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Prevalence of iron deficiency anaemia among blood donors in Sokoto, North Western, Nigeria

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ABSTRACT

Objective: To investigate the prevalence and socio-demographic factors associated with iron deficiency anaemia among blood donors in Sokoto, North Western, Nigeria using a combination of haemoglobin haematocrit and serum ferritin measurements.

Methods: One hundred and fifty consecutively recruited whole blood donors, comprising of 148 (98.7%) family replacement donors and 2 (1.3%) voluntary non-remunerated donors aged 18-60 years and mean age 39±21 years constituted the subjects for this study. The full blood count was carried out using Mythic 22 CT fully automated haematology analyser (Orphee SA, Switzerland). Serum was tested for ferritin using a human ferritin enzyme immunoassay kit-ACCU Diag™ ELISA Ferritin kit (Diagnostic Automation/Cortez Diagnostic Inc. California, USA).

Results: The prevalence of anaemia (haemoglobin<11.0 g/dL) was evident in 24 (16%) and iron deficiency anaemia (serum ferritin<12 ng/mL+haemoglobin<11 g/dL) in 5 (10%) of donors. The haemoglobin and ferritin levels was significantly lower among regular voluntary remunerated blood donors (13.50±0.00 and 34.88±0.00) compared to family replacement donors (14.10±2.40 and 74.12±45.20) respectively (P=0.01 and 0.05 respectively). The mean haemoglobin and ferritin level was compared among donors based on gender. The haemoglobin and ferritin was significantly higher among male donors (14.20±2.00, 78.02±49.10) compared to female donors (12.35±2.5 and 42.20±32.13) (P=0.01). The mean haemoglobin and ferritin level was compared among donors based on occupational groups. The haemoglobin and ferritin was significantly higher among civil servants compared to farmers and students (P=0.01).

Conclusions: Iron deficiency anaemia is prevalent among blood donors in Sokoto, North Western, Nigeria. There is need to include routine ferritin in the blood donor testing protocol in the area to enable the diagnosis of donors with latent iron deficiency anaemia to facilitate iron supplementation for regular blood donors at risk and those with iron deficiency anaemia.

1. Introduction

Iron deficiency is a global public health problem and the most common nutritional disorder in both developed and developing countries[1]. Chronic iron deficiency is a well-recognized complication of regular blood donation[2]. A significant number of study indicates a relationship between prevalence of iron deficiency anemia and increase in the number of episodes of blood donation [3-5].

Previous report recommend the estimation of serum ferritin to check pre-clinical iron deficiency among blood donors[6]. A healthy individual can donate blood up to four times a year[7]. A cutoff value of haemoglobin of 12.5 g/dL is often recommended before a blood donation is made. Regular blood donation put a significant

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toll on iron stores. Blood donation leads to substantial iron loss, as about 0.5 mg iron is lost per each millilitre of blood donated. If not compensated for efficiently, the iron loss may eventually lead to iron deficiency and anaemia[8].

Increase in the number of donations results in an increase in the frequency of depleted iron stores and subsequently in erythropoiesis resulting in iron deficiency and anaemia[9]. There is paucity of data on the prevalence of iron deficiency anaemia among blood donors in the Sokoto, North Western Nigeria. The present study was, therefore, designed to assess the prevalence of iron deficiency anaemia and its associated socio-demographic factor using a combination of haemoglobin and serum ferritin measurements.

2. Materials and methods

2.1. Study area

The selected area for this study is Usmanu Danfodiyo University Teaching Hospital which is located in Wamakko Local Government within Sokoto Metropolitan city in Sokoto State. Sokoto State is located in the extreme Northwest of Nigeria, near the confluence of the Sokoto River and Rima River. With an annual average temperature of 28.3 ˚C. Sokoto is, on the whole, a very hot area. However, maximum day time temperatures are for most of the year generally under 40 ˚C. The warmest months are February to April when daytime temperatures can exceed 45 ˚C. The rainy season is from May to October during which showers are a daily occurrence. There are two major seasons, wet and dry which are distinct and are characterized by high and low malarial transmission respectively. Report from the 2007 National Population Commission indicated that the State had a population of 3.6 million[10].

2.2. Study population

One hundred and fifty apparently healthy consecutively-recruited blood donors visiting the blood bank in Usmanu Danfodiyo University Teaching Hospital for blood donation purpose constituted the subjects for this case study.

2.3. Inclusion criteria

All consecutively-recruited, consenting blood donors aged 18-60 years, resident in Sokoto without any history of long-term medication use, illness, history of recent blood transfusion in the last 4 months and menstruation (female) visiting the Blood Transfusion Department of Usmanu Danfodiyo University Teaching Hospital Sokoto for blood donation purpose were recruited into the study.

2.4. Exclusion criteria

All blood donors visiting the Transfusion Laboratory of Usmanu Danfodiyo University Sokoto for Blood Transfusion purpose who did not meet the inclusion criteria were excluded from the study. Ethical approval was sought from the ethical committee of Usmanu Danfodiyo University Sokoto, Nigeria.

2.5. Sampling and methods

About 6 mL of whole blood were collected using monovette vacutainer syringe into ethylene diamine tetraacetic acid anticoagulated tube and plain tubes without anticoagulant. The ethylene diamine tetraacetic acid anticoagulated blood was used for full blood count investigation to obtain the haemoglobin. The full blood count was carried out using Mythic 22 CT fully automated haematology analyser (Orphee SA, Switzerland). The analyser is a fit for purpose fully automated 22-parameter haematology analyser with associated low reagent consumption and less maintenance. It is based on the impedance technology for cell counting. Sample collected into the plain tube was allowed to clot and the serum was obtained. Serum was tested for ferritin using a human ferritin enzyme immunoassay kit-ACCU Diag™ ELISA ferritin kit (Diagnostic Automation/Cortez Diagnostic Inc. California, USA). Test procedures were conducted as described in the manufacturer's standard operating manual included with the kit. The ferritin quantitative test is based on a solid phase ELISA.

2.6. Statistics

Statistical analyses were conducted using SPSS (version 18) software. Comparisons between populations were made using the student's *t*-test for parametric data and the Mann-Whitney test for non-parametric data. A *P*-value of <0.05 denoted a statistically significant difference in all statistical comparisons.

3. Results

One hundred and fifty consecutively-recruited whole blood donors, comprising of 148 (98.7%) family replacement donors and 2 (1.3%) voluntary non-remunerated donors aged 18-60 years with mean age 39±21 years constituted the subjects for this study. Two haematological parameters (haemoglobin and serum ferritin) was assessed among blood donors. Anaemia (haemoglobin<11.0 g/dL) was evident in 24 (16%) and iron deficiency anaemia (serum ferritin<12 ng/mL+haemoglobin<11 g/dL) in 5 (10%) of donors. Table 1 shows the prevalence of anaemia based on serum ferritin and low haemoglobin level. The serum ferritin and haemoglobin levels was significantly higher among family replacement donors compared to regular voluntary non-remunerated donors [(74.12±45.20) ng/mL and (14.10±2.40) ng/mL *vs* (35.00±10.00) ng/mL and (13.50±1.20) ng/mL] (*P*=0.01 and 0.05 respectively). Table 2 shows mean values of haematological parameters based on donor type. The haemoglobin and serum ferritin levels were compared among blood donors based on gender. The haemoglobin and serum ferritin levels was significantly higher among male donors compared to female donors [(14.20±2.00 ng/mL and (75.25±44.60) ng/mL *vs* (12.35±2.50) ng/mL and (42.42±32.13) ng/mL] (*P*=0.001). Table 3 shows the mean values of haemoglobin and ferritin level based on gender. Serum ferritin level and haemoglobin level were compared based on occupational groups of donors. Serum ferritin and haemoglobin level was higher among civil servants compared to farmers and students (*P*=0.07 and

0.005 respectively). Table 4 shows the mean values of ferritin and haemoglobin level based on occupational group.

Table 1

Prevalence of anaemia causes based on serum ferritin and low haemoglobin level.

Classification	Cut-off values	Prevalence [*n* (%)]
Anaemia	Haemoglobin<11.0 g/dL	24 (16%)
Iron deficiency anaemia	Serum ferritin<12 ng/mL Haemoglobin<11g/dL	15 (10%)

Table 2

Mean values of haematological parameters based on donor type[40-42].

Parameter	Donor type		*P*-value
	VNRD	FRD	
Haemoglobin (g/dL)	13.50±0.00	14.10±2.40	0.05
Serum ferritin (ng/mL)	34.88±0.00	74.12±45.20	0.01

VNRD: Voluntary non remunerated donor; FRD: Family replacement donors.

Table 3

Mean values of haemoglobin and ferritin level based on gender.

Parameter	Gender		*P*-value
	Male	Female	
Haemoglobin (g/dL)	14.20±2.00	12.35±2.50	0.01
Serum Ferritin (ng/mL)	78.02±49.10	42.20±32.13	0.01

Table 4

Mean values of haematological parameters based on occupational group of donors.

Parameter	Occupational group			*P*-value
	Farmers	Civil servants	Students	
Haemoglobin (g/dL)	12.50±2.10	13.30±2.90	13.21±2.00	0.07
Serum ferritin (ng/mL)	78.02±49.10	92.50±36.00	87.80±50.50	0.05

4. Discussion

Iron deficiency and anaemia are the main factors responsible for the deferral of blood donors. In this present study, we observed iron deficiency anaemia (serum<12 ng/mL+haemoglobin<11 g/dL) among 15 (10%) of our cohort of 150 blood donors in Sokoto, North Western, Nigeria. Our finding in this present study is consistent with a prevalence of iron-deficiency anaemia (haemoglobin<11.0 g/dL+serum ferritin <12.0 ng/mL) of 12.0% observed in Port Harcourt Nigeria by Jeremiah and Koate[11]. Our finding is higher than a prevalence of iron deficiency anemia of 2.14% reported among regular donors in Iran[12]. Also another survey in Iran that observed a prevalence of iron deficiency anemia among 16% of regular male donors[1]. Similarly, a survey in Denmark observed a prevalence of iron deficiency anaemia (ferritin less than 15 and haemoglobin lower than 12.9) and (ferritin less than 15 and haemoglobin lower than 13.7) of 0.26% and 0.5% respectively among their cohort of male donors[13]. Screening donors and determining their fitness to donate blood using indices of haemoglobin and ferritin levels is vital in protecting the health of the donor as well as ensuring that the aim of red cell transfusion to manage anaemia in the recipient is achieved. A previous report indicates that screening with haemoglobin and iron indices enables prediction of donors at risk of subsequent anaemia and who would likely benefit from prevention strategies[14]. Several practices have adverse consequences for donors, including elevated incidence of donation[9]. It is the responsibility of blood collection centres to ensure that the well-being of blood donors are adequately protected. Previous report recommended that blood donors with deficient iron stores and anaemia should be referred for treatment and monitoring[15].

In this present study, we observed a high incidence of iron deficiency anaemia (10%) among our cohort of blood donors. There are several factors responsible for the high incidence of iron deficiency anaemia in developing countries. The most significant cause of iron-deficiency anemia in the developing world is parasitic worms infestation (hookworms, whipworms and roundworms[16]. Malaria and vitamin A deficiency also contribute to anemia in most underdeveloped countries[17]. In women over 50 years old, the most common cause of iron-deficiency anemia is chronic gastrointestinal bleeding from non-parasitic causes (gastric ulcers, duodenal ulcers or gastrointestinal cancers). The most common causes of anaemia in Nigeria include; nutritional deficiencies of iron and folate, parasitic diseases such as malaria and hookworm, haemoglobinopathies such as sickle cell disease and recently human immunodeficiency virus infection[18].

In this present study, we observed that the haemoglobin and serum ferritin levels was significantly higher among male donors compared to female donors. Blood donation leads to substantial iron loss (about 0.5 mg iron per each millilitre of blood donated). If not compensated for efficiently, the iron loss may eventually lead to iron deficiency and anaemia. Iron deficiency anaemia is an important limiting factor for the number of donations in regular donors. A previous study was conducted to evaluate the prevalence of iron deficiency anaemia and its related factors among 337 blood donors at Yazd blood transfusion centre, Iran. The prevalence of iron deficiency and iron deficiency anaemia was significantly higher among regular female blood donors compared to male regular donors (78% and 55.6%) *vs* (28% and 16%) respectively[19]. Previous report among Danish blood donors indicates that iron deficiency is an important challenge, particularly among menstruating women donating frequently and that the risk of iron depletion was largely explained by sex, menopausal status, donation frequency, dietary and supplemental iron intake[20]. Early detection of iron deficiency and anaemia among blood donors would allow appropriate re-adjustment of donation intervals and would guide the use of iron supplementation to prevent the development of iron deficiency anaemia. There are several factors that may be responsible for the high prevalence of iron deficiency anaemia among female blood donors compared to male donors. The most common causes of iron deficiency and anaemia among women in sub Saharan Africa include; effect of menstruation, malaria, nutritional deficiencies of iron and folate, parasitic diseases such as hookworm whipworms and roundworms, haemoglobinopathies such as sickle cell disease and recently human immunodeficiency virus infection[17,21-22]. It has recently been recommended that short-term iron supplementation combined with adjustments of haemoglobin acceptance levels may reduce the rate of donor deferral for low haemoglobin[14].

In this present study, we observed that the mean serum ferritin levels and haemoglobin was significantly higher among family replacement donors compared to regular voluntary non-remunerated donors. This finding is consistent with previous reports which indicated that the ferritin concentrations decreased significantly with an increase in the number of donations[23].

Our finding is variance with a previous report by Adediran and

colleagues[24] in Lagos, Nigeria which suggest that hemoglobin concentration, packed cell volume, and serum iron levels are not significantly affected by regular blood donation. Our finding is also at variance with previous report[25] which indicated that the haemoglobin concentration in regular blood donors was not significantly different from that of first-time donors. Similarly, Szymczy-Nuzka and Woloweic[26] reported a normal haemoglobin and haematocrit in their cohort of 151 regular male donors who had given over ten units of whole blood at a frequency of 4–6 units per year. However, our finding in this present study is consistent with previous reports[11,27] which reported a significantly lower haemoglobin and packed cell volume in regular blood donors when compared with healthy controls.

The haemoglobin and serum ferritin levels were significantly higher among male donors compared to female donors. Our finding is consistent with previous report which indicated that anaemia is significantly higher in female donors compared with male donors[1]. In pre-pubertal humans no major differences can be found between the sexes in red blood cell count or haemoglobin. Only after the onset of menstruation does a difference emerge[28]. Not until 10 years after the menopause does this situation revert in women, when the haemoglobin concentration becomes similar to that of aged- matched men. Our finding is consistent with a previous report among Iranian blood donors in which the prevalence of iron deficiency was higher in female compared to and male regular donors[1]. Also a previous report among Thai blood donors indicated that depleted iron stores (serum ferritin≤15 ng/mL) is higher among female donors compared to male[6]. Previous report indicates that there are substantial gender-related differences in Hb and other indicators of iron status during infancy[29]. Previous report indicated that anaemia is significantly higher in female donors compared with male donors. Similarly, a previous study among 500 Spanish blood donors of both sexes indicated that iron deficiency was lower among men compared to women blood donors[24]. A previous report had queried why women should have lower reference limits for haemoglobin and ferritin concentrations[30]. There are no differences in the haemoglobin and ferritin based on gender in pre-pubertal phase. It is only after the onset of menstruation in women does a difference emerge[31]. Not until 10 years after the menopause does this situation revert in women, when the haemoglobin concentration becomes similar to that of aged matched men.

Haemoglobin and serum ferritin level was significantly higher among civil servants compared to farmers and students. The reason for this occupational difference in haemoglobin and ferritin level is unknown. However, civil servants are more educated. They are more likely to have more access to finance to support better nutrition, live a better quality life and protect themselves from factors that predispose people to anaemia and low iron stores.

Current guidelines in Sokoto and other parts of Nigeria require a pre-donation haemoglobin level of 12 g/dL before blood donation. Low haemoglobin below this threshold is usually a common reason for donor deferral. Pervious report indicates that low haemoglobin-associated deferral occurs in about 10% of attempted whole blood donations and that it is commonly a consequence of iron deficiency anaemia particularly among pre-menopausal women who often have iron deficiency anaemia caused by menstruation and pregnancy[31]. It is becoming increasingly clear that just measuring the haemoglobin level of blood donors alone is not sufficient for fitness of donors to donate blood[32]. This study indicate the need to review current guidelines in Nigeria and other developing countries which require the determination of haemoglobin or haematocrit level alone before blood donation. Previous report suggest that screening for haemaglobin and iron indices enables prediction of donors at risk of subsequent anaemia and who would most benefit from prevention strategies[33]. In addition, testing of the ferritin level and iron supplementation are recommended in regular donors with more than one donation per year[14]. In other to ensure the objective of ensuring the safety of blood donors and recipient, there is the urgent need to introduce routine ferritin testing into the donor screening menu in Nigeria in particular and sub Saharan Africa in general to protect the safety of blood donors. A significant number of our cohort of donors despite being eligible to donate blood based on current guidelines of pre-donation haemoglobin of 12.0 g/dL) had suboptimal ferritin level, a reflection of low iron status. Serum iron concentration and ferritin level measurements may be an objective way to ensure a safer blood donation process particularly among regular blood donors. Our observation is consistent with results from a previous study which showed that subclinical iron deficiency is prevalent even among blood donors that meet the haemoglobin criteria for blood donation[33,34].

This current study indicates that there is a high prevalence of iron deficiency anaemia among donors in Sokoto, North Western Nigeria. There is need to review the screening tests for the selection of blood donors and include serum ferritin measurement in the donor screening menu as well as provide iron supplementation for regular blood donors. The serum ferritin levels should possibly be determined at the time of first donation and subsequently once every year and donors found to be iron deficient should be offered iron supplementation to protect blood donors.

Donors recruited for this study were predominantly family replacement donors. Family replacement donors to meet the blood transfusion need of a member of the donor's family or community. The number of voluntary donated blood in Nigeria is significantly lower compared to developed countries. In this present study we had only 2 voluntary donors among our consecutively recruited 150 blood donors. We have had to base our conclusions on comparing 148 family replacement donors to 2 voluntary donors. The disparity of the numbers in two groups may affect the comparism of the 2 group as well as the conclusion arrived at. Similarly subjects recruited into this present study were predominantly male. The number of women who donate blood in this environment is significantly low compared to observation in developed countries. Education, awareness and religious misconceptions may be responsible for this low female gender-related participation in the blood donation process in Sokoto, Nigeria.

Conflict of interest statement

We declare that we have no conflict of interest.

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