had donated 1–7 times in the last two years, the latest being at least 3 months back. The iron stores were measured by determining serum ferritin levels. **Results:** We found reduction in serum ferritin with increasing frequency of blood donations that became very significant in donors donating 4 or more times in the last two years. Finding of 40% and 50 % iron deficient subjects in the groups donating 6 and 7 times in two years respectively was a surprise for us, as this much high frequency has not been reported from elsewhere. We have tried to justify this extraordinary high frequency with the studies reporting low iron status of Pakistanis and Karachi population. **Conclusions:** Iron deficiency is very common in regular blood donors of Karachi, there is an immediate need to educate the donors about iron supplementation and yearly ferritin checking of so called 'super donors'.

INTRODUCTION

The voluntary unpaid blood donation is a humanitarian act towards the sick by the healthy. No transfusion service can survive without blood donors. The well being and health of the blood donors is of prime importance for the medical profession. A lot has been discovered and written about protection of the recipients from the potential hazards of blood transfusion. A lot of money is being spent for the screening of donors for protection of recipients but very little attention is given to the health status of donors. The main reason is the fear of losing the donor in a time when the demand of blood is soaring all over the world and the donors are becoming scarce.

The need for blood is great. On any given day, approximately 32,000 units of Red Blood Cells are needed. Accident victims, people undergoing surgery, and patients receiving treatment for leukemia, cancer, or other diseases, such as sickle cell disease and thalassemia, all utilize blood. More than 23 million units of blood components are transfused every year[1]. In most countries, strict regulations have been established for the selection of blood donors that incorporate criteria that serve to protect both the donor and recipient[2]**.**

A donor generally donates approximately 450 ml blood at the time of donation. One gram of haemoglobin contains 3.4 mg of iron. In a normal individual with 15 g 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[3]. If 450 ml of blood are 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. Hence adequate iron stores are very important in maintenance of the donor health[4].

Acceptable frequency of donation is normally two or three times a year. Women of child bearing age are especially liable to iron depletion, many men can donate more frequently without such an ill effect[5]. Men are able to maintain adequate iron status while donating up to 5 units of blood annually, but women are at risk for iron deficiency if they donate more than 1 unit per year[6]. Iron deficiency, often associated to anemia, is the main cause of deferring women from blood donation: an incidence of 9.5% over a series of 1,437 women was found by Hermosa *et al*[7]. Iron stores are exhausted in virtually all female donors regardless of the frequency of blood donations[8].

An anemic person cannot donate blood. To protect against this possibility, a haemoglobin test, usually done by the 'copper sulphate specific gravity method' is required for every blood donor on each donation. The American Association of blood banks has a standard of minimum haemoglobin of 13.5 g/dl for men and 12.5 g/dl for women donors4. However except for a very few modern blood banks most of the blood banks in our country do not care much for the donors health.

Iron is a universal cofactor for mitochondrial energy generation and supports the growth and differentiation of all cell types. The regulation of systemic iron is through the proteins 'Transferrin' (iron mobilization) and 'Ferritin' (iron

sequestration)[9]. The physiologic importance of the storage iron is that it provides a rapidly available supply in the event of blood loss[10]. Serum ferritin concentration is an indicator of mobilizable body iron stores[11]. In various clinical disorders serum ferritin is found to correlate with the marrow iron stores assessed histologically[12]. Serum ferritin averages about 90 and 30 microgram/L in normal men and women respectively, a difference that accurately reflects the well known difference in iron stores of the two sexes[13].

The iron content of the body is kept constant by maintaining a balance between the amount absorbed and the amount lost. The iron available in the diet is absorbed in a small portion only. This amount also depends upon the interaction of foods, drugs and abnormal components of diet[14]. Iron requirements depend on age, sex, race, pregnancy, lactation and altitude[15].

Considerations of the iron deficiency have traditionally focused on anemia, that reduces maximum Oxygen consumption and maximum work performance in proportion to its severity[10]. Whatever the basis, iron deficiency induces a hypochromic microcytic anemia. Simultaneously depletion of essential iron containing enzymes in cells throughout the body may cause other changes, including koilonychia, alopecia, atrophic changes in the tongue and gastric mucosa, and intestinal malabsorption. Awareness of subtle symptoms of mild iron deficiency is increasing[16]. It is now appreciated that depletion of iron dependent tissue enzymes occurs in concert with the decrease in haemoglobin production[17]. Most importantly there is now evidence that iron deficiency has an adverse effect on brain function[18]. Lack of iron effects the body systems and produces variable symptoms. Increased catecholamine levels in children leading to abnormal behaviour have been found associated with iron deficiency[19]. An impaired response of triiodothyronine to cold was reported in iron deficiency by Dilman *et al*[20].

After a single donation, a person needs approximately 3 months to replenish iron stores[21]. Some experts believe that frequent bleeding even with iron supplementation is not justified and that the maximum annual rate of donation should be twice for men and once for women[8].

The objective of this study was to evaluate the effect of frequent blood donations on iron stores of regular male blood donors in Karachi.

MATERIALS AND METHODS

This study was conducted at the department of Physiology, Basic Medical Sciences Institute, Jinnah Postgraduate Medical Center, Karachi in 1995–1996. Lists of regular blood donors were acquired from three patient welfare organizations of the city. Male donors in the age group of 20–40 years, with a record of 2–8 adult bag donations in the last two years with the latest one at least three months back, were identified. Based upon the number of donations in the previous two years, seven groups of these donors were formed and every individual in each group was given a serial number. A sample of 20 donors from each of these groups was drawn using a table of random numbers. A group (convenience sample) of 20 'first time' male donors of age between 20–40 years was taken as controls. The groups and total donors in each group are given in Table-1.

Table-1. Total population in various donor groups from which the sample (20 from each group) was drawn

Group	Number of donations in the last two years	Total Population (Males donors 20–40 years of age)
Control (D0)	Nil	Not determined
D1	1	232
D2	2	167
D3	3	289
D4	4	134
D5	5	27
D6	6	39
D7	7	34

The donors were approached through their phones or addresses in record. The next random number was taken for the very few who were unable to participate in the study for one reason or the other. The exclusion criteria were donation within last three months, use of iron supplements, donation elsewhere (outside the registering organization), anaemia (tested by cyanmethaemoglobin) or a major trauma/surgery in the last three months. Our final sample was 8 groups of 20 subjects each that gave a total of 160.

Five ml blood was collected from all the donors. Serum was extracted after clotting of blood and it was stored for estimation of serum ferritin. Serum ferritin was estimated by Enzymoimmuno-assay using kit supplied by Boehringer Mannheim Immunodiagnostics (Cat No. 1 488 708-122, ch-B/Lot 188495-01, Expiry date August 1996).

The data were organized and analyzed using software 'Statistica for Windows' version 4.1 Statsoft Inc., USA. Means and standard deviations for haemoglobin and serum ferritin were calculated for each group. The means of all the groups were then compared for significance using 't- test'.

Based upon the internationally accepted norms, a cut off point of 12 ηg/ml for serum ferritin was taken for depleted iron stores[13]. Percentages of the iron deficient subjects were then calculated.

RESULTS

The results of our study have been summarized in tables 2 and 3.

Table-2: Serum Ferritin Levels of the controls and regular donors

(The values are given as Mean ± SD)

Group	No. of donations in the last 2 years	Serum ferritin (ηg/ml)
D0	0	74.40 ± 22.06
D1	1	68.10 ± 20.34
D2	2	82.45 ± 24.70
D3	3	68.25 ± 34.36
D4	4	38.30 ± 18.76*
D5	5	20.50 ± 14.11*
D6	6	16.45 ± 10.36*
D7	7	14.90 ± 9.19*

**P value <0.05 when compared with controls*

Table-3: Frequency of iron deficient subjects based upon serum ferritin level <12 ηg/ml

Group	Number of donations in the last two years	Percentage of iron deficient subjects
D0	0	0
D1	1	0
D2	2	0
D3	3	5
D4	4	5
D5	5	15
D6	6	40
D7	7	50

DISCUSSION

The salient feature of our study is a statistically significant decrease in mean serum ferritin level of donors donating more than 3 times in 2 years. This statistically significant difference becomes clinically significant when we observe that the iron stores are empty in many of the donors donating 6 or 7 times in 2 years. Similarly we observed that the standard deviation from the mean serum ferritin decreased in the groups donating more times reflecting a uniform effect on most, if not all, of the donors. Our potentially controversial results are the percentages of iron deficient subjects in donors with six or seven donations in 2 years. It would have been more controversial if it had been for one group only.

This much high percentage for male blood donors has never been reported from anywhere else. If we insist upon accuracy of our methodology the only support to our claim will be a number of studies that have clearly reported a low iron level of Karachi population[22], small erythrocytes with low haemoglobin in Pakistanis[15,23] and dietary habits of Pakistanis leading to iron deficiency[24].

Under developed Asian countries are considered to be areas of highest prevalence of iron deficiency due mainly to poverty, dietary habits and worm infestation[25]. The magnitude of the problem seems to be the greatest in our population and the reason for that is lower iron status of our population as compared to the Western norms[15,22,23]. The reasons for that in turn are racial, environmental, parasitic and dietary factors[15,22,23]. Among the dietary factors the most important ones are low 'haem' proteins in diet and high phytate content of the wheat flour[24].

Our results compare well with only one study that is by Mackintosh and Jacob[26] who reported decreased ferritin in 53% of a sample of 566 non-anaemic healthy male donors. Our results are nearly identical with a study conducted in Thailand by Linpisarn *et al*[27]. In which the serum ferritin level was lower significantly in those who donated three times per year compared to the first time donors. Similar results were observed by Morse *et al*[28] in female blood donors.

Another resembling study is the one by Guilleman *et al*[29] who evaluated 217 regular donors and reported that an increase in the donation frequency was followed by a significant decrease in serum ferritin concentration.

Halvorsen *et al*[30] reported that 10% of the male donors in their study had reduced iron stores while in 3% iron stores were empty. In donors donating frequently, variable percentages have been reported. Some of them are 6% for people who donated three times per year[31], 7.9–12.7% for people who donated four or more times per year and 8 and 19 % with a donation frequency of five and six times respectively[6,31,32] to as high as 28% in a study of so called 'super donors' who donated an average of 17 times over a period of 4 years[33].

A recent study from Germany has reported that ferritin decreases after 10 donations and with the increase of donation frequency. They found 26% of regular donors to have ferritin levels of less than 15 µg/L and 12% of them were anaemic due to low haemoglobin[34]. Another study conducted in Denmark reported that the prevalence of depleted iron depots is higher in donors than in non-donors[11].

A study from Brazil has recently reported a higher frequency of iron deficiency in multi-time blood donors that is more serious in female blood donors. They found frequency of 7.6% iron deficiency in multi-time donors with three or more donations per year[35].

We feel that there is a need to understand the problem and to educate the regular donors regarding iron supplementation. We also suggest that the blood banks must check serum ferritin of all the regular donors at least once every year. This is our responsibility towards these very important persons who are donating life to others.

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