

Lipid and Haematologic Profiling of Regular Blood Donors Revealed Health Benefits

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Background: Blood banks have been suffering a shortage of blood worldwide due to limited donations. By and large, it is widely believed that blood donation has multiple health benefits. However, there are limited studies that support it. As a result, assessing the biochemical profiles of the regular blood donors is indispensable to evaluating an individual's risk for chronic inflammation.

Objective: We strived to compare lipid and haematological profiles of the regular and first-time blood donors in the National Blood Bank Service of Ethiopia.

Materials and Methods: A comparative cross-sectional study, involving 104 blood samples (52 each of regular and first-time donors), was designed to analyze lipid and haematological profiles and anthropometric parameters were measured. Data were analyzed using SPSS version 25, Chi-square (χ^2) was used to compare the relationship between categorical variables and an independent Student's *t*-test was used to compare the mean of the two groups. A *p*-value <0.05 was considered statistically significant.

Results: Regular blood donors had lower mean TC (144.3 ± 28 mg/dL), TG (159.3 ± 88.2 mg/dL), LDL-c (75.9 ± 25.9 mg/dL) than the first-time blood donors with values of TC (158.1 ± 38.94 mg/dL), TG (163.9 ± 82.7 mg/dL), LDL-c (93.1 ± 31.5 mg/dL), respectively. The ratio of LDL-c/HDL-c and TC/HDL-c was found to be lower in regular blood donors when compared to the first-time donors ($P < 0.05$). Even though the level of HDL-c was higher (39.8 ± 8.8 mg/dL) in regular blood donors compared to first-time blood donors (36.8 ± 7.7 mg/dL), it was not statistically significant. The mean of some haematologic parameters like a platelet, RDW, lymphocyte, and MCH was significantly lower in regular blood donors than in first-time blood donors. BMI and WHR in regular donors were less than the first-time donors, albeit statistically insignificant.

Conclusion: Interestingly, blood donation has a significant health benefit by lowering TC, TG and LDL-c, which have the potential risk of developing chronic inflammation.

Keywords: blood donation, lipid profile, hematologic parameters, National Blood Bank Service of Ethiopia, chronic inflammation

Introduction

Blood is an important element of human life, and there is no compensation for its Nubila.¹ Blood donation is a life-saving process for people who have lost large volumes of blood from serious accidents, obstetric and gynaecological haemorrhages and during various surgical procedures. The blood taken from donors could be either whole blood or blood products.²

WHO gives a global rate of 117.5 million blood donations annually, of which 60% are voluntary donors and the rest are for family or paid donors.³ Although blood is very essential to save every life, acute shortage of blood and blood products encountered even in big cities with high populations fail to supply 50% of their demand.²

Blood transfusions in sub-Saharan Africa have emphasized areas of concern, yet there have been very few studies of its history. Record found that transfusions were first reported in Africa in the early 1920s and organized transfusion practices were established before the Second World War and then blood transfusion grew rapidly after 1945. However, there is a great shortage of blood and blood products in sub-Saharan Africa.⁴ In Ethiopia, there has been inadequate and inequitable access to blood. According to a report from the Ethiopian Ministry of Health, Ethiopia, collected 223,000 units of blood in 2019/20, meeting only 22% of its requirements as per the standard of the World Health Organization.⁵

Blood donation makes blood less viscous and lowers LDL-c and TC due to loss of fibrinogen, albumin and lipid loss during donation; Therefore, evaluating lipid profile is very important to assess risk factors for chronic illnesses like diabetes mellitus, hypertension, heart disease, and so on.⁶ Oxidized LDL-c directly delivers various lipid oxides and hydroperoxides to target cells. These compounds variably act as cytotoxins, monocyte, chemoattractant, and stimulators of cholesterol ester accumulation by macrophages.⁷ The accumulation of LDL-c in the vessel wall contributes to the formation of fatty streaks.^{8,9} According to a study, blood donation was to reduce the enzyme responsible for the oxidation of LDL-c, which is linked with the development of atherosclerosis.¹⁰

The study conducted in Argentina reported that HDL-c of regular blood donors were higher than irregular or non-donors.¹¹ HDL-c associated enzyme protects LDL-c from oxidizing because oxidized LDL-c facilitates the formation of platelet activation factor and production of free radicals that are potential to produce pro-inflammatory cytokine.¹² HDL-c also inhibits platelet-activating factor (PAF) synthesis in the endothelial cell by inhibiting PAF acetyltransferase.^{6,13}

A comparative study done on various hematologic parameters among voluntary first-time and regular blood donors in India, Indicated that the level of Hb, MCV, MCH, RBC and serum ferritin were significantly decreased in regular blood donors.¹⁴

Another study conducted on CBC in Sudan Hospitals Blood Bank showed that 70% with the normal range, 26% increased, and 4% decreased in RBCs count. On WBCs count, 82% and 18% were in the normal range and decreased, respectively. In addition, when 90% of the PLTs count is in the normal range, 8% and 2% were increased and decreased in PLTs count, respectively.¹⁵

Some studies have reported that blood donation decreases the risk of cardiovascular and other chronic diseases.^{6,16} However, limited studies were conducted worldwide and to our knowledge, there were no studies in Ethiopia that compared the lipid profile and hematologic parameters among regular and first-time blood donors.

Therefore, this study was primarily focused on comparing the lipid profile and hematologic parameters among regular blood donors and first-time blood donors at the National Blood Bank Service of Ethiopia.

Methods and Materials

Study Design, Area, and Period

An institutional-based comparative cross-sectional study was conducted among 104 regular and first-time blood donors at the National Blood Bank Service of Ethiopia, from January to December 2020.

Population and Eligibility Criteria

The source population for this study was all blood donors who have voluntarily donated their blood at the National Blood Bank Service of Ethiopia, whereas all blood donors who have visited the National Blood Bank Service of Ethiopia during the study period were considered as the study population. All regular and first-time blood donors between the ages of 18–65 years were included in this study; however, donors who were smokers, alcohol drinkers, on lipid-lowering medication, weight less than 45 Kg, pregnant and lactating women, hypertensive, diabetic, cardiovascular and anaemic patients were excluded from the study.

Sample Size Determination and Sampling Technique

The sample size was determined based on the specific mean \pm standard deviation for each sub-groups since there were no reported studies in Ethiopia. The mean \pm SD of HDL for regular blood donors was 0.86 ± 0.24 (mmol/L) and for non-donors was 1.0 ± 0.26 (mmol/L), which was taken from the study done in Nigeria entitle “lipid profile among blood donors”.⁶ The sample size is determined by using the G power software Statistical Power Analyses for Windows (3.1.2.9 version) with the following assumptions: Significance level = 95%, power = 80%, type of test = two independent mean *T*-test, $Z_{\alpha/2}$ = the critical value at 95% ($\alpha = 0.05$) and 1:1 ratio. The computed sample size based on the above assumption was 104, which comprised 52 samples from each category. Convenient sampling methods were used, for both regular and first-time blood donor groups until the required sample size was attained.

Sampling Methods and Producers

A structured questionnaire translated to the local language, Amharic, was used for the socio-demographic data collection. Anthropometric measurements including weight, height, waist-circumference and hip-circumference were measured with the subjects wearing light clothing. Body mass index (Kg/m^2) was calculated by dividing the weight in Kg by height in m^2 and waist-to-hip ratio (WHR) was calculated.

Blood Collection and Processing

About 6 mL of blood sample was drawn by qualified health care professionals and divided into two (3 mL for lipid profile and 3 mL for CBC). While the haematological analysis was performed right away at the time of sample collection, lipid profiles were performed one time after we reached our sample size. Three-milliliter blood was added in SST and allowed to stand for 30 minutes at room temperature for complete clotting and clot retraction. Then, Serum was separated by centrifugation at 3500 rpm for 15 minutes by Megafuge r 1.0 Heraeus centrifuge (Germany, 2017). The serum was used to determine the levels of TC, HDL-c and TG by a Cobas 6000 Chemistry Analyzer (Germany, 2020). LDL-c cholesterol was calculated using the Fried-Wald formula ($\text{LDL-c}=\text{TC}-(\text{TG}/5+\text{HDL})$).¹⁷ Finally, serum lipid profile ratios (TC/HDL-C, TG/HDL-C and LDL-C/HDL-C) were calculated. Another 3 mL for CBC was added to the EDTA tube to determine hematologic parameters by Beckman haematology Analyzer (Germany, 2018).

Study Variables

Serum lipid profile (TC, LDL-c, HDL-c and TG) and CBC were dependent variables, whereas socio-demographic factors and anthropometric indicators were our independent variables.

Operational Definition

Lipid Profile: is a panel of blood tests that serves as an initial broad medical screening tool for abnormalities in lipids, such as cholesterol, HDL-c, LDL-c, and triglycerides.

Regular blood donors: individuals who had donated blood every three months, at least for the last consecutive two years.

First-time blood donors: an individual who has donated blood for the first time with no history of blood donation previously.

Data Quality Control and Management

Data collection tools were prepared to meet the highest quality and monitored at the time of sampling. Professional laboratory technologists handled all the experimental procedures and all instruments were operated according to the manufacturer's instructions. High-quality standards were used as a control and calibration was used to calibrate the instruments and no analyses were done if the control is out of normal range.

Data Processing and Analysis

Data obtained from the questionnaire and laboratory analysis were checked for completeness and refined. It was coded and entered into the Epi-Data statistical software version 3.1 and exported to SPSS software version 25 package and different variables were tested and analyzed. Simple descriptive statistics were used to present the socio-demographic characteristics of the study subjects. While the Chi-square (χ^2) test was used to compare categorical variables, the continuous variable was present as mean \pm SD and compared using the Student's t-tests for groups. A p-value of less than 0.05 at a 95% confidence level was considered to be statistically significant.

Results

Socio-Demographic Characteristics of the Blood Donors

Table 1 illustrates the socio-demographic characteristics of the study populations. The study included 104 study participants: 52 of each were regular and first-time blood donors. Among the regular blood donors, 84.6% and 15.4% were donated four and three times a year, respectively.

Table 1 Socio-Demographic Characteristics of the Study Participants at the National Blood Bank Service, Ethiopia, from June to July 2020 (n = 104)

S. No.	Variables	Category	RBD (%)	FTB (%)	P-value
1	Gender	Male	84.6	71.2	0.098
		Female	15.4	28.8	
2	Age group	18–38	65.3	73.1	0.095
		39–58	34.6	26.9	
3	Marital status	Married	50.0	55.8	0.84
		Unmarried	48.1	42.3	
		Divorced	1.9	1.9	
4	Religion	Orthodox	57.5	51.9	0.11
		Muslim	11.5	25.0	
		Protestant	30.8	19.2	
		Others	0.0	3.8	
5	Residence	Urban	100.0	96.2	0.15
		Rural	0.0	3.8	
6	Level of education	Illiterate	1.9	3.8	0.75
		Primary school	7.7	1.9	
		Secondary school	25.0	25.0	
		Undergraduate	21.2	17.3	
		Graduate	44.2	51.9	

Among regular blood donors, 65.3% were in 18–38, while 34.6% were in 39–58 years: from first-time donors, 73.1% and 26.9% were 18–38 and 39–58 years, respectively ($P > 0.05$). Eighty-four percent (84.6%) of regular blood donors and 71.15% of first-time blood donors were found to be males ($P > 0.05$).

Among regular blood donors, 57.69% were Orthodox, 30.77% Protestant, and 11.5% Muslim. Likewise, of first-time blood donors, 51.9% were Orthodox, 25% Muslim and 19.23% protestant ($P > 0.05$).

More than 98.5% and 50% were urban dwellers and married, respectively, regular blood donors. Among regular blood donors, 1.9% have no formal education and 44.2% graduated from college or university level. Of first-time blood donors, 3.8% have no formal education and 51.9% graduated from college or university level ($p > 0.05$). Our socio-demographic data reflected an ideal matching between the study participants.

Anthropometric Parameters of Study Participants

This study showed that the mean \pm SD of BMI of regular blood donors was 23.33 ± 2.77 kg/m², while that of first-time blood donors was 23.86 ± 2.84 kg/m². Regarding the waist-to-hip ratio, the mean \pm SD was found 0.85 ± 0.03 and 0.86 ± 0.04 for regular blood and first-time blood donors, respectively ($P > 0.05$; Table 2). The result indicated that the physical status of donors does not affect the level of lipid profile and haematological parameters.

Lipid Profile of the Study Participants

The lipid profile data showed that the regular blood donors had lower mean TC (144.3 ± 28 mg/dL), TG (159.3 ± 88.2 mg/dL), LDL-c (75.9 ± 25.9 mg/dL) and higher HDL-c (39.8 ± 8.8 mg/dL) than the first-time blood donors with

Table 2 Anthropometric Parameters of Study Participants at the National Blood Bank Service, Ethiopia, from June to July 2020 (n = 104)

S.No	Variables	Mean \pm SD		P-value
		RBD	FBD	
1	Height (m)	1.73 \pm 0.07	1.70 \pm 0.08	0.11
2	Weight (Kg)	70.4 \pm 10.1	69.5 \pm 11.2	0.68
3	BMI (Kg/m ²)	23.3 \pm 2.78	23.9 \pm 2.84	0.34
4	WC (cm)	84.4 \pm 4.82	83.9 \pm 5.74	0.67
5	HC (cm)	98.0 \pm 4.0	97.8 \pm 3.9	0.85
6	WHR	0.86 \pm 0.03	0.87 \pm 0.04	0.74

values of 158.1 \pm 38.94 mg/dL, 163.9 \pm 82.7 mg/dL, 93.1 \pm 31.5 mg/dL and 36.8 \pm 7.7 mg/dL, respectively (Figure 1). LDL-c and TC in regular blood donors were significantly lower than in the first-time blood donors. Succinctly, the ratio of LDL-c/HDL-c and TC/HDL-c was found to be lower in regular blood donors when compared to the first-time donors (P < 0.05). Except for a few participants, the mean value of lipid profile among the groups falls within the normal biological range indicating there was no prior history of abnormal lipid profiles that affect the outcome of the present result.

Hematologic Parameters

Table 3 illustrates the haematologic parameters of the 104 study participants classified as regular and first-time donors. The result showed that values of WBC, Neu%, and Lymph% (all in mean \pm SD) were found in regular blood donors at 5.59 \pm 1.5 $\times 10^3/\mu\text{L}$; 58.08 \pm 10.5; 29.9 \pm 9.1 compared to the first-time donors 5.85 \pm 1.7 $\times 10^3/\mu\text{L}$; 52.2 \pm 9.7; 35.7 \pm 8.6. The neutrophils of regular blood donors were significantly higher than the first-time blood donors. However, the lymphocyte of regular blood donors was significantly lower than first-time blood donors. Mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and RDW-SD were found to be significantly lower in regular blood donors compared to first-time donors. However, the majority of RBC indices were found to be similar.

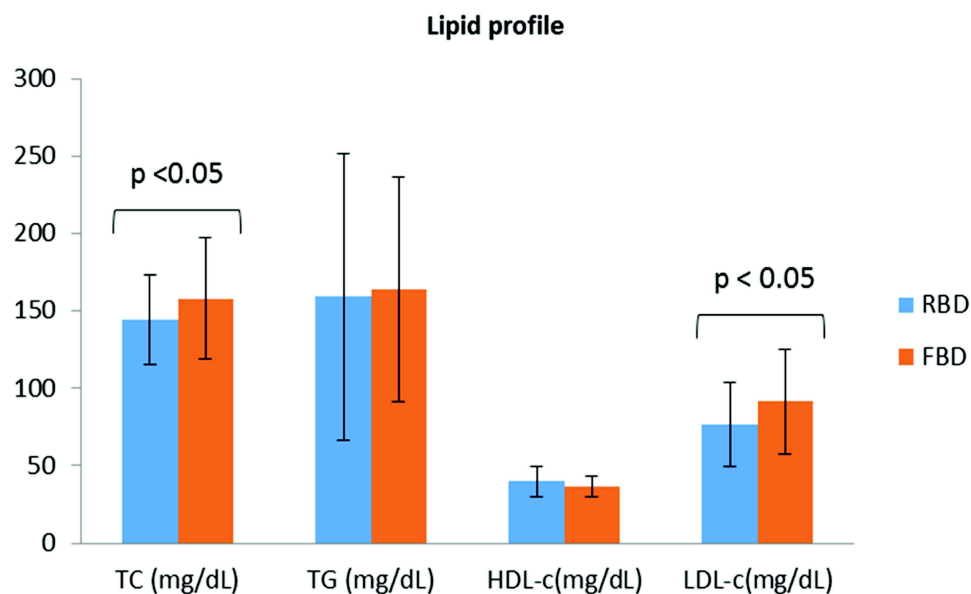
**Figure 1** Levels of lipid profiles in regular and first-time blood donors at National Blood Bank Service, Ethiopia, from June to July 2020 (n = 104).

Table 3 Levels of Haematological Parameters in Regular and First-Time Blood Donors at National Blood Bank Service, Ethiopia, from June to July 2020 (n = 104)

S.No	Variables	Mean \pm SD		P-value
		RBD	FBD	
1	WBC* $10^3/\mu\text{L}$	5.6 \pm 1.5	5.8 \pm 1.7	0.43
2	Neu (%)	58.2 \pm 10.5	52.2 \pm 9.7	0.004*
3	Lymph (%)	29.9 \pm 9.1	35.7 \pm 8.6	0.001*
4	Plt* $10^3/\mu\text{L}$	208.3 \pm 24.8	229.5 \pm 59.5	0.04*
5	Mpv (fL)	9.2 \pm 1.1	9.3 \pm 1.1	0.89
6	RBC ($10^3/\mu\text{L}$)	4.76 \pm 0.6	4.71 \pm 0.5	0.65
7	HCT (%)	42.0 \pm 4.3	42.3 \pm 4.3	0.40
8	HGB (g/dL)	14.7 \pm 1.7	15.0 \pm 1.7	0.75
9	MCH (pg)	30.8 \pm 2.1	31.7 \pm 1.7	0.016*
10	MCHC (g/dL)	35.0 \pm 1.0	35.3 \pm 1.1	0.017*
11	RDW (%)	13.7 \pm 1.1	14.2 \pm 2.2	0.133
12	RDW-SD	42.2 \pm 2.8	43.8 \pm 3.7	0.01*
13	Neu/Lymph	2.4 \pm 1.0	1.7 \pm 0.8	0.003*
14	Platelets/Lymph	115.5 \pm 24.3	113.3 \pm 31.6	0.48

Note: The *indicates $p < 0.05$.

Concerning platelet indices, the values (mean \pm SD) of regular blood donors versus first-time blood donors are as follows: PLT (208.3 \pm 42.8 and 229.5 \pm 59.5* $10^3/\mu\text{L}$) and mean platelet volume (MPV) (9.25 \pm 1.08 and 9.28 \pm 1.09fL), respectively (Table 3). The platelets of regular blood donors were significantly lower when compared to first-time blood donors. The ratio of Neutrophil to lymphocyte (NLR) and platelet-to-lymphocyte ratio (PLR) were found to be lower for the first time compared to regular blood donors.

Generally, the mean values of all hematologic parameters were in the normal range for both regular and first-time blood donors.

Discussion

This study assessed the lipid and haematologic profiles of the regular blood donors (those who donate every three months in a year) and first-time donors (no recorded history of blood donation) voluntarily coming to the National Blood Bank Services of Ethiopia. The present study showed that the socio-demographic status of the blood donors, viz., age, religion, marital status and education level were well matched. This indicated that sociodemographic characteristics did not affect the results as a confounding, which is in congruence with previous reports.^{6,18} However, the number of male donors was found to be higher in regular blood donors (RBD) and first-time blood donors (FTD), compared to females, albeit statistically insignificant. Rizvi's report showed a similar trend.¹⁹ This might be due to the very low-haemoglobin levels or/and the susceptibility of females to various anaemia.

In addition, BMI and WHR were found to be similar between the regular and first-time blood donors. While our report on BMI value agrees with two researchers in Iran and Palestine,^{6,18} other groups claimed that BMI was lower²⁰

and higher²¹ in regular blood donors when compared to the first-time donors. The latter is due to the high interest of obese people who understood the health benefits of blood donation.²²

Two decades back, regular blood donors have been identified as having a reduced risk of cardiovascular disease when compared with non-donors.¹⁰ The present study compared the lipid profile of regular blood donors with that of first-time donors. Our study vividly proved that TC, LDL-c, and the ratios of TC/HDL-c and LDL-c/HDL-c were found to be significantly lower in regular blood donors (RBD) than the first-time donors (FTD). TG and HDL-c were lower and higher, respectively, in RBDs compared to FTDs, although statistically insignificant.

Most of the previous studies here under were found to be in agreement with our outcomes: lower TC, LDL-c, LDL-c/HDL-c and TC/HDL-c;^{6,18} lower LDL-c;²³ lower TG and LDL-c;²⁴ lower TC and LDL-c;²⁵ healthier HDL-c and TC/HDL-c;⁸ higher HDL-c^{10,11,13} levels in RBDs compared to FBDs. However, others reported that there was no change in the values of TC, TG and LDL-c¹³ for both regular donors and higher HDL-c for non-regular donors.²³

From our result, lower LDL-c and higher HDL-c have health benefits for the regular blood donor. HDL-c is the type of lipoprotein, which mainly contains Apolipoprotein A-I as a major protein component. The atheroprotective activity of HDL-c is often explained by the unique ability of these lipoproteins to remove cholesterol from peripheral tissues, including the arterial wall, and transport it to the liver.²⁶ Therefore, the higher the concentration of HDL-c in regular blood donors reduced the level of cholesterol by scavenging from peripheral tissues and transporting it to the liver for synthesis of other important biomolecules. In addition, the lower LDL-c in regular blood donors is also advantageous over first-time donors. LDL-c is responsible for spasm of the blood vessels that are easily blocked by plaques²⁷ and oxidized LDL-c delivers lipid oxides and hydroperoxides to target cells variable acts as cytotoxins, monocytes, chemoattractants and stimulators of cholesterol ester accumulation by macrophages, which leads to fatty strikes.⁹ In our study, blood donation lowers LDL-c which increases its oxidative (not peroxidation) potential, in which the chance of formation of oxides and hydroperoxides, plaques, and fatty strikes (all the major contributors of atherosclerosis and other complications) are significantly reduced. As a result, we can deduce that regular blood donors have benefited more than the first time and non-donors.

Higher TC/HDL-c and LDL-c/HDL-c ratios are predictors of high cardiovascular risk and coronary artery disease.^{28,29} The present study indicated that these ratios were found to be significantly lower in regular blood donors compared to first-time donors, which is in agreement with the previous study done in Cameroon.³⁰ This confirmed that regular blood donors or blood donation, in general, have reduced the chance of developing cardiovascular risk and coronary heart disease.¹¹

This study was also designed to compare the haematological parameters (RBC, WBC, PC, and packed cell volume) of regular blood donors with first-time blood donors. The analysis of our data showed that the levels of WBC, lymphocyte, platelet, MPV, HCT, HGB, MCH, RDW, and RDW-SD were lower in RBD compared to the FTD, albeit statistical significance was merely observed in lymphocyte, platelet, MCH, and RDW-SD ($P < 0.05$). However, the levels of RBC ($p > 0.05$) and Neutrophil ($p < 0.01$) were higher in RBD compared to FTD. None of the hematologic parameters of both groups deviated from the normal biological ranges, which is highly pronounced in regular blood donors. Elnour's group data is incongruous with ours.¹⁵ This proved how safe is the procedure and adequate interval between consecutive blood donations. The latter allows erythropoiesis to compensate for any minor decline in any of these haematological profiles.³¹

The HCT, also known as packed cell volume or erythrocyte volume fraction, is the volume percentage of RBCs in blood and functions as a major determinant of blood viscosity, blood pressure, venous return, cardiac output, and platelet adhesiveness.³² Although statistically insignificant, our result showed a lower HCT level in regular blood donors which is in agreement with previous reports.¹⁸ As the frequency of donation increases (for example, first to fourth times), the haematocrit value significantly decreases.³³

In our study, the mean value of platelet counts was significantly lower in regular blood donors than in first-time donors ($p < 0.05$). It coincided with the following research.³³⁻³⁵

RDW is a quantitative measure of the red blood cell volume (RBCV) heterogeneity. Increased RDW causes impairment of RBCs deformability and negatively affects blood flow through microcirculation due to the complete standstill movement of RBCs.³⁶ Our analysis showed a significant decline ($p < 0.05$) in the level of RDW in regular

blood donors compared to the first-time donors. This asserted regular blood donation may be attributed to lowering the risk of chronic inflammation.

NLR and PLR can be an important measure of systemic inflammation as it is cost-effective, readily available, and could be calculated easily.³⁷ The previous study showed that NLR of chronic diseases like diabetes and hypertension were higher than a cut-off value.³⁸ In our study, both NLR and PLR were lower in FTD compared to RBD.

We believe our current study answered the important question of how donating blood is indispensable both while saving millions of lives, and the health status of frequent blood donors is improved. Despite that, our study has a limitation: Since the sample size is small and our request to Ethiopian Blood Bank Services to increase it was challenged by the Covid-19 pandemic severe situation, we could not be able to stratify regular blood donors into subgroups.

Conclusion

Our study proved that the TC, TG, LDL-c and the ratios TC/HDL-c and LDL-c/HDL-c were found to be lower in regular blood donors. Interestingly, HDL-c was also found to increase in regular blood donors compared to first-time blood donors. Body-mass index (BMI) and waist-hip ratio (WHR) as well as some haematological profiles like a platelet, haematocrit, white blood cell, lymphocyte and RDW, were also found to be lower in regular blood donors. Combining all the above-mentioned parameters, regular blood donors have gotten less chance of developing the risk of cardiovascular complications and other chronic inflammation. As a result, we can deduce that blood donation has multiple health benefits to our best knowledge, this is the first-ever research in Ethiopia.

Abbreviations

BMI, body mass index; CBC, complete blood count; CVD, cardiovascular disease; FTD, first-time donors; HDL-c, high-density lipoprotein cholesterol; LDL-c, low-density lipoprotein cholesterol; NBBS, National Blood Bank Service; NLR, neutrophil to lymphocyte ratio; PLR, platelet to lymphocyte ratio; RBC, red blood cell; RBD, regular blood donors; TC, total cholesterol; TG, triglyceride; VLDL-c, very-low density lipoprotein cholesterol; WBC, white blood cell; WHR, waist to hip ratio.

Data Sharing Statement

Anyone interested in the full data in excel format can have the data by writing to solomon.tebeje@aau.edu.et.

Ethics Approval, Consent to Participate and Publication

Before the study, an ethical clearance letter (with a reference number SOM/DRERC/BCHM/088/2012) was obtained from the Research and Ethics Review Committee of the Department of Medical Biochemistry, School of Medicine, College of Health Sciences, Addis Ababa University. A collaboration letter for data collection was also obtained from the National Blood Bank Service. The research proposal was presented and thoroughly discussed at the National Blood Bank Service of Ethiopia as well.

The objective of the study was clarified and explained to each participant before enrolling any of the eligible study participants. Written informed consent for samples, data collection, and publication was obtained from the study participants ([Supporting Information](#)). Confidentiality, anonymity, neutrality, accountability and academic honesty were maintained throughout the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

All authors declare that they have no competing interests.

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