Original Article

Comparative Study of Hematological Parameters among First-Time Blood Donors & Repeat Blood Donors of Kathmandu Valley

Raksha Rimal [1] *, Anu Kafle [2], Arju Sah [3], Ankur Bista [4], Anshu Yadav [5], Sampada Khatiwada [6]

1. Nobel College, Department of B.Sc.MLT Affiliated to Pokhara University, Nepal.
2. Nobel College, Department of B.Sc.MLT Affiliated to Pokhara University, Nepal.
3. Nobel College, Department of B.Sc.MLT Affiliated to Pokhara University, Nepal.
4. Nobel College, Department of B.Sc.MLT Affiliated to Pokhara University, Nepal.
5. Nobel College, Department of B.Sc.MLT Affiliated to Pokhara University, Nepal.
6. B.P. Koirala Institute of Health Sciences, Koshi, Nepal.

* Correspondence: raksharimalng@gmail.com

Abstract: Blood transfusions have recently emerged as a crucial element in the global healthcare system. The procedure is carried out by giving the recipient blood that a healthy (disease-free) donor donated. Repeat blood donors could be more at risk of iron deficiency anaemia than first-time donors. Even in those with normal haemoglobin levels, iron levels can become low. Iron deficiency anaemia caused by blood donation in donors who have given blood multiple times has been documented. This Study is conducted to assess the comparative haematological parameters among first-time blood donors and repeat blood donors of Kathmandu Valley. Eighty blood donors of both genders were included in the Study from different locations of Kathmandu Valley through the blood bank of Frontline Hospital. Blood was collected from blood donors according to the guidelines for blood donation by the World Health Organization (WHO). Blood was collected from an anti-cubital vein in an EDTA vial, which was used for the estimation of Hematological parameters (Hemoglobin, RBC, PCV, MCV, MCH, MCHC, RDW). MCV, MCH, and MCHC were found to be significantly lower in repeat blood donors who have donated blood five times and more when compared to first-time blood donors ($p< 0.05$), whereas RDW was seen to be significantly higher($p<0.05$).On the other hand, haemoglobin, RBC, and PCV were not significantly different in repeat donors and first-time blood donors. The main conclusion of this Study was that donors with a blood donation history of five or more times had significantly lower MCV, MCH, and MCHC and significantly greater RDW. Since these repeat donors have a high risk of iron deficiency, the proportion of subclinical anaemia that was recorded.

Keywords: Blood donors, Hemoglobin, Clinical and sub-clinical iron deficiency anaemia

1. INTRODUCTION

Blood transfusions have recently emerged as a crucial element in the global healthcare system. The procedure is carried out by giving the recipient blood that was donated by a healthy (disease-free) donor [1]. Under specific conditions, anyone between the ages of 18 and 65 who weighs more than 45 kg is eligible to give 450 ml of blood [2]. In order to be a donor, a person's haemoglobin concentration must be at least 12 g/dl in females and 14.0 g/dl in males [3]. Donors documented over time that iron deficiency anaemia may be the issue that develops most frequently following many blood donations [4]. Every time 450–500 ml of whole blood is donated, 220-250 mg of iron is lost. To restore the lost iron in the blood, it takes roughly 27–30 weeks [5]. Iron deficiency anemia is caused due to the lack of

healthy red blood cells or due to low iron in the red blood cells [6]. There could be various reasons for iron deficiency, which include dietary intake, due to physiological conditions and some diseased conditions [7]. Microcytic hypochromic anaemia is iron-deficient anaemia. Three stages make up the pathophysiological event [8]. Iron depletion: When the body's demand for iron exceeds its ability to store it due to a variety of factors, there is an iron depletion. When blood donors frequently lose iron from their bodies, the body may not be able to meet their needs for iron. Iron Deficiency Erythropoiesis: This process results in the generation of red blood cells that are deficient in iron when the amount of iron that is stored is low. Iron Deficiency Anemia: This condition is brought on by the replacement of healthy red blood cells by iron-deficient microcytic hypochromic red blood cells [9].Haematological measurements such as haemoglobin, total red blood cell count, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and red cell distribution width can be used to make a preliminary diagnosis of iron-deficiency anaemia. [10].When haemoglobin is low, an individual cannot donate blood. Sub-clinical cases of donation-induced iron deficiency anaemia may occur when the haemoglobin is still in the normal range, whereas other haematological parameters, especially red cell indices (MCV, MCH, MCHC, and RDW), were said to be the presumptive indication in frequent blood donors [11].Hemoglobin in blood donors is normal sometimes in the presumptive conditions, as the Red Blood Cells are yet to enter the circulation. There is a possibility of a significant difference in Red Cell indices and RDW with normal haemoglobin in sub-clinical cases [12]. An individual donating blood for more than the fifth time was seen to be prone to donation-induced sub-clinical cases of iron deficiency anaemia, where the iron is deficient and triggers the erythropoiesis, but the clinical iron deficiency anaemia is not seen as the haemoglobin appears to be normal Donating blood is regarded as the most sanitary and secure volunteer technique. Before the donation process starts, a number of donor screening tests are taken into account to ensure that the recipient will receive blood of a high standard. There are few safety precautions for those in the donor category [13]. Given that iron is a key component of haemoglobin and is lost along with haemoglobin when giving blood, this is obvious. Over time, Iron deficiency anemia may be the issue that develops frequently following several blood donations. Iron Deficiency Anemia may be a problem for regular blood donors compared to first-time donors, even though new red blood cells are produced to replace the old ones because bleeding results in the loss of stored iron [14]. It takes time for the lost iron to re-establish, and in the long run, this could lead to issues that disturb erythropoiesis by reducing iron uptake in the bone marrow, which in turn causes iron-deficient erythropoiesis, which eventually results in iron deficiency anaemia once it fully enters the circulation [15].There could be a substantial variation in haematological parameters such as Total Red cell Count, PCV, MCV, MCH, MCHC, and RDW when comparing the haematological parameters of repeat blood donors with those of first-time donors. As repeat blood donors could be more at risk of iron deficiency anaemia than first-time donors, this Study is concerned with the difference in haematological parameters in first-time and repeat blood donors [16].The assessment of potential sub-clinical donation-related consequences is another focus of this investigation. Moreover, to determine the donor category individual's safety threshold [17].To assess the comparative haematological parameters among first-time blood donors and repeat blood donors of Kathmandu Valley. To estimate the value of H.B., RBC, MCV, PCV, MCH, MCHC and RDW in first-time blood donors and in repeat blood donors of Kathmandu Valley [18].To assess the comparative difference in the RBC parameters among first-time blood donors and repeat blood donors [19].To describe the findings of Hematological patterns in First time and Repeat blood donors of people from Kathmandu valley [20].

2. MATERIALS & METHOD

Study Design This Study is a cross-sectional observational analytical Study. This research was conducted at FRONTLINE Hospital. The sample was collected from donors in Kathmandu Valley. Donors attending

the Blood Bank of Frontline Hospital and Blood Donation Camps organized by Frontline Hospital were selected as the Sample Population. Sampling was conducted using the non-probability sampling method. The sample will be collected conveniently. Generated categorical data was represented as frequencies and percentages, and continuous data was presented as mean and standard deviation. One-way ANOVA was used to compare the means of three groups of data. Post hoc Bonferroni was used to reduce type 1 error, as multiple pairwise tests were performed on a single set of data. The chi-square test was used to compare observed data with expected data. Statistical Package for Social Sciences (SPSS) version 20 was used for data analysis.

3. RESULTS & DISCUSSION

This Study was conducted over 6 months from December of 2022- April of 2023. A total of 80 samples were recruited for the Study. Among total donors, 55 of whom were male and 25 of whom were female, were recruited for the Study. 50% of donors were first-time donors, and 50% were repeat donors when the total number of donors was taken as 100%. First, second, third, fourth, fifth, sixth, and seventh-time donors occurred 40, 6, 9, 5, 9, 6, respectively. The number of donations was divided into three categories: one for first-time donors, two for second, third, and fourth-time donors, and three for fifth, sixth, and seventh-time donors. The examination of a few demographic factors with blood donors is shown in Table. With a maximum age of 53 and a minimum age of 18, the donors' typical mean and standard deviation ages were 28.23 and 8.173, respectively. The frequency and percentage tabulated below show that most of the respondents are aged between 28-38. Among 50% repeat donors, the frequency and percentage of respondents show that the average interval between donations is 6-12 months, and the least frequent interval was in 2 years and more.

Table 01: Demographic characteristics and features of blood donors

Characteristic	**Male**	**Female**	**Frequency**	**Percentage**
Age range (year)				
18-28	30	14	44	55.0
28-38	19	7	26	32.5
38-48	3	4	7	8.8
48 and above	3	0	3	3.8
Total			80	100
Average mean and standard deviation: 28.23 + 8.173				
Maxima: 53				
Minima: 18				
Number of donations				
	Male	Female	Frequency	Percentage
First time Donation	24	16	40	50
Second time- Fourth-time donation	15	5	20	25.0
Fifth-time donation- Seventh time donation	16	4	20	25.0
Total	55	25	80	100
Interval of Donation	Male	Female	Frequency	Percentage
Zero (First time donor)	24	16	40	50

3-month	8	1	9	11.3
3–6-month	6	3	9	11.3
6–12-month	14	2	16	20
12–24-month	2	2	4	5
More than 24 Months	1	1	2	2.5
Total	55	25	80	100

The table above lists the haematological parameters at normal levels, including haemoglobin, red blood cells, PCV, MCV, MCH, MCHC, and RDW.

Table 02: Reference range of haematological parameters

Parameters	Reference Range	Unit
HB	Male: 14-18 Female: 12-16	g/DL
RBC	Male: 4.5-6.0 Female:4.1-5.1	Cells/ mcL
PCV	Male: 42-51 Female:36-46	%
MCV	Male: 80-96 Female:79-94	Fl
MCH	27-33	Pg
MCHC	33-36	g/DL
RDW	12-15	%

Reference Range for haematological parameters [24]

Table compares a few haematological variables between donors based on the volume of donations. It was discovered that the test of repeat donors and First-time donors' total Red Cell Count, haemoglobin and packed cell volume (PCV) were not significantly different ($p > 0.05$). Post hoc analysis revealed statistical differences among repeat donors when compared to first-time donors. The red cell indices (MCV, MCH, and MCHC) of first-time blood donors were equivalent to those of second-, third-, and fourth-time donors and were considerably higher in first-time donors compared to those of fifth-, sixth-,and seventh-time donors ($p < 0.05$). The first-time blood donor's Red Cell Distribution Width (RDW) was equivalent to that of the second, third, and fourth donors but considerably lower when compared to the fifth, sixth, and seventh donors ($p<0.05$)

Table 03: Comparison of haematological parameters among donors based on the number of donations

Parameters	Number of donations			
	1	2	3	P-value
	Mean+ SD	Mean+ SD	Mean+ SD	
HB gm%	15.45+2.64	15.09±2.35	15.47±2.53	0.886
RBC Cells/mm3	4.81+0.8	4.72 ±0.92	4.96+1.009	0.914
PCV %	40.17+5.02	38.05+ 4.52	40.73± 8.46	0.166

MCV FL	86.50+7.42	84.21± 5.6	77.8 ±4.84	0.001
MCH PG	31.44+3.07	30.95± 2.5	28.0 ± 2.57	0.001
MCHC g/DL	35.25+2.44	34.41± 2.94	31.88± 2.24	0.000
RDW %	12.27+1.69	12.9± 1.68	14.95± 2.16	0.000

The comparison of mean and standard deviation of haematological parameters among blood donors based on their number of donations are represented in the form of a Bar Diagram below.

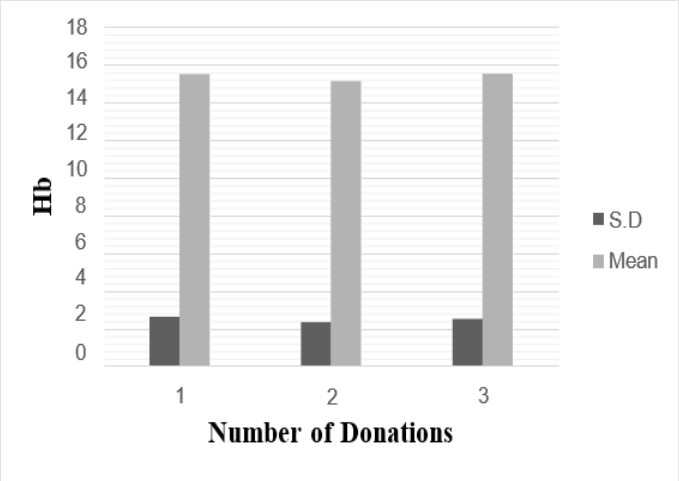

Figure 01: Comparison of H.B. among blood donors based on the number of donations

The above bar diagram shows that the mean and S.D. of H.B. are within the same range and show no significant difference among blood donors based on their number of donations.

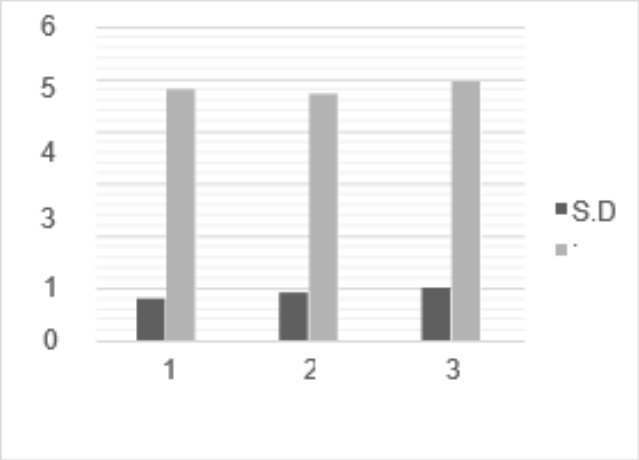

Figure 02: Comparison of RBC among blood donors based on the number of donations

The above Bar Diagram shows that the mean and S.D. of RBCs are within the same range and show no significant difference among blood donors based on their number of donations.

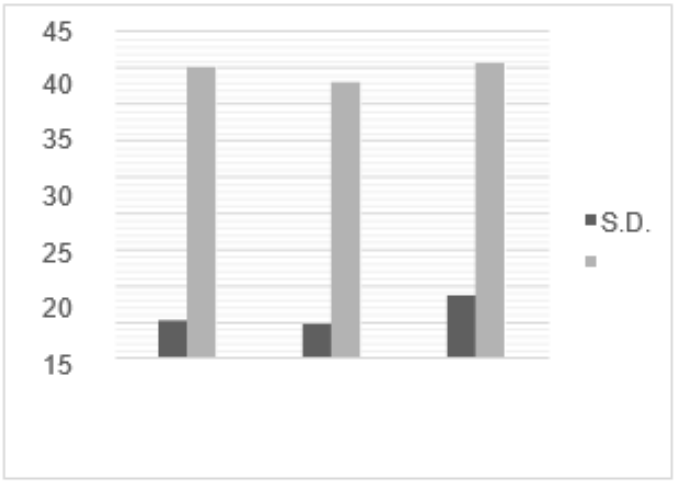

Figure 03: Comparison of PCV among blood donors based on the number of donations

The above bar diagram shows that the mean and S.D. of RBCs are within the same range and show no significant difference among blood donors based on their number of donations.

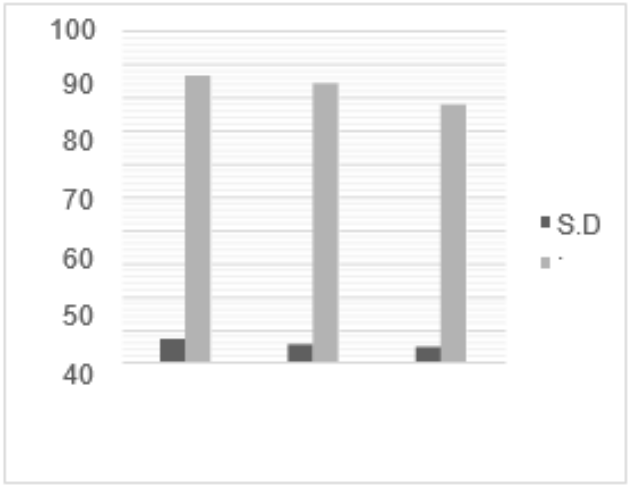

Figure 04: Comparison of MCV among blood donors based on the number of donations

The above Bar Diagram shows that the Mean and Standard deviation of MCV are in a decreasing order with an increase in a number of donations.

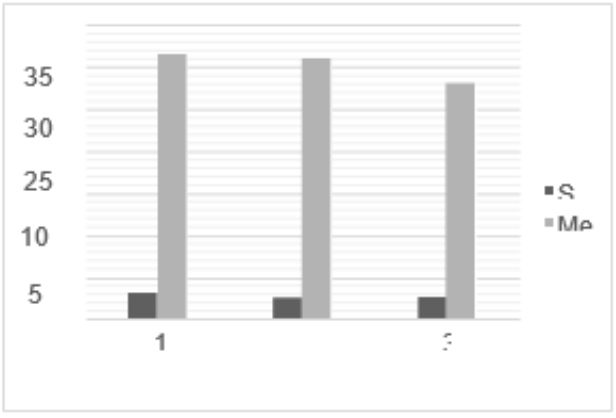

Figure 05: Comparison of MCH among blood donors based on the number of donations

The above Bar Diagram shows that the Mean and Standard deviation of MCH are in decreasing order with an increase in a number of donations.

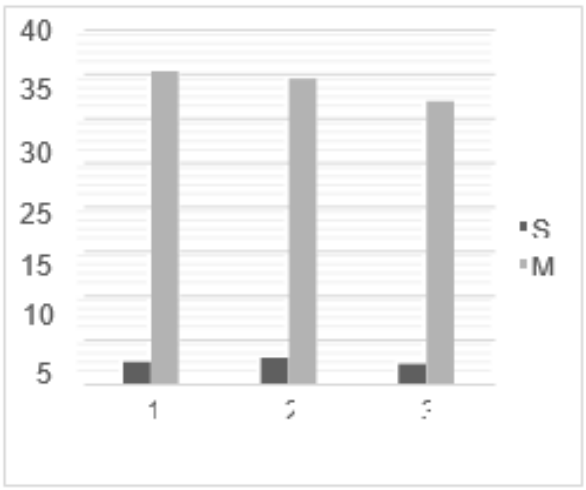

Figure 06: Comparison of MCHC among blood donors based on the number of donations

The above Bar Diagram shows that the Mean and Standard deviation of MCHC are in decreasing order with an increase in the number of donations.

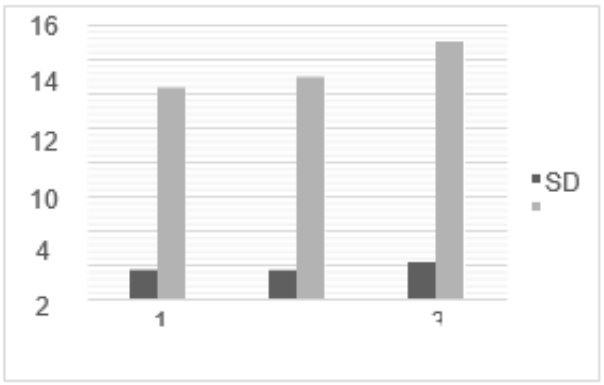

Figure 07: Comparison of RDW among blood donors based on the number of donations.

The above Bar Diagram shows that the Mean and Standard deviation of RDW increase with the number of donations. Table displays the percentage of study participants who were anaemic based on haemoglobin levels; no donors were included in this calculation (p >0.05).

Table 04: The proportion of study participants with anaemia (Based On HB)

Numberof Donations	Frequency (%)	p-value
First-time donor	4 (5)	
Second time donor- Fourth-time donor	5(6.3)	
Fifth time donor- Seventh time Donor	6(7.6)	0.523

Table demonstrates the number of anaemic donors using red cell indices dependent on the number of donations. Using all four parameters (MCV, MCH, MCHC, and RDW), anaemia was shown in donors donating blood more than five times compared to first-time donors. A linear-by-linear study utilizing red cell indices reveals that the proportion of anaemia rises as the number of donors rises.

Table 05: The proportion of donors with anaemia using red cell indices based on the number of donations

Numberof	Red Cell Indices			
Donations	MCV (%)	MCH (%)	MCHC (%)	RDW (%)
First-time donor	10(12.5)	3(3.8)	6(7.5)	13(16.3)
Second time donor- Fourth-time donor	5(6.4)	2(2.6)	9(11.3)	3(3.9)
Fifth time donor-Seventhtime Donor	16(29.9)	8(10)	16(20.1)	2(2.6)
	X2: 27.02, p=0.008	X2: 27.02, p=0.021	X2:35.54, p=0.000	X2:30.80, p=0.002

The test result variable(s): MCV, MCH, MCHC, RDW, Under non-parametric assumption, Null Hypothesis rejected (p<0.05

DISCUSSION

The haematological parameters of first-time and repeat blood donors in the Kathmandu Valley were compared in a study. This Study included 80 blood donors of all genders, aged 18 to 53, of which 55 were men and 25 women. The majority of respondents, who were between the ages of 28 and 38, indicate that young males are active donors. Age was calculated with a mean and standard deviation of 28.23 and 8.173. Of the 80 blood donors, 40 were first-time donors, which represents 50% of the Study's participants. 25% of the remaining 50% of repeat blood donors had donated between two and four times, while the remaining 25% had donated between five and seven times. The average time between donations was 6-12 months. All the study subjects were voluntary donors. This Study was conducted over 6 months from December of 2022 to April of 2023. The total red cell count, haemoglobin, and hematocrit of the first-time donors and the repeat donors were within the reference range. This discovery agrees with the Christopher Ogar. report from June 2021 [21]. Regular donation increases the likelihood of developing an iron deficiency and would consequently affect the red cell indices. In a similar vein, repeat donors who have donated blood two to four times had lower MCV, MCH, and MCHC when compared to first-time donors, and they were comparable but not statistically different. Our Study was similar to the one conducted in Pakistan in 2018 [22]. When a donor donated blood for the fifth or more time, their RDW was noticeably greater than when they donated blood for the first to fourth time, which was within the usual range. Additionally, using post hoc analysis, red cell indices (MCV, MCH, MCHC) from fifth-time donors and higher were significantly lower, and RDW was significantly higher, indicating that a significant portion of the repeat donors had sub-clinical iron deficiency anaemia. There is evidence that the MCV, MCH, MCHC, and RDW are trustworthy proxy markers for iron insufficiency, as suggested by Kim S, Cho HI, and Nah E.H. in 2020. [23]. In accordance with the results of the linear-by-linear analysis, the likelihood of sub-clinical anaemia increases with the number of blood donations [24]. We conducted a Study on 80 samples, which are relatively smaller in size but sufficient to show the differences in parameters [25]. However, we did not witness any clinical anaemia, which could be due to the haemoglobin benchmark set in the blood donation criteria. The

results of this Study still raise the worry and the necessity to look beyond the pre-donation H.B. benchmark, even if the H.B. value was used to determine whether or not all the donors were considered to be non-anaemic. Given the necessity to safeguard donors from injury in the future, especially those who have donated more than five times, and to prevent iron depletion, donors must be protected.

4. CONCLUSIONS

This study found the status of adolescent friendly health service delivery in Kaski district was below the certification criteria of adolescent friendliness except indicators of organizing effective services, making conducive environment, addressing the sexual and reproductive health rights of adolescents but other standards set by ASRH implementation guideline were below the set benchmark. Most of the adolescents observed that the health facilities were located in convenient location and had conducive environment. Though adolescents perceived that confidentiality was maintained and privacy was protected by the service providers in the facility majority of the adolescents did not have trust on providers regarding the assurance of confidentiality. The AFHFs in Kaski had conducive environment, friendly and respectful service providers but the service providers were not trained on AFHS. Almost all the health facilities had established IEC corner but community outreach programs regarding the adolescent friendly sexual and reproductive health services had not been conducted by health facilities. There was no specific clinic hours allocated to adolescents in Kaski district and the involvement of adolescents in planning and implementation of AFHS is lacking. This Study's key conclusion was that donors who have given blood five or more times have significantly lower MCV, MCH, and MCHC and much greater RDW. According to the Study's data, a significant risk of iron deficiency exists for these recurrent donors because of the prevalence of subclinical anaemia.

5. RECOMMENDATIONS

On the basis of our research, we advise complete blood counts for donors as well as serum ferritin tests for iron storage analysis and confirmation, particularly for donors who have given blood five times or more. There could be a substantial variation in haematological parameters such as Total Red cell Count, PCV, MCV, MCH, MCHC, and RDW when comparing the haematological parameters of repeat blood donors with those of first-time donors. As repeat blood donors could be more at risk of iron deficiency anaemia than first-time donors, this Study is concerned with the difference in haematological parameters in first-time and repeat blood donors. The assessment of potential sub-clinical donation-related consequences is another focus of this investigation. Donors are kindly asked to eat foods high in iron and to follow up with iron supplements if necessary to treat an iron deficit; this Study is concerned with the difference in haematological parameters in first-time and repeat blood donors. The assessment of potential sub-clinical donation-related consequences is another focus of this investigation. Moreover, to determine the donor category individual's safety threshold. There could be various reasons for iron deficiency, which include dietary intake, due to physiological conditions and some diseased conditions. An individual donating blood for more than the fifth time was seen to be prone to donation-induced sub-clinical cases of iron deficiency anaemia, where the iron is deficient and triggers the erythropoiesis, but the clinical iron deficiency anaemia is not seen as the haemoglobin appears to be normal Donating blood is regarded as the most sanitary and secure volunteer technique. Before the donation process starts, a number of donor screening tests are taken into account to ensure that the recipient will receive blood of a high standard. There are few safety precautions for those in the donor category. This is obvious given that iron is a key component of haemoglobin and is lost along with haemoglobin when giving blood. Over time, Iron deficiency anaemia may develop frequently following several blood donations. Iron Deficiency Anemia may be a problem for regular blood donors compared to first-time donors, even though new red blood cells are produced to replace the old ones because bleeding results in the loss of stored iron.

REFERENCES

[1] Abro, S. U., Saleem, Q., Begum, A., Azhar, S., Naseer, A., & Qureshi, A. A. (2020). Association of BMI (Body Mass Index) to haemoglobin and red blood cell indices among adolescents. The Professional Medical Journal, 27(10), 2210-2215.

[2] Ms. Saroja Poudel & Dr. Rajesh Niraula (2024). Comprehensive study of Placenta Previa & Its Psychological Consequences. Dinkum Journal of Medical Innovations, 3(02):174-187.

[3] Kang, W. (2021). Physiological, Environmental, and Genetic Influences on Iron Homeostasis.

[4] Oswald, D. M. (2020). Local and Systemic Immune Regulation by Liver and Plasma Protein Glycosylation. Case Western Reserve University.

[5] Bain, B. J. (2020). Haematology: A Core Curriculum. WorldScientific.

[6] Ogar, C. O., Okpokam, D. C., Okoroiwu, H. U., & Okafor, I. M. (2022). Comparative analysis of haematological parameters of first-time and repeat blood donors: Experience of a blood bank in southern Nigeria. Haematology, Transfusion and Cell Therapy, 44, 512-518.

[7] Abdul Mumin, Abdullah Al Amin, A.K.M. Shahriar Kabir, Rifat Ara Noor & Urmi Rahman (2024). Role of C-Reactive Protein (CRP) and Neutrophil Lymphocyte Ratio (NLR) in detecting severity & Predicting outcome of Acute Pancreatitis patients. Dinkum Journal of Medical Innovations, 3(01):01-12.

[8] Kumar, A. (2019). A Study On Changes In Hematological Parameters Due To Multiple Blood Donations (Doctoral dissertation, BLDE (Deemed to be University)).

[9] Vhanda, D., Chinowaita, F., Nkomo, S., Timire, C., & Kouamou, V. (2021). Effects of repeated blood donation on iron status of blood donors in Zimbabwe: A cross-sectional study. Health science reports, 4(4), e426.

[10] Kebalo, A. H., Gizaw, S. T., Gnanasekaran, N., & Areda, B. G. (2022). Lipid and Haematologic Profiling of Regular Blood Donors Revealed Health Benefits. Journal of Blood Medicine, 385-394.

[11] Tsamesidis, I., Lymperaki, E., Pantaleo, A., Vagdatli, E., Nikza, P., Lettas, A., ... & Fozza, C. (2019). Haematological, biochemical and antioxidant indices variations in regular blood donors among Mediterranean regions. Transfusion and Apheresis Science, 58(6), 102659.

[12] Hindawi, S., Badawi, M., Hussein, D., Al-Riyami, A. Z., Daghman, N. A., Rafie, N. I., ... & Oumeziane, N. (2021). The impact of blood donation on blood counts and ferritin levels: A multi-centre study from the Eastern Mediterranean region. Transfusion and Apheresis Science, 60(3), 103072.

[13] Marco Irene, Juan Carlos Lopez, Andrea Sveria & Maria Dolevro (2023). Physicians' All-Inclusive Guide on De Novo Donor-Specific Antibodies after Heart Transplantation. Dinkum Journal of Medical Innovations, 2(12):540-548.

[14] Sibanda, N. H. (2022). Multi-ethnic Study on the Distribution of Full Blood Count Parameters in First Time Donors in South Africa (Doctoral dissertation, University of Johannesburg).

[15] Intharanut, K., Nimnuch, P., Naiwijarn, W., Pimsiri, W., Khantisitthiporn, O., & Nathalang, O. (2023). Characteristics of Donors and Modelling of the Characteristics to Possible Forecast the Repeat Donors Profile at Thammasat University Hospital. Indian Journal of Hematology and Blood Transfusion, 39(1), 146-150.

[16] Marie Diack & Derak Stewart (2022). Development of Cardiovascular Abnormalities Because of Periodontitis in Nepali Population. Dinkum Journal of Medical Innovations, 1(01):27-30.

[17] Zhu, H., Wang, J., & Lin, H. (2023). Prevalence and causes of pre-donation deferrals among potential plateletpheresis donors at a blood centre in Eastern China. Transfusion Clinique et Biologique, 30(2), 189-194.

[18] Balogun, T. M., Aile, K., Nnamani, A. C., Kareem, O. S., & Salu, A. (2023). Haematology Parameters of Apparently Healthy Prospective Whole Blood Donors in a Nigerian Hospital Setting. Open Journal of Blood Diseases, 13(2), 59-68.

[19] Muhammad, D. M. I. D. D., Efe, O. E. M. D. O., & Onorieode, O. O. T. D. O. (2024). SOCIO-DEMOGRAPHIC AND HAEMATOLOGICAL PARAMETERS OF BLOOD DONORS IN A TERTIARY HOSPITAL IN SOUTHERN NIGERIA. DYNAMIC MULTI-DISCIPLINARY JOURNAL OF NIGERIA.

[20] Kumar, A. S., Geetha, A., Joe, J., & CHACKO, A. (2021). Estimation of Serum Ferritin Levels in Blood Donors and its Association with Frequency of Blood Donation and Blood Indices. Journal of Clinical & Diagnostic Research, 15(4).

[21] Hirani, R., & Mondy, P. (2021). Review of full blood count reference interval using a large cohort of first-time plasmapheresis blood donors. Pathology, 53(4), 498-502.
[22] Marie Diack, Derak Stewart & Parshu Kirby (2023). Predisposing Factors and Effects of Re-Procedure after Cardiac Resection. Dinkum Journal of Medical Innovations, 2(01):29-34.
[23] van den Berg, K., Swanevelder, R., Ingram, C., Lawrie, D., Glencross, D. K., Hilton, C., & Nieuwoudt, M. (2019). The iron status of South African blood donors: balancing donor safety and blood demand. Transfusion, 59(1), 232-241.
[24] Kaptoge, S., Di Angelantonio, E., Moore, C., Walker, M., Armitage, J., Ouwehand, W. H., ... & Mant, J. (2019). Longer-term efficiency and safety of increasing the frequency of whole blood donation (INTERVAL): extension study of a randomized trial of 20 757 blood donors. The Lancet Haematology, 6(10), e510-e520.
[25] Wang, H. H., Liao, L. N., Chang, C. W., Chang, Y. C., Wu, K. H., & Ko, J. L. (2019). The alteration of ferritin and transferrin saturation under body mass index and blood pressure in first-time and regular male blood donors in Taiwan. Medicine, 98(22), e15854.

