

Comparative Analysis of Red Blood Cell Parameters in First-Time and Repeated Blood Donors

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Abstract: Background: Repeated blood donation results in loss of iron and may predispose donors to iron deficiency anemia. Routine donor screening is mainly based on hemoglobin estimation, which may not detect early iron depletion. Aim: To compare red blood cell parameters and iron status in first-time and repeated blood donors. Materials and Methods: A prospective analytical study was conducted on 200 healthy male blood donors categorized into first-time donors (n=125) and repeated donors donating two, three, or four times (n=25 each). Complete blood count parameters and serum ferritin levels were analyzed using standard laboratory methods. Results: Hemoglobin levels showed a mild decline with increasing donation frequency but remained within acceptable limits. Serum ferritin levels showed a statistically significant reduction in repeated donors, with the lowest levels observed in four-time donors (p<0.001). Other red blood cell indices such as RBC count, MCV, RDW, and MCHC did not show significant variation. Mean corpuscular hemoglobin showed a significant increase in frequent donors. Conclusion: Repeated blood donation leads to significant iron store depletion despite normal hemoglobin levels. Hemoglobin alone is insufficient to detect early iron deficiency. Monitoring iron stores is essential to ensure donor safety.

Keywords: Blood donors, Hemoglobin, Red blood cell indices, Serum ferritin, Iron deficiency

1. Introduction

Blood transfusion services depend heavily on voluntary blood donors.¹ Ensuring donor health is essential for maintaining a safe and sustainable blood supply. Each unit of whole blood donation results in the loss of approximately 200–250 mg of iron.² Repeated blood donation without adequate iron replacement may lead to iron deficiency and anemia.³

Hemoglobin estimation is routinely used for donor screening; however, it is a late indicator of iron deficiency.⁴ Donors may have depleted iron stores even when hemoglobin levels are normal.⁵ Red blood cell indices and serum ferritin estimation provide better insight into early iron depletion.⁶ This study was undertaken to analyze red blood cell parameters and iron status in first-time and repeated blood donors.⁷

2. Aims and Objectives

Aim: To analyze red blood cell parameters in first-time and repeated blood donors.

Objectives: To compare hemoglobin and red blood cell indices among donor groups

- To assess iron status using serum ferritin
- To identify early iron deficiency in repeated blood donors

3. Materials and Methods

This prospective analytical study was conducted on 200 healthy male voluntary blood donors aged 18–60 years.

Donor Grouping

- Group I: First-time donors (n = 125)
- Group II: Two-time donors (n = 25)
- Group III: Three-time donors (n = 25)
- Group IV: Four-time donors (n = 25)

Inclusion Criteria

- Eligible male donors fulfilling standard blood donation criteria

Exclusion Criteria

- Female donors
- Donors with known anemia, chronic illness, or recent transfusion
- Laboratory Analysis

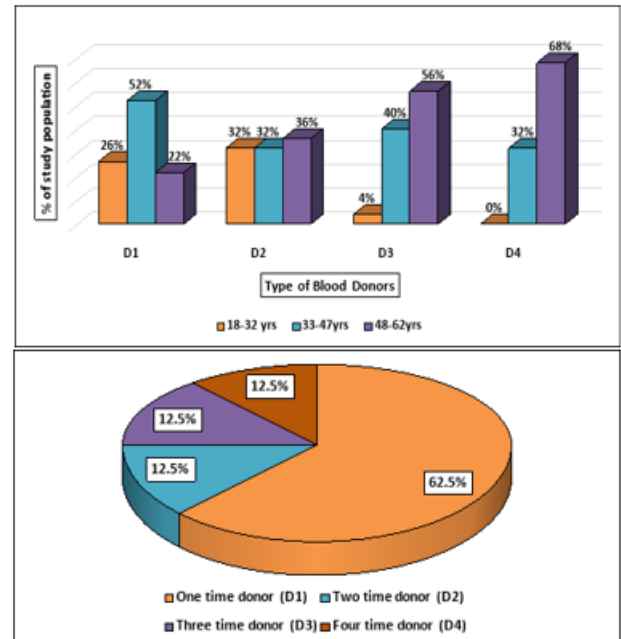
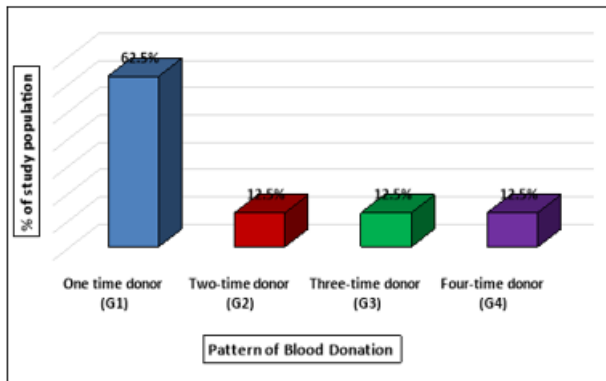
Blood samples were collected prior to donation. Complete blood count parameters (Hb, RBC count, MCV, MCH, MCHC, RDW) were analyzed using an automated hematology analyzer. Serum ferritin was measured using standard immunoassay methods.

Statistical Analysis

Data were analyzed using appropriate statistical tests. A p-value <0.05 was considered statistically significant.

4. Results

Hemoglobin levels showed a mild decline with increasing frequency of donation, although all donors maintained levels above the minimum eligibility criteria. Serum ferritin levels showed a significant and progressive decrease with repeated donations, with the lowest values observed in four-time donors ($p < 0.001$). Red blood cell count, mean corpuscular volume, red cell distribution width, and mean corpuscular hemoglobin concentration did not show statistically significant differences between groups. Mean corpuscular hemoglobin showed a statistically significant increase in frequent donors.



Comparison of Hb levels among pattern of donors

Hb (g/dL)	Hb level (≥ 12.5)	Mean $\pm$ SD
One time donor (G1)	125	14.52 $\pm$ 0.93
Two-time donor (G2)	25	14.34 $\pm$ 1.03
Three-time donor (G3)	25	14.24 $\pm$ 0.92
Four-time donor (G4)	25	13.79 $\pm$ 1.21
Grand Total	200	14.37 $\pm$ 1.01

(*) = significant P value (< 0.005)

Comparison of RBC levels among pattern of donors

RBC ($10^{12}/L$)	One time donor (G1)		Two-time donor (G2)		Three-time donor (G3)		Four-time donor (G4)		Grand Total		P value (ANOVA)
	n = 125	%	n=25	%	n=25	%	n=25	%	n=200	%	
Normal (4.7 to 6.1)	50	40%	8	32%	8	32%	16	64%	82	41%	F=1.40; P = 0.243
Low (< 4.7)	75	60%	17	68%	17	68%	9	36%	118	59%	
Mean $\pm$ SD	4.72 $\pm$ 0.35		4.78 $\pm$ 0.36		4.76 $\pm$ 0.31		4.60 $\pm$ 0.30		4.72 $\pm$ 0.34		

Comparison of MCV levels among pattern of donors

MCV (fl)	n	Mean	SD	P value (ANOVA)
One time donor (G1)	125	88.48	3.77	F = 2.57; P = 0.055
Two-time donor (G2)	25	88.32	4.35	
Three-time donor (G3)	25	87.74	3.51	
Four-time donor (G4)	25	86.16	6.67	
Total	200	88.08	4.31	

Comparison of RDW levels among pattern of donors

RDW (%)	n	Mean	SD	P value
One time donor (G1)	125	13.72	0.85	F = 1.75 ; P = 0.158
Two-time donor (G2)	25	13.60	0.77	
Three-time donor (G3)	25	15.03	7.34	
Four-time donor (G4)	25	13.74	1.39	
Total	200	13.87	2.73	

Comparison of MCH levels among pattern of donors

MCH (pg)	n	Mean	SD	P value
One time donor (G1)	125	29.97	1.42	F = 6.74; P = < 0.001 *
Two-time donor (G2)	25	29.85	1.32	
Three-time donor (G3)	25	30.16	1.62	
Four-time donor (G4)	25	31.78	10.08	
Total	200	30.20	3.79	

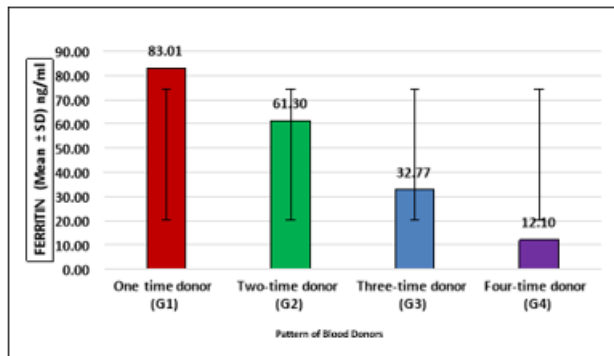
(*) = significant P value (< 0.005)

Comparison of Ferritin levels among pattern of donors

FERRITIN (ng/ml)	n	Mean	SD	P value
One time donor (G1)	125	83.01	56.41	F = 21.17; P = < 0.001
Two-time donor (G2)	25	61.30	26.98	
Three-time donor (G3)	25	32.77	19.68	
Four-time donor (G4)	25	12.10	6.08	
Total	200	65.15	53.00	

Comparison of MCHC levels among pattern of donors

MCHC (g/dl)	n	Mean	SD	P value
One time donor (G1)	125	33.82	1.45	F = 0.92; P = 0.434
Two-time donor (G2)	25	33.58	1.25	
Three-time donor (G3)	25	33.06	4.49	
Four-time donor (G4)	25	33.11	1.49	
Total	200	33.61	2.07	



5. Limitations

- Female donors were not included
- Single-center study
- Long-term follow-up was not done

6. Discussion

Repeated blood donation leads to gradual depletion of iron stores, which may not be detected by hemoglobin estimation alone.⁸ In the present study, serum ferritin showed a significant reduction in repeated donors, indicating latent iron deficiency. The stability of MCV and RDW suggests that most donors were in early stages of iron depletion, prior to the development of overt microcytic hypochromic anemia.⁹ These findings are consistent with previous studies reporting iron deficiency among frequent blood donors.¹⁰

7. Conclusion

Repeated blood donation results in significant iron store depletion even when hemoglobin levels remain normal. Hemoglobin estimation alone is insufficient to detect early iron deficiency. Routine monitoring of iron stores using serum ferritin, along with appropriate preventive strategies, is recommended to ensure donor safety and maintain a healthy donor pool.

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