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Iron supplementation post-blood donation in Vietnam: Impact on hemoglobin, red cell indices, and iron reserves

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ABSTRACT

Background. Regular blood donation plays a pivotal role in mitigating the formation of free radicals by regulating iron accumulation. However, frequent blood donation can lead to chronic iron deficiency. In this study, we aimed to evaluate the effectiveness of daily iron supplementation as an intervention to expedite hemoglobin (Hb) recovery among frequent blood donors at a hospital in Vietnam.

Methodology. Conducted longitudinally within the Hematology Department of a Hanoi hospital from February to July 2023, our study involved 104 eligible participants. They received a daily iron supplement comprising 100 mg of elemental iron, 0.75 mg of folic acid, and 5 mg of zinc sulfate for a minimum of 8 weeks. Blood samples were collected at three key time points: before blood donation during recruitment, immediately after donation, and at least 8 weeks post-donation.

Results. Our findings revealed moderate, statistically significant positive correlations between elemental iron administration and changes in platelet count (PLT), hematocrit (HCT), and mean corpuscular hemoglobin (MCH) ($r = 0.753$, $p < 0.001$; $r = 0.887$, $p < 0.001$; and $r = 0.703$, $p < 0.001$, respectively). Additionally, weak but significant correlations were observed between elemental iron administration and red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width coefficient of variation (RDWC), and red cell distribution width standard deviation (RDWS) ($r = 0.260$, $p = 0.002$; $r = 0.302$, $p = 0.005$; $r = 0.160$, $p = 0.010$; $r = 0.120$, $p = 0.020$; and $r = 0.400$, $p < 0.001$, respectively).

Conclusion. Over an eight-week duration, the regimen of daily iron supplementation yielded significant improvements in both red cell variables, red cell indices, and iron study variables, demonstrating its potential clinical impact.

Keywords: blood donors, blood donation, iron-deficiency anemia

INTRODUCTION

Regular blood donation serves as a preventive measure against the formation of free radicals by curbing iron accumulation [1,2]. However, it's important to note that chronic iron deficiency often arises as a consequence of frequent blood donation [3-5]. With each donation, a substantial amount of iron, typically ranging from 200 to 250 mg, is lost. Studies estimate that 25% to 35% of regular blood donors experience iron depletion due to this continuous loss. If not adequately addressed, this iron deficiency can progress to anemia, posing a significant challenge to sustaining an adequate blood supply [6,7].

In developed nations, low hemoglobin (Hb) levels constitute the primary cause of blood donor deferral, with women being disproportionately affected. Conversely, in low- and middle-income countries (LMICs), deferrals due to positive tests for transfusion-transmissible infections and hypertension are more prevalent, with low Hb ranking as the third most common reason for deferral [8]. This pattern has been observed in several Asia countries, including Vietnam [9-11]. These findings underscore the multifaceted

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challenges inherent in maintaining a robust and sustainable blood donation system, particularly in resource-constrained settings.

The existing body of research indicates that implementing iron supplementation following blood donation enhances iron status, facilitates hemoglobin (Hb) restoration, and mitigates donor deferrals [12,13]. Such intervention holds considerable promise for optimizing blood donation practices, particularly in low- and middle-income countries (LMICs) like Vietnam, where maintaining healthy Hb and iron levels among donors is imperative [9-14]. By safeguarding the well-being of the blood donor population, this approach can alleviate the strain on existing resources and foster a sustainable blood supply chain. Consequently, this study aimed to assess the efficacy of daily iron supplementation as an intervention to expedite Hb recovery among frequent blood donors at a hospital in Vietnam.

METHODOLOGY

Study design

This longitudinal study was conducted in a Hematology Department of a hospital in Hanoi, Vietnam, during the period from February to July 2023.

Study participants

Eligible participants included regular blood donors aged 18–65 years who were consecutively selected for the study.

Exclusion criteria comprised individuals with any blood disorders, those taking iron supplements (including multivitamins containing iron) who refused to discontinue usage for at least 8 weeks during the study, and individuals with baseline ferritin levels exceeding 300 µg/L, as this threshold was used to exclude those with hemochromatosis.

Sampling method

We employed a nonprobability sampling method for participant recruitment. Eligible individuals were consecutively enrolled as they presented for blood donation. Recruitment was contingent upon their voluntary willingness to donate blood and their cooperation with the study procedures. In total, 104 participants were included in the study

Study intervention

The participants in this study were administered a daily iron supplement (Feroglobin B12) via capsules containing 305 mg of ferrous fumarate, equivalent to 100 mg of elemental iron, along with folic acid (0.75 mg) and zinc sulfate (5 mg). This supplementation followed the successful donation of one unit of blood. Participants received one Feroglobin B12 capsule daily for a minimum of 8 weeks.

Outcome measures

Blood samples were collected from all eligible participants at three time points during the study. First, at the recruitment stage before blood donation; second, immediately after blood donation; and third, at a minimum of 8 weeks post-donation

The primary outcome measures were the mean levels of Hb, PCV, MCV, MCH, MCHC, serum iron, serum % iron saturation, serum ferritin, and serum transferrin.

Statistical analysis

We employed descriptive statistics to calculate frequencies and percentages. For continuous variables, we conducted analyses using either the Student's t-test or the Mann–Whitney U-test, depending on the data distribution. Discrete variables were analyzed using the Chi-square test, and we also computed Pearson's correlation coefficient. The level of statistical significance was set at ($p < 0.05$)

RESULTS

TABLE 1. Sociodemographic characteristics of the participants (n=104)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
18- 20	5	4.8
21 - 30	48	46.2
>30	51	49.0
Mean±SD (Min-Max)	30.22±5.97 (19-40)	
Gender		
Male	88	84.6
Female	16	15.4
Marital status		
Single	27	26.0
Married	77	74.0
Educational level		
Highschool and under	39	37.5
College/university	34	32.7
Postgraduate	31	29.8
Job		
Student	11	10.6
Unemployed	15	14.4
Blue-Collar Jobs	37	35.6
White-Collar Jobs	26	25.0
Business/Self employed	15	14.4

A cohort of 104 healthy blood donors was recruited for this study. The participants' mean age was

TABLE 2. Complete blood count before blood donation (T1), after donation (T2), and 8 weeks post-intervention (T3) (n=104)

Variable	Before blood donation (T1)	After donation (T2)	8 weeks post-intervention (T3)	Percentage Difference (mean) [23]	P [23]
Hb (g/dl)	16.45±0.87	13.46±1.38	14.9±1.1	12	**0.001***
PLT (10^9/L)	268.49±15.89	179.5±23.16	250.12±17.14	41.9	**0.001***
RBC (10^{12}/L)	4.51±0.3	4.92±0.34	4.7±0.27	-3.9	0.1
HCT (%)	39.88±1.66	37.09±3.07	39.67±1.99	7.8	**0.001***
MCV (fL)	83.6±4.11	79.98±4.16	81.63±3.91	2.3	**0.0056***
Percentage saturation (%)	26.78±6.37	25.49±5.59	27.82±6.8	13.8	**0.0133**
Serum iron (μmol/L)	17.96±3.64	15.34±3.48	18.48±3.93	27.3	**0.001***
Serum ferritin (ng/mL)	70.36±26.87	66.91±30.56	71.81±25.48	45.4	**0.001***
Serum transferrin (mg/dL)	2.71±0.3	2.42±0.23	2.51±0.3	4.7	**0.0281***
MCH (pg)	28.18±2.49	29.68±2.45	29.08±2.4	-1.5	0.481
MCHC (g/dl)	33.43±0.88	34.53±0.92	34.04±0.57	-1.4	0.3
RDWC (%)	14.88±1.03	15.88±1.17	15.45±0.79	-2.2	0.132
RDWS (fL)	42.8±1.69	44.4±1.4	43.49±2.03	-2	0.2

*Hb: Hemoglobin; PLT: Platelet; RBC: Red blood cell; HCT: Hematocrit; MCV: Mean cell volume; MCH: Mean cell Hb; MCHC: MCH concentration; RDWS: Red cell distribution with standard deviation; RDWC: Red cell distribution width coefficient of variation. *p ≤0.05*

30.22±5.97 years. A significant proportion (49.0%) of the subjects were over 30 years of age, whereas only a small fraction (2.2%) were 18-20 years. The sample predominantly consisted of males (84.6%), with the majority (74.0%) being married (Table 1).

The hematological parameters of participants before donation (T1), were shown in Table 2. the mean values for hemoglobin (Hb), Platelet (PLT), hematocrit (HCT), mean corpuscular volume (MCV) among the participants were 16.45 ± 0.87g/dL, 268.49 ± 15.89 × 10^9/L, 39.88 ± 1.66%, and 83.6 ± 4.11fL, respectively. Additionally, the percentage saturation, mean serum iron, serum ferritin and mean serum transferrin levels were recorded at 26.78 ± 6.37%, 17.96 ± 3.64 μmol/L, 70.36 ± 26.87 ng/mL and 2.71 ± 0.3 mg/dL, respectively (Table 2).

A significant variation was observed in hemoglobin (Hb), platelet count (PLT), hematocrit (HCT), mean corpuscular volume (MCV), percentage saturation, mean serum iron, serum ferritin, and mean serum transferrin levels between the measurements taken at T3 (8 weeks post-intervention) and immediately post-donation. Eight weeks post-intervention, participants exhibited a 12% increase in Hb levels, a 41.9% increase in PLT count, a 7.8% rise in HCT values, a 2.3% increment in MCV, a 13.8% change in percentage saturation, a 27.3% increase in serum iron levels, a 45.4% increase in serum ferritin levels, and a 4.7% increase in serum transferrin levels ($p<0.05$) (Table 2).

Table 3 demonstrated that there were moderate significant positive correlations between the administration of elemental iron and the changes in platelet count (PLT), hematocrit (HCT), and mean corpuscular hemoglobin (MCH) ($r = 0.753$, $p < 0.001$; $r = 0.887$, $p < 0.001$; and $r = 0.703$, $p < 0.001$, respectively). Addi-

TABLE 3. Complete blood count before blood donation (T1), after donation (T2), and 8 weeks post-intervention (T3) (n=104)

Variable	Number of participants (n)	Percent recovery after 8 weeks period (%)	Correlation (r)	P
Hb (g/dl)	104	-9.1	-0.0549	0.58
PLT (10^9/L)	104	-6.5	0.753	**0.000***
RBC (10^{12}/L)	104	4.8	0.26	**0.002***
HCT (%)	104	-0.4	0.887	**0.000***
MCV (fL)	104	-2.1	0.302	**0.005***
Percentage saturation (%)	104	10.6	0.0965	0.33
Serum iron (μmol/L)	104	7.4	0.0221	0.82
Serum ferritin (ng/mL)	104	19	0.0214	0.83
Serum transferrin (mg/dL)	104	-6.5	0.0279	0.78
MCH (pg)	104	4	0.703	**0.000***
MCHC (g/dl)	104	1.9	0.16	**0.01***
RDWC (%)	104	4.4	0.12	**0.02***
RDWS (fL)	104	1.8	0.4	**0.000***

*Hb: Hemoglobin; PLT: Platelet; RBC: Red blood cell; HCT: Hematocrit; MCV: Mean cell volume; MCH: Mean cell Hb; MCHC: MCH concentration; RDWS: Red cell distribution with standard deviation; RDWC: Red cell distribution width coefficient of variation. *p ≤0.05* tionally, weak significant correlations were observed between the administration of elemental iron and red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width coefficient of variation (RDWC), and red cell distribution width standard deviation (RDWS) ($r = 0.260$, $p = 0.002$; $r = 0.302$, $p = 0.005$; $r = 0.160$, $p = 0.010$; $r = 0.120$, $p = 0.020$; and $r = 0.400$, $p < 0.001$, respectively).

DISCUSSION

The demographic distribution observed in our study provides insights into the typical profile of blood donors within our sample population. The higher mean age and the substantial proportion of donors over 30 years old suggest that blood donation is more prevalent among middle-aged adults. This age distribution might reflect a greater sense of civic duty or a higher level of health awareness within this age group, compared to younger individuals who may be less inclined or less eligible to donate blood. The predominance of male donors (84.6%) aligns with trends observed in various blood donation studies globally [15]. Men are often more likely to donate blood due to factors such as fewer deferral rates and higher hemoglobin levels compared to women [16, 17]. The high percentage of married participants (74.0%) might indicate that individuals with stable family structures are more likely to engage in regular blood donation. This could be due to a combination of socio-economic stability and a supportive family environment that encourages such altruistic behavior. These demographic insights are crucial for understanding the composition of the donor population and for designing targeted interventions to encourage a more diverse donor base. Strategies could include educational campaigns aimed at younger potential donors and initiatives to address barriers that may prevent women and single individuals from donating blood. By broadening the donor demographic, blood banks can enhance their ability to maintain a robust and diverse blood supply [15,18].

This study has demonstrated that eight weeks following iron supplementation, significant differences were observed in hemoglobin (Hb), platelet count (PLT), hematocrit (HCT), mean corpuscular volume (MCV), percentage saturation, mean serum iron, serum ferritin, and mean serum transferrin levels ($p<0.001$). These variables may serve as potential indicators of erythropoietic recovery post-blood donation. Previous studies by Ashish et al. (2018) and Rigas et al. (2019) have identified MCV and MCH as potential markers of iron deficiency in repeat blood donors [19,20]. Consequently, red cell indices such as MCV and MCH could be proposed as early indicators of recovery during iron supplementation post-blood donation. Further studies are necessary to substantiate these findings.

This study also demonstrated significant increases in the percent recovery of all red cell and iron study variables six weeks post-intervention with iron supplementation. Specifically, the observations revealed a 112% increase in hemoglobin (Hb) levels, a 41.9% increase in platelet (PLT) count, a 7.8% rise in hematocrit (HCT) values, and a 2.3% increment in mean corpuscular volume (MCV). Notably, the participants still met the Hb eligibility criteria for safely donating another unit of blood eight weeks post-intervention. These results are consistent with the findings of Kiss JE et al. (2015), [8] which reported that iron supplementation enhanced the percent recovery of Hb levels, red cell indices, and iron study parameters post-donation.

This study reported a significant positive correlation between red cell indices and iron supplementation. It also underscores the benefits of an eight-week regimen of daily iron supplementation in reducing the recovery time of erythropoiesis in blood donors post-donation, corroborating findings from previous studies [8, 19, 20-22]. This evidence has already been incorporated into guidelines for blood bank services in developed regions. Similar to the findings of Joseph et al. (2018) and Alan E et al. (2020), this study supports the advantages of iron supplementation in improving iron status following blood donation [21, 22].

Limitation of the study

Our study had the relatively small sample size and the single-center design, which could limit the generalizability of the findings to broader populations. Additionally, the study's focus on short-term outcomes up to eight weeks post-intervention may not capture longer-term effects or potential complications associated with iron supplementation. Furthermore, the lack of a control group receiving a placebo or alternative intervention could introduce bias and confound the interpretation of results.

CONCLUSION

The study found moderate, statistically significant positive correlations between elemental iron administration and changes in platelet count (PLT), hematocrit (HCT), and mean corpuscular hemoglobin (MCH) ($r = 0.753$, $p < 0.001$; $r = 0.887$, $p < 0.001$; $r = 0.703$, $p < 0.001$). Additionally, weak but significant correlations were identified for red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width coefficient of variation (RDWC), and red cell distribution width standard deviation (RDWS) ($r = 0.260$, $p = 0.002$; $r = 0.302$, $p = 0.005$; $r = 0.160$, $p =$

0.010; r = 0.120, p = 0.020; r = 0.400, p <0.001). An eight-week regimen of daily iron supplementation led to significant improvements in red cell variables and iron levels. This investigation highlighted the value of iron supplementation in blood donor programs, especially in low and middle-income countries (LMICs), to reduce deferrals due to low hemoglobin and enhance the sustainability of blood donation efforts.

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