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Research Article

Hematological Parameters in Apparently Healthy Eritrean Blood Donors at the National Blood Transfusion Center, Asmara, Eritrea

Faris M. Abdon[1], Elias T. Adgoy[2], Nahom Y. Berhane[3], Senet A. Ibrahim[3], Adil K.H. Khalil[4], Yemane Seyoum[5], and Osama S. Abbadi[6]

[1]Department of Biochemistry, Orotta College of Medicine and Health Sciences, Asmara, Eriteria
[2]Community Medicine and Primary Health Care, Orotta College of Medicine and Health Sciences, Asmara
[3]Department of Laboratory Medicine, National Blood Transfusion Service (NBTS), Eritrea
[4]Department of Basic Medical Science, College of Medicine, Dar Al Uloom University, Riyadh, Kingdom of Saudi Arabia
[5]Dean, Orotta College of Medicine and Health Sciences, Asmara, Eritrea
[6]Department of Biochemistry, Faculty of Medicine, Omdurman Islamic University, Sudan

Corresponding Author:
Osama S. Abbadi;
Department of Biochemistry,
Faculty of medicine,
Omdurman Islamic University,
Sudan.
Current address: Riyadh city,
Saudi Arabia.
P.O. Box: 22490, Riyadh
11426.
Tel: 00966531549824.
email: aslikhalis@yahoo.com

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Abstract

Background: This study was conducted to measure the hemoglobin (Hb) levels, erythrocytes, and related measurements (particularly mean corpuscular volume [MCV], mean corpuscular hemoglobin [MCH], mean corpuscular hemoglobin concentration [MCHC], and hematocrit) in healthy individuals donating blood at the National Blood Transfusion Center (NBTS) in Asmara city, Eritrea.

Methods: Venous blood samples were taken from the candidates' peripheral veins into the EDTA tube and examined for red blood cell(RBC) count, Hb, hematocrit (%),MCV, MCH, MCHC, and red cell distribution width (RDW), analyzed and measured by automated blood analyzer.

Results: The mean Hb level was 14.428±1.485g/dl, RBCs count was 4.744±0.482×10^{12}/L, HCT was 41.929 ±3.75%, RDW mean was 13.571±0.744%, MCV was 88.582± 4.0558 Femtoliter, MCH was 30.470±2.188picogram, and MCHC was a mean of 34.393±1.347g/dl. The difference between males and females in MCV and MCHC was significant in favor of female donors. A correlation of a weak positive naturewas found between the ages and genders of donors and the Hb level. All measured values were found to be within the global referenced ranges.

Conclusion: Hb, RBCs count, and RBCs indices of apparently healthy Eritrean blood donors were measured for reference, and all values were found to be within the normal reference ranges.

Keywords: blood donors, hemoglobin, RBCs, RBCs indices

1. Introduction

The red blood cells (RBCs) are a type of cells primarily composed of the quaternary protein hemoglobin (Hb) that serves as the carrier of oxygen to the tissues, carbon

dioxide, bicarbonates, and proton (H+) to the lungs [1]. Most RBCs are round and flattened at the center, probably due to the absence of nuclei and most of the cell organelles [2]. Through a process known as erythropoiesis, couple million erythrocytes are formed within the human bone marrow each second [3, 4]. An adult human body has an estimated 2–3 ×1013 RBCs in total, with males having the higher average count due to physiological and hormonal causes [4,5]. People living at high altitudes with low oxygen tension will have higher erythrocyte level [6]. Except for 2% of the dissolved oxygen in plasma, RBCs carry the majority of molecular oxygen in the blood [1]. The RBCs of an average adult human male store collectively about 2.5 gram of iron, which is two-thirds of the total body iron, in the heme of erythrocytes [4,5].

Some important terms were developed to describe the physiological and pathological parameters of erythrocytes: measured in femtolitres (fl), the average volume oferythrocytes is known as mean corpuscular volume (MCV). If the majority of RBCs in a sample are smaller or larger than the population MCV, this implies that there is micro or macrocytic anemia, respectively.Variable sizes of erythrocytes are measured through the RDW.Hb in RBCs is either described inpicograms for the amount in RBCs;in this case, the measurement is called mean corpuscular hemoglobin (MCH) and otherwise, it could be measured as a fraction of Hb in the erythrocyte, which is called MCH concentration. Either described in g/dl or percentage, the MCHC is the same index [4].

Blood transfusion is an essential component of quality healthcare service package. Voluntary blood donors are the main contributor to safe blood to be transfused. The availability and accessibility of safe blood and blood products save life, mainly in emergencies such as hemorrhagic anemia due to obstetric and gynecological emergencies, general surgeries, accidents, conflicts, and complex medical and surgical conditions for improving the life expectancy and quality of life. Sufficient and safe blood donation/transfusion service is an essential component of the healthcare system of a nation. Those who are selected for blood donation should be from a group of population with low risk of infection and prevalence of infectious diseases.

According to different studies and clinical trials, Hb level and RBC count are commonly and routinely used in clinical diagnostic measures. To the best of the researchers' knowledge, so far, no study has been conducted on the Hb level and RBC indices in apparently healthy Eritrean blood donors. Therefore, this study will help in establishing the reference ranges of Hb level and erythrocytes count in Eritrean people and to correlate them with genders and ages of the participants.

2. Materials and Methods

2.1. Study design and area

This study was a descriptive cross–sectional study performed at the National Blood Transfusion Center (NBTS) of Eritrea between October and December 2019. The NBTS is the only blood bank in the country that is situated around the National Referral Hospitals of the country.

2.2. Study participants

Voluntary donors were chosen according to specific health parameters – including suitable age, average weight and body mass index (BMI); passing a general physical examination; the absence of non-communicable chronic diseases, namely diabetes mellitus and hypertension; and the absence of blood-transmitted infections, particularly syphilis, hepatitis B, hepatitis C, and HIV. Hb level assessment was performed using the Hemocue 201 hemoglobinometre®, and donors were reported as fit for the donation if a drop of blood sankin a copper sulphatesolution, of a certain specific gravity. The sample size was determinedusing anonline software available at: https://www.surveysystem.com/sscalc.htm. Putting a confidence level of 95% and confidence interval 4.0, and previously knowing that the population of Eritrea is 3,200,000 (according to a 2010census), the calculated sample size was 601 participants.Accordingly, a total of 610 volunteered blood donors –205 females and 405 males –between the ages of 16 and 65 years consented to participate in the study.

2.3. Data collection methods

2.3.1. Questionnaire

A standard donor questionnaire, designed by the ENBTS for counseling purposes, was used to collect information such asthe demographic data, social habits, current health status, and past medical history of each blood donor.

2.3.2. Laboratory investigations

The required blood samples were taken during the donation process. Blood sampling was performed by trained staff working in the ENBTS, following a standard operating

procedure for blood sample collection. Moreover, 4 mL of blood from peripheral veins was collected into the K3EDTA tubes (Becton Dickinson, Plymouth, UK) and 6mL venous blood was collected into serum tube from all participants of the study. Blood samples collected into the EDTA tubes were examined for Hb, erythrocytes count, packed cell volume (HCT%), RDW, MCV,MCH, and MCHC by automated blood analyzer: Beckman coulter DxH500 series, within the first 4 hr of sample collection. The 6mL venous blood collected were analyzed using the Cobas-e 411 for the screening HIV, syphilis, hepatitis B virus surface antigen (HbsAg), and hepatitis C virus antibodies (HcAbs). Both instruments participate in an external quality assurance program, and routine internal quality control product was run before analyzing each sample.

2.3.3. Data analysis

The basic datasheet, descriptive statistics, and tests of significance were all performed usingthe Microsoft® 2007 Excel software.

3. Results

The study Participants (*n*=601) were found to have a mean weightof 60.633 ± 10.312kg and aged between 16 and 71 years. The Hb level was14.428 ± 1.485g/dl; RBCs count 4.744 ± 0.482×10^{12}/L; HCT 41.929 ± 3.75%; RDW mean 13.571 ± 0.744%; MCV 88.582 ± 4.0558 fl; MCH 30.470 ± 2.188 pg; and MCHC mean 34.393 ± 1.347 g/dl (See Table 1).The Differences between female(*n*=205) and male (*n*=405) donors in MCV and MCHC were found to be significantly higher in female donors when compared to males. However, the differences in the RBCs counts, Hb levels, and hematocrits were found to be insignificant (Table 2).A positive correlation was observed between the weight and age of the apparently healthy blood donors with RBCs count, and also a correlation between weight and age with Hb level (Table 3). While Figure 1 shows a line chart of RBCscount comparing the male and female donors,Figure 2 shows a line chart of Hb levels comparing the twodonor groups.

4. Discussion

Thecurrentstudy of blood parameters is considered as the first to be performed among theEritrean blood donors. The study revealed the hematological values that includeHb, erythrocytes count, hematocrit, and other RBC indices, namely MCV, MCH and MCHC to

Table 1: The results calculated to eight variables in erythrocytes and hemoglobin.

Variable	Mean	Median	Mode	Standard deviation	Standard error	Sample variance	Range	Minimum	Maximum	Confidence level (95.0%)
Weight in kg	60.633	57	55	10.312	0.4175	106.331	60	50	110	0.82
Age in years	22.5	17	16	10.808	0.438	116.808	45	16	61	0.859
Hb level g/dl	14.428	14.36	15.25	1.485	0.06	2.204	8.54	11.14	19.68	0.118
RBCs count 10^{12}/liter	4.744	4.73	4.8	0.482	0.02	0.232	3.04	3.45	6.49	0.038
HCT %	41.929	41.7	40	3.75	0.152	14.066	24.7	32.8	57.5	0.298
MCV (fL/cell)	88.582	88.4	86.7	4.056	0.164	16.45	36.1	72	108.1	0.322
MCH (pg/cell)	30.47	30.2	30.2	1.88	0.076	3.535	14.7	23.2	37.9	0.15
MCHC (g/dL RBCs)	34.393	34.1	33.9	1.347	0.055	1.814	10.5	29.5	40	0.107
RDW (%)	13.57	13.45	13.4	0.744	0.03	0.554	6.7	11.9	18.6	0.0592

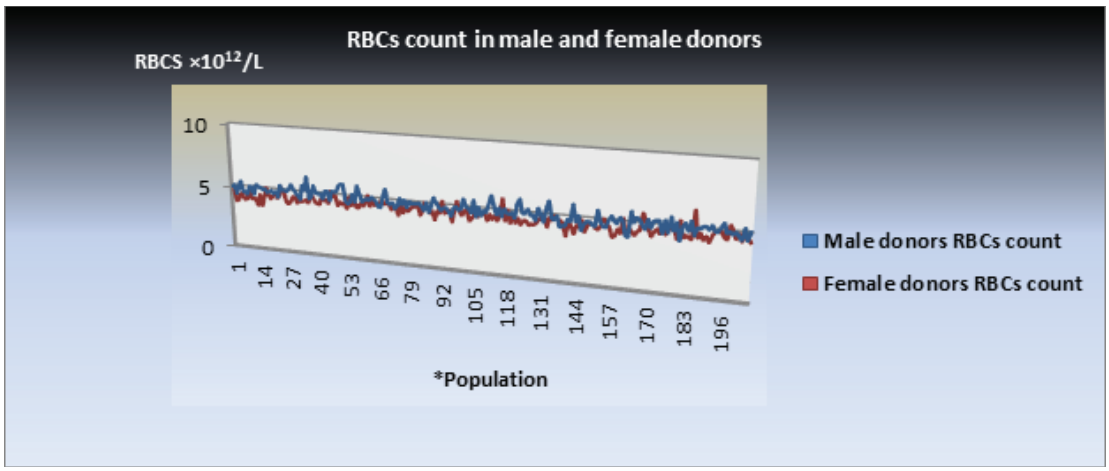

Figure 1: Diagram demonstrating RBCs count in male and female donors. *Population limitation is from the software.

Table 2: The significance of the difference between male and female donors in regards to RBCs count, hemoglobin level, and hematocrit (HCT).

Parameter	Male mean	Female mean	Statistic t	Critical two-tailed t	Difference status
RBCs count	4.913	4.408	–14.0369	1.963886	Insignificant
Hb level	15.008	13.266	–16.417	1.963886	Insignificant
HCT	43.341	39.128	–15.3919	1.963886	Insignificant
MCV	88.394	89.092	2.045407	1.963886	**Significant**
MCH	30.609	30.197	–2.56531	1.963873	Insignificant
MCHC	34.012	35.146	10.69728	1.963873	**Significant**
RDW	13.618	13.479	–2.18499	1.963873	Insignificant

be within the referenced normal ranges [6], although the MCV and MCHC in the female donors were higher than the male donors by 0.7fL/cell and 1.13pg/cell, respectively.

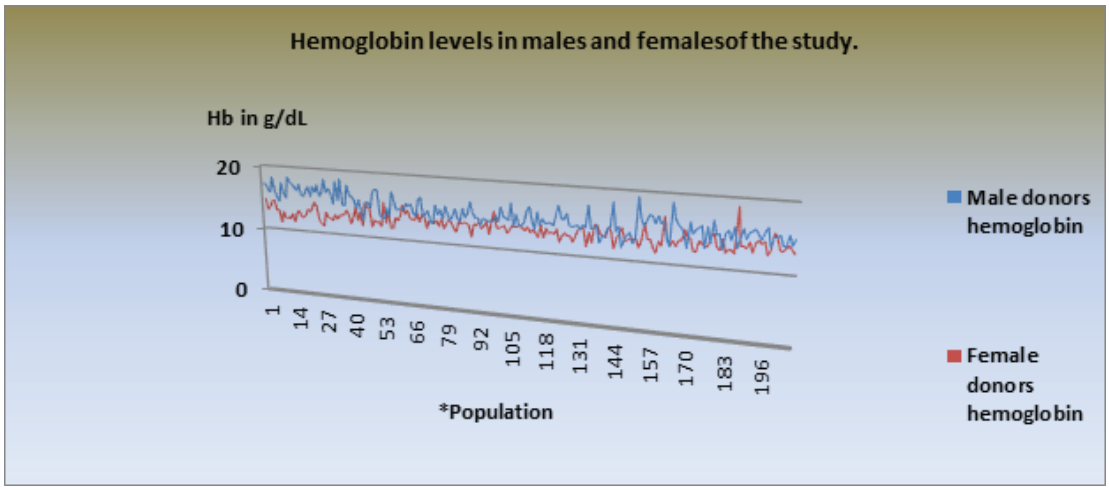

Figure 2: A line chart representing the hemoglobin levels in males and females of the study population. *Population limitation is from the software.

Table 3: Correlations ofthe weight and age to both RBCs count and hemoglobin level.

Parameter	Correlations withthe RBCs count	Comment	Correlationswith theHb level	Comments
Weight	0.146203767	Very weak positive	0.231729022	Weak positive
Age	0.091116727	Very weak positive	0.276022551	Weak positive

This is the only parameter which was found to have statisticallysignificant difference between the two genders. These results might be due to a compensatory response to the absenceof testosterone hemopoietic effect in females [7]. However, both the MCV and MHCH values were found to be within the normal range of hematologicreferences. Some studies documented increased MCVdue to aplastic anemia, liver disease, myelodysplastic syndrome, and chemotherapy [8].

A population-based study in Eritrea, which was performed in 2018, revealed that the mean Hb level was 15.4 g/dl for males, whereas females scored 14.9 g/dl; males had a mean RBCs count of 5.3×10^{12}/L and females 4.7×10^{12}/L.The hematocrit in that study was 49.3% and 44.2% for males and females, respectively;the mean MCV in males was 93.8 fL/cell, while females gave a mean of 93.6 fL/cell. Also, the MCH value for males was 30.8pg/celland for females 30.4pg/cell and the mean MCHC for males was 32.8, whereas the females scored a mean of 32.4g/dL RBCs[9]. One can notice that apart from the MCHC, all the current results are lower than the population-based study.

According to another hematologic study conducted on apparently healthy male donors in Sudan by Abbas *et al*, the results were documented with a mean Hb level of 14.509±1.2076 g/dl, mean RBCs count of $5.1515\pm0.45432\times10^{12}$/L, mean MCV of 85.08±5.7391fl, mean MCH of 28.244± 2.1959 pg, and MCHC of 32.218±1.9002 g/dl

[4],which are relatively consistent to this study. Besides, two another studies in Ethiopia (1979[10] and 1999[11]) and one in Tanzania (2008 [12]) have also been documented and summarized in Table 4.

Table 4: Comparison between the studies done in healthy population within Sudan, Eritrea, Tanzania, and Ethiopia with regards tohemoglobin, RBCs count, and RBCs indices.

Parameter	Eritrea 2019 (current study)	Eritrea 2018 population-based study	Sudan 2015 study	Ethiopia 1979 study	Ethiopia 1999 study	Tanzania 2008 study	Williams Manual of Hematology.
Hemoglobin ± SD (g/dL)	Males : 15.008 (SD ± 1.228) Females: 13.266 (SD ± 1.026)	Males : 15.4 Females: 14.9	14.509 (SD ± 0.208)	16.4 (SD ± 1.5)	Males: 16.1 (SD ± 1.1) Females: 14.3 (SD ±1.2)	Males: 15.4 Females: 13.5	Range: M = 14–18 F = 12–15
RBCs count ±SD (10^{12}/L)	Males: 4.913 (SD ± 0.428) Females: 4.408 (SD ± 0.401)	Males: 5.3 Females:4.7	5.152 (SD ± 0.454)	_____	Males: 5.1 6 (SD ± 0.4) Females: 4.5 6 (SD ± 0.4)	Males: 5.21 Females: 4.69	Range: M = 4.5–6.0 F = 4.1–5.1
HCT±SD (Percentage)	Males: 43.341 (SD ± 3.364 Females: 39.128 (SD ±2.801	Males:49.3 Females:44.2	43.625 (SD ± 3.775)	47.3 (SD ± 3.5)	Males: 48.3 (SD ± 3.4) Females: 42.0 (SD ±3.2)	Males: 46.6 Females: 41.5	Range: M = 42–51 F = 36–46
MCV±SD (fL/cell)	Males: 88.394 (SD ± 3.77) Females: 89.092 (SD ± 4.338)	Males:93.8 Females:93.6	85.08 (SD ± 5.7391)	_____	_____	Males: 89.3 Females: 89.5	Range: M = 80–96 F = 79–94
MCH±SD (pg/cell)	Males: 30.609 (SD ± 1.886) Females: 30.197 (SD ± 1.843)	Males:30.8 Females:30.497	28.244 (SD ± 2.1959)	_____	_____	Males: 30.0 Females: 29.3	Range: 27–33
MCHC±SD (g/dL RBCs)	Males: 34. 012 (SD ± 0.663) Females: 35.146 (SD ± 1.92)	Males:32.8 Females:32.4	32.218 (SD ± 1.9002)	_____	_____	Males: 33.3 Females: 32.7	Range: 33–36

The hematologic values of this study are in between those reported by the Ethiopia and Sudan studies. Knowing the fact that both countries are within the range of the Ethiopian plateau, where high altitude induces polycythemic changes, it is suspected that the participants of this study, Eritreans, have the same Hb and RBCs readings as that of Ethiopia (1979); however,thedifference with the study of 1999 may be attributed to the nutritional causes [13]. Our study has the advantage of recruiting both genders and adding a broader range of variables with a representative sample size (*n*=601). In this study, the microscopic examination was not performed; therefore we have no insight about the RBCs' descriptive remarks. According to Abbas et al. (2015), erythrocytes microscopy showed that 3% of the Sudanese blood donors exhibited anisocytosis (unequal RBCs sizes), 18% showed microcytic- hypochromic RBCs, and 2% showed macrocytic RBCs in their samples [4]. The study recommends a further population-based research of hematological parameters including erythrocytes microscopy with multi-regional recruitment of healthy blood donors throughout the country.

5. Conclusion

This descriptive cross–sectional study was performed at the National Blood Bank of Eritrea, where blood samples of 610 healthy voluntary blood donors were taken to be measured for the Hb level, RBCs count, and RBCs indices. The results were found to be within the normal range of the international reference value. The mean Hb level and RBCs count were recorded at values lower than those measured in Ethiopian donors and higher than the Sudanese, whereas the values differences with regard to gender might be due to physiological causes.

Declaration Section

Acknowledgements

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Ethical considerations

All study participants filled an informed consent to participate in the study. Ethical approval for the research was obtained from the Deanship of Orotta college of Medicine and health Sciences and the National Blood Transfusion Service (NBTS) of Eritrea.

Competing Interests

The authors declare that there are no competing interests.

Availability of Data and Material

Data recorded and collected for this study is available in Excel files and questionnaire papers.

Funding

None.

Authors'Contributions

FMAA and ETA designed the study; NYB and SAI performed the practical procedure and data collection; AKHK is the counsellor and the critical reviewer of the experiment; YSreviewed the draft for final approval; and OSA performed the statistical analysis and prepared the final manuscript.

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