Anaemia, iron deficiency and iron deficiency anaemia among blood donors in Port Harcourt, Nigeria

Zaccheaus Awortu Jeremiah, Baribefe Banavule Koate

Department of Medical Laboratory Sciences, College of Health Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

Background. There is paucity of information on the effect of blood donation on iron stores in Port Harcourt, Nigeria. The present study was, therefore, designed to assess, using a combination of haemoglobin and iron status parameters, the development of anaemia and prevalence of iron deficiency anaemia in this area of Nigeria.

Materials and Methods. Three hundred and forty-eight unselected consecutive whole blood donors, comprising 96 regular donors, 156 relatives of patients and 96 voluntary donors, constituted the study population. Three haematological parameters (haemoglobin, packed cell volume, and mean cell haemoglobin concentration) and four biochemical iron parameters (serum ferritin, serum iron, total iron binding capacity and transferrin saturation) were assessed using standard colorimetric and ELISA techniques.

Results. The prevalence of anaemia alone (haemoglobin <11.0 g/dL) was 13.7%. The prevalence of isolated iron deficiency (serum ferritin <12 ng/mL) was 20.6% while that of iron-deficiency anaemia (haemoglobin <11.0 g/dL + serum ferritin <12.0 ng/mL) was 12.0%. Among the three categories of the donors, the regular donors were found to be most adversely affected as shown by the reduction in mean values of both haematological and biochemical iron parameters. Interestingly, anaemia, iron deficiency and iron-deficiency anaemia were present almost exclusively among regular blood donors, all of whom were over 35 years old.

Conclusion. Anaemia, iron deficiency and iron-deficiency anaemia are highly prevalent among blood donors in Port Harcourt, Nigeria. It will be necessary to review the screening tests for the selection of blood donors and also include serum ferritin measurement for the routine assessment of blood donors, especially among regular blood donors.

Keywords: anaemia, iron deficiency, iron-deficiency anaemia, blood donors, regular blood donors.

Introduction

The impact of blood donation on iron status has been studied since the late 1970s[1–5] . Blood donation results in a substantial (200-250 mg) loss of iron at each collection procedure, during which up to 425 - 475 mL of whole blood are withdrawn, and subsequent mobilisation of iron from body stores. Chronic iron deficiency is a well-recognised complication of regular blood donation[6]. A healthy individual can donate blood up to four times a year i.e. at 3- monthly intervals as iron stores can be depleted if blood is donated more frequently[7]. A cut-off value of haemoglobin of 12.5 g/dL is often recommended before a blood donation is made[6].

An increase in the frequency of blood donation among our donor population is liable to result in excessive iron loss and development of iron-deficiency anaemia. The reason is that blood donation

practices in Port Harcourt do not conform to acceptable world standards. Apart from not always respecting the recommended cut-off level of pre-donation haemoglobin, other criteria such as donor weight and frequency of blood donation are often not strictly adhered to. The result is that many blood donors present more than four times a year. Ironically, there has been a steady push for recruitment of more regular blood donors and encouragement of first time donors to become repeat donors in order to increase the quantity and safety of national blood supplies[8].

In the absence of a national blood bank service to regulate the practice of blood donation, the safety of blood supplies and that of donor is source of concern. In the majority of blood banks, haemoglobin and/or haematocrit measurements are used as screening tests for the ability to donate blood even though iron stores may be depleted in donors with haemoglobin values above the arbitrarily defined limit for anaemia[9]. It is well-known that iron-deficiency anaemia is the last stage of iron deficiency and it is evident that haemoglobin levels alone are inadequate for detecting blood donors with iron deficiency without anaemia[9-11]. Studies have also shown that haemoglobin levels may not correlate with iron status. It follows that individuals at risk of developing iron deficiency can be detected only by estimating serum ferritin levels. In order to fulfil the global and national drive to recruit and retain regular repeat voluntary blood donors, the iron status of the donors needs to be identified and necessary steps for iron supplementation need to be taken.

To the best of our knowledge, no systematic study has been conducted in Port Harcourt to assess the iron stores of regular blood donors. The present study was, therefore, designed to assess, using a combination of haemoglobin and iron status parameters, the development of anaemia and the prevalence of iron deficiency and iron-deficiency anaemia in blood donors in this area of Nigeria.

Materials and methods

Subjects

Three hundred and forty-eight unselected consecutive whole blood donors who were all males (96 regular donors, 156 relatives of patients and 96 voluntary blood donors), donating blood at the Braithwaite Memorial Specialist Hospital, Port Harcourt, Nigeria were recruited into the study after having given informed consent. Regular donors in this study were defined as donors who had made at least four previous donations within the past year. All the regular donors in this study were remunerated. Donors who were patients' relatives (family replacement) were those donating for their relatives for the first time or at most once in the previous year. Voluntary donors were those who donated blood without remuneration or any relative to donate to. All donors were screened using a Hemocure Hb 201+ analyser (Angelholm, Sweden). Only donors whose haemoglobin was between 10.0 and 12.0 g/dL test were eligible for the study. Each donor donated 300 –450 mL of whole blood depending on their body weight.

Study area

Port Harcourt is the capital city of Rivers State, Nigeria. It is located in the Niger Delta at a latitude of 4°31' – 5°31' and longitude 6°31' – 7°21'. The estimated population is 1,620, 214 people.

Methods

Serum iron, total iron binding capacity (TIBC) and transferrin saturation were estimated using a ferrozine–based iron/TIBC reagent set (Pointe Scientific, USA). Test procedures were conducted as described in the manufacturer's standard operating manual included with the kit. Transferrin saturation was calculated from the serum iron concentration and TIBC values as follows: transferrin saturation = serum iron/TIBC x 100.

Serum ferritin was measured using a human ferritin enzyme immunoassay kit (Pointe Scientific, USA). The ferritin quantitative test is based on a solid phase enzyme–linked immunosorbent assay (ELISA). The assay was carried out on an ELISA machine (STAT FAX 2100, Awareness Technology, USA). Test procedures were conducted according to the instructions in the manufacturer's standard operating manual. Readings were carried out using the point-to-point mode from an analogue printer (Epson Lx 300x).

Haemoglobin concentration was determined colorimetrically using the cyanmethaemoglobin method as recommended by the National Committee for Clinical Laboratory Standards[11]. Haemoglobin reagents from Pointe Scientific (USA) were used for the determinations. Packed cell volume (PCV) was

determined using a microhaematocrit centrifuge (HETTICH, Germany). Results are expressed as percentages. Mean cell haemoglobin concentration (MCHC) was calculated from the haemoglobin (Hb) and PCV values as follows: MCHC = Hb/PCV x 100.

Statistics

Statistical analyses were conducted using SPSS (version 11) software. Comparisons between populations were made using the Student's t-test for parametric data and the Mann-Whitney test for non-parametric data. An alpha value of < 0.05 denoted a statistically significant difference.

Results

Three hundred and forty-eight blood donors at a tertiary hospital, Braithwait Memorial Specialist Hospital, Port Harcourt were assessed for the presence of anaemia and iron deficiency using biochemical iron parameters (serum iron, serum ferritin, TIBC and transferrin satruation) and some haematological parameters (Hb, PCV and MCHC). Table I shows the mean values of the seven parameters that were analysed among the various donor groups. The mean values of all the parameters were significantly lower among the regular blood donors than among the other groups of donors, with the differences having various levels of statistical significance. The relationship between age of blood donors and donor types are as shown in table II. It is striking to note that all regular donors were over 35 years old, while all those who came to donate blood for their sick relatives were 30 years old or below. The remaining category (the voluntary donors) were all between 31–35 years old.

Table I - Mean values of the biochemical and haematological parameters among blood donors

Parameters	Donor types			Overall mean	F value
	Regular	PR	VD	n = 348	
	n = 96	n = 156	n = 96		
SF (ng/mL)	15.4	77.8	138.8	77.4	3.587*
SI (ìg/dL)	70.8	145.7	158.3	128.5	2.966*
TIBC (ìg/dL)	219.5	278.4	316.8	273.7	2.815*
TS (%)	39.5	61.3	39.8	53.3	2.740*
Hb (g/dL)	8. 5	13.5	13.4	12.1	29.310 ***
PCV (%)	26.7	40.3	40.2	36.5	25.310 ***
MCHC (%)	31.8	33.5	33.4	33.0	28.940***

Legend: PR = Patients' relatives, SF = Serum ferritin, VD = Voluntary donors, SI = Serum iron, TIBC = Total iron binding capacity, Hb = Haemoglobin, PCV = Packed cell volume, MCHC = Mean cell haemoglobin concentration, TS = Transferrin saturation.
*= P < 0.05; **= P < 0.01; ***= P<0.001

Table II - Distribution of the types of donors according to age group of the study participants

Donor types	Age group (years)			
	≤ 30	31 –35	36-40	Total
	n (%)	n (%)	n (%)	n (%)
Regular	0 (0)	0 (0)	96 (27.6)	96 (27.6)
Patients' relatives	156 (44.8)	0 (0)	0 (0)	156 (44.8)
Voluntary donors	0 (0)	96 (27.6)	0 (0)	96 (27.6)
Total	156 (44.8)	96 (27.6)	96 (27.6)	348 (100.0)

Pearson chi-square value = 110.0 ***
*** = p < 0.001

Table III - Classification and prevalence of anaemia, iron deficiency and iron-deficiency anaemia in the study population

Classification	Cut-off value	Prevalence n (%)
Anaemia alone	Hb < 11.0 g/dL	48/348 (13.7)
Iron deficiency alone	SF < 12 ng/mL	72/348 (20.6)
Iron-deficiency anaemia	SF < 12 ng/mL + Hb < 11/g/dL	42/348 (12.0)

Hb = Haemoglobin; SF = Serum ferritin

The difference in age distribution was statistically significant ($p<0.001$). Table III shows the prevalences of anaemia, iron deficiency and iron-deficiency anaemia among the blood donors. The prevalence of anaemia alone (Hb < 11.0 g/dL) was 13.7%, while that of isolated iron deficiency was 20.6%. The prevalence of iron-deficiency anaemia in the study population was 12.0%. Interestingly, all three of these abnormalities were found almost exclusively among regular blood donors.

Discussion

Iron is a vitally important element in human metabolism. It plays a central role in erythropoiesis and is also involved in many other intracellular processes in all the tissues of the body[12]. The potential for an individual donor to give blood without developing iron-deficiency anaemia is dependent on many factors such as differences in nutritional iron intake, the prevalence of iron deficiency in the particular population, menstrual iron loss in females and the frequency of blood donation[13,15]. Recent studies have shown that the frequency of iron deficiency is high in blood donors and more dependent on the frequency of donation than on the accumulated number of donations[13-15].

This study confirmed the finding of previous studies, in that the prevalence of iron deficiency increased with frequent blood donations. Of the entire study population, 20.6% and 12.0% had iron deficiency and iron-deficiency anaemia, respectively. The values of iron and haematological parameters were significantly lower in regular donors than in the other categories of donors. Simon *et al*.[15] showed that 8% of men and 38% of women have reduced iron stores, as assessed by serum ferritin status, after five donations. In a large Danish study, the prevalence of depleted iron stores was found to be higher in donors than in people who did not donate blood. Furthermore, in the study by Milman[16], 26% of regular blood donors had low ferritin levels and 12% were found to be anaemic. In Nigeria, in 1990, Usanga[17] observed that the mean ferritin concentration of 64.75 ng/mL ± 4.6 in normal males was significantly higher than the mean value of 49.19 ng/mL among blood donors suggesting that some blood donors may have pre-latent or latent iron deficiency at the time of donation and become iron deficient after blood donation.

In contrast, in a recent study of blood donors in Calabar, Nigeria, Akpotuzor *et al*. observed no difference in biochemical iron parameters between male donors and healthy controls[18], although in that study donors were not separated into several categories as they were in this study. All donors who attended their bleeding bay were enlisted into the study. In this study, the high prevalences of iron deficiency and iron-deficiency anaemia could be attributed to the larger volumes of blood (450 mL) that the regular blood donors donate at short intervals. This calls for supervision of ferritin levels and adequate iron supplementation, in order that iron deficiency does not develop among this vulnerable population.

Haemoglobin cut-off levels at the time of donor screening do not appear to be predictive of iron deficiency as shown by a significant proportion of individuals with low ferritin levels who had a haemoglobin concentration above 12g/dL. It may, therefore, be necessary to review the screening criteria used at the time of donation. It also seems logical to include serum ferritin measurement in the assessment of regular blood donors.

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Correspondence: Zaccheaus Awortu Jeremiah, Ph.D
P.O Box 1437
Diobu, Port Harcourt 500001
Rivers State, Nigeria
e-mail: zacjerry@yahoo.com