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Hematological Profiles of Eligible Blood Donors at Kenyatta National Hospital, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine hematological profile of eligible blood donors at Kenyatta National Hospital (KNH), Kenya.
Study Design: Adopted a cross-sectional study.
Place and Duration of Study: Kenyatta National Hospital, between March 2021 and August 2021.
Methodology: This study recruited 202 eligible blood donors comprising of 173 males and 29 females aged 18-57 years. Blood samples (4ml) were drawn from donated units into ethylene diamine tetraacetic acid (EDTA) tube. Hematological parameters were estimated using a complete blood count (CBC) analyzer (Humacount 5D®). A total of eighteen hematological parameters were analyzed. These parameters included; red blood cell (RBC) count, hemoglobin concentration, RBC indices, white blood cell (WBC) count, absolute and differential WBC and platelet (PLT) count. Results were presented in medians and 95% interquartile ranges and compared using Mann–Whitney U test.
Results: The median counts for all hematological parameters were within the accepted reference ranges for the adult urban population in Kenya. The median and interquartile range for total red cell count was 4.9×10^6/µL [0.74], hemoglobin level was 14.3g/dL[1.8], hematocrit was 44.9% [5.1], white blood count was 4.9×10^3/µL [1.4] and platelet was 234×10^3/L [64]. Among the red cell parameters

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analyzed, male donors had a significantly higher RBC count (P<0.001), hematocrit (P=0.001) and hemoglobin (P<0.001) than female donors. Among white blood cell parameters analyzed, only lymphocytes (P=0.011) were significantly higher in female donors than male donors. Platelet count (P<0.001) was also significantly higher in females than male donors.

Conclusion: This study showed eligible donors at KNH had significant differences in red cell count, hematocrit, hemoglobin, lymphocytes and platelets between male and female donors. Additionally, it highlighted that some blood donors had hematological parameters below and above the recommended reference ranges. These findings support the need to review the current donor recruitment criteria recommending the inclusion of complete blood count in screening.

Keywords: Hematological parameters; reference ranges; eligible blood donor; Kenya.

1. INTRODUCTION

Assessment of hematological parameters is commonly used to diagnose blood disorders among individuals exposed to diverse environmental conditions. Reference values/ intervals are known to vary based on sex, age, altitude, and ethnicity [1]. Hematological profiles can also be affected by several factors, even in seemingly healthy individuals. These factors include; nutritional, body build, environmental factors, sex, ethnic background and genetic characteristics of study populations [2]. Thus, there are variations between acceptable reference ranges obtained from different populations. A previous study on the American donor population reported that African-Americans have lower average mean corpuscular volume (MCV), hematocrit and hemoglobin levels than their Caucasian compatriots living in the same environment, with the sex and age [3]. However, according to a transfusion research group report, the screening of hematological parameters is minimal during recruiting donors in French-speaking countries [4]. Adopting local reference ranges for hematological profiles is essential for donor screening, diagnosis, treatment, and follow-up.

The reference ranges used in donor recruitment in most African and Asian countries were borrowed from developed countries and may not apply in most geographical locations [5]. Implementing unsuitable hematological reference values may fail to determine an underlying disease or cause unessential further investigations [6]. Furthermore, previous studies in Africa and Asian countries documented lower hematological profiles than those from populations in developed countries [7,8,9]. Another report documented that some hematological parameters have significant variation at different stages of life. For instance, hematocrit (Hct), red cell count (RBC), and hemoglobin (Hb) are found to be higher at birth than at any other stage of life [10]. Elevated levels of these parameters gradually decrease at different rates in the following stages of life after birth. In some individuals, the red cells will turn hypochromic as a result of physiological iron deficiency anemia. Eventually, as age advances, the concentration of red cells and hemoglobin content will rise in adult levels [11].

Leucocytes are cellular elements responsible for body defense mechanisms [12]. They are broadly classified into granulocytes and agranulocytes based on the presence or absence of intracellular granules. The distribution and the number of leucocytes in the body fluctuate; however, each parameter has a specific percentage and specific reference range. The acceptable references ranges for the various WBC parameters are likely to change in response to infections, body mass index (BMI), sex, age and microbial threats [13]. A previous study on white blood cells counts among adults in the United States observed that the white population had significantly higher mean values for percent segmented neutrophils and absolute numbers than the black population. The study further observed the black population had a significantly higher absolute and percent lymphocyte numeric value than the whites. Among the white population, females had lower lymphocyte mean, and higher segmented neutrophil means than white males of comparable age [14]. Another study on the Saudi Arabian population observed that platelets values were lower than the African studies, the Caucasians and USA values. Though female platelet counts differed significantly from the male values, the main cause of the variation is yet to be established [15].

Due to variations in hematological parameters, the WHO [16] has suggested consideration of sex, age, ethnicity, and other local evidence

when formulating appropriate reference ranges for hematological parameters. Despite recommendations to regularly review references ranges based on local demographic factors, there is limited hematological profile among eligible blood donors in Kenya. The existing reference ranges were heavily borrowed from the American and European population over two decades ago, and they may not be appropriate to the Kenyan population. This study aimed to determine the hematological profiles of presumably healthy blood donors presenting to donate whole blood at Kenyatta National Hospital, Kenya.

2. METHODOLOGY

2.1 Study Area

This study was conducted at Kenyatta National Hospital, Blood Transfusion Unit (KNH-BTU). The facility is located in Nairobi County, the capital city of Kenya. It serves as the largest referral hospital providing specialized medical care to the country's population. This study started in March 2021 and ended in August 2021.

2.2 Study Design, Population, and Sampling Technique

A cross-sectional study design was used to target prospective blood donors presenting to donate whole blood at Kenyatta National Hospital. A systematic random sampling technique was usedto recruit 384 prospective blood donors. Participants were either allowed (eligible) or deferred for various reasons based on donor recruitment criteria. Only 202 blood donors aged 18 – 57 years were allowed to donate in this study.

2.3 Laboratory Procedures

Blood samples (4ml) were drawn from donated units into ethylene diamine tetraacetic acid (EDTA) tube. Total blood count was performed using HumaCount 5D® hematology analyzer. Eighteen hematological parameters, which included; red blood cell (RBC) count, hemoglobin concentration, RBC indices, white blood cell (WBC) count, absolute and differential WBC and platelet (PLT) count were measured. All blood samples were analyzed within 8 hours of collection.

2.4 Statistical Analysis

Socio-demographic data collected from consenting study participants were cleaned, sorted, coded, and keyed into Microsoft Excel then exported to SPSS version 20 for analysis. The variables collected were not normally distributed. Non-parametric data collected in this study were analyzed using the Mann Whitney U test. Medians and interquartile ranges (IQR) were used to describe and compare hematological parameters. Statistical significance level was set at a P-value of <0.05.

3. RESULTS

A total of 202 participants were allowed to donate whole blood based on donor recruitment criteria. Of these, 173 (86.6%) were males and 29 (14.4%) were female donors with a median age of 28 years. A total of eighteen hematological parameters were analyzed. Among these, the parameters for red blood cells were six, white blood cells (absolute and differential counts) were eleven, and one for platelets. This study found medians and interquartile ranges of all hematological parameters within the accepted reference ranges. However, some donors had hematological values below or above the recommended reference ranges, as shown in Table 1.

Table 2 shows male donors had a significantly higher red cell count (P<0.001), hematocrit (P=0.001) and hemoglobin (*P*<0.001) than female donors. Whereas, Table 3 and Table 4 show female donors had significantly higher lymphocyte (*P*= 0.011) and platelet count (*P*<0.001) compared to male donors.

4. DISCUSSION

The current study determined hematological profiles of whole blood donated at Kenyatta National Hospital, Nairobi, Kenya. Eighteen hematological parameters were determined and compared to reference ranges established for the adult urban population in Kenya [17]. The reference ranges used were derived from adult Kenyans aged 18 to 65 years residing in urban towns located in Nairobi, Kiambu, Thika, Kisii, and Nakuru. Previous studies had established that Kenyan hematological reference ranges were generally lower than those used in Europe and the American States [17,18]. The findings from the current study showed the median

counts for all parameters were within the accepted local reference ranges. This observation might be due to similarities in demographic characteristics among participants involved in this study. According to a comparison study done in Kenya, there was marked difference in some hematological reference values developed in Kericho and Kisumu counties [19]. This variation was attributed to the difference in ethnicity, geographical locations, and age group among the study participants.

Table 1. Comparison of hematological profiles of whole blood donated at Kenyatta National Hospital with local reference ranges

Parameter	Median (IQR) for males and female combined (N=202)	Median percentiles 2.5 - 97.5 (IQR)	Minimum	Maximum	Reference ranges
RBC (10^6/µl)	4.9 (.74)	4.1- 6.5	4.01	41.6	4.41-6.48
HB (10^6/µl)	14.3 (1.8)	12.7- 17.2	12.5	26.1	12.8-19.0
HCT (%)	44.9 (5.1)	38.8- 54.4	36.4	67.4	38-55
MCV (fL)	90 (5)	80.3 - 97.9	75.2	99.5	75.7-95.6
MCH (pg)	29.4 (1.9)	25.5- 31.8	22.5	33.8	24.8-33.8
MCHC (g/dl)	33(1.4)	30.7- 35.1	29.9	36.8	32.2-35.2
WBC (10^3/µl)	4.9 (1.4)	3.1- 7.9	2.7	9.6	3.08-7.83
Lym # (10^3/µl)	2.1 (.67)	1.2- 3.5	1.0	4.1	1.29-3.40
Lym%(10^3/µl)	41.9 (12.1)	28.7- 59.4	20.1	69.8	27.2-60.0
Neu # (10^3/µl)	2.3 (.89)	1.0-4.5	0.46	6.5	1.05-4.08
Neu % (10^3/µl)	47.8 (12.1)	29.8- 64.8	14.3	72.3	28.0-63.3
Mon%(10^3/µl)	6.7 (3.1)	3.3 -11	1.9	12.5	3.4 -13.3
Mon# (10^3/µl)	.35 (.7)	0.2- 0.6	0.08	0.78	0.14-0.74
Eos %(10^3/µl)	2.8 (2.8)	0.8- 10	0.2	22.5	1.1-11.9
Eos # (10^3/µl)	0.14 (.14)	0.03-0.5	0.01	1.2	0.04-0.59
Bas % (10^3/µl)	0.3 (.2)	0.1- 0.7	0.0	1.0	0.30-1.10
Bas # (10^3/µl)	0.01(0.1)	0.0- 0.04	0.0	0.05	0.0-0.2
PLT (10^3/µl)	234 (64)	128- 339.4	112	412	144-409

KEY: # = absolute count, % = percentage, IQR= interquartile range, RBC = red blood cells (erythrocytes), Hb = Hemoglobin, MCH = mean corpuscular hemoglobin, MCV = mean corpuscular volume, WBC = white blood cells (leucocytes), Lym= lymphocytes, Net= neutrophils, Mon= Monocytes, Eos= eosinophils, Bas= basophils and PLT= platelet

Table 2. Comparison of red blood cell parameters donated at Kenyatta National Hospital between males and females

Erythrocytes parameters	Gender		Mann Whitney U test statistic		
	Female (N=29) Median (IQR)	Male (N=173) Median (IQR)	U –value	Z score	P Value
RBC (10^6/µl)	4.96 (0.5)	5.06 (0.7)	1446.5	-3.65	0.000*
HCT (%)	42.4 (5.0)	45.3 (5.0)	1530.5	-3.36	0.001*
HB (g/dl)	13.3 (1.5)	14.3 (1.7)	1466.4	-3.58	0.000*
MCV (fL)	90.8 (4.3)	89.8 (5.1)	2050	-1.572	0.116
MCHC (pg)	33.1 (1.2)	32.9 (1.5)	2412.5	-0.33	0.742
MCH	29.3 (1.6)	29.4 (1.8)	2322.0	-0.641	0.521

*KEY: N= number, IQR= interquartile range, RBC = red blood cells, Hb = Hemoglobin, HCT= Hematocrit, MCH = mean corpuscular hemoglobin, MCHC mean corpuscular hemoglobin concentration, MCV = mean corpuscular volume, * statistically significantly at P ≤ 0.05.*

Table 3. Comparison of white blood cells parameters donated at Kenyatta National Hospital between males and females

Leucocyte parameters	Gender		Mann Whitney U test statistic		
	Female (N=29) Median (IQR)	Male (N=173) Median (IQR)	Z score	U – value	P Value
WBC (10^3/µl)	5.34 (1.3)	4.91(1.3)	-1.91	1952	0.056
Lymphocytes # (10^3/µl)	2.37 (0.5)	2.06 (0.7)	-2.55	1765	0.011*
Lymphocytes % (10^3/µl)	43.1 (11.0)	41.8 (12.0)	-0.66	2315	0.507
Neutrophil # (10^3/µl)	2.34 (1.1)	2.25 (0.88)	-0.95	2231	0.341
Neutrophil % (10^3/µl)	47.3 (12.6)	47.1 (12.1)	-0.11	2476.5	0.913
Monocytes # (10^3/µl)	0.36 (0.3)	0.35 (0.53)	-0.72	2401	0.469
Monocytes % (10^3/µl)	6.3(3.7)	6.8 (3.1)	-0.36	2297.4	0.712
Eosinophils # (10^3/µl)	0.16(0.2)	0.13 (0.1)	-0.88	2433	0.379
Eosinophils % (10^3/µl)	3.1 (3.3)	2.7 (2.5)	-0.26	2253	0.712
Basophils # (10^3/µl)	0.01(0.0)	0.01(0.1)	-0.76	2494	0.446
Basophils % (10^3/µl)	0.3 (0.2)	0.3 (0.2)	-0.05	2286.5	0.962

*KEY: # = absolute count, % = percentage, N= number, IQR= interquartile range, WBC= white blood cells (leucocytes), * statistically significantly at P ≤ 0.05*

Table 4. Platelet values for whole blood donated at Kenyatta National Hospital in males and females

Parameter	Gender		Mann Whitney U test		
	Female (N=29) Median (IQR)	Male (N=173) Median (IQR)	Z score	U – value	P Value
PLT (10^3/µl)	262 (57)	225 (62)	-3.63	1450	0.000*

*KEY: PLT = platelet, N= number, IQR= interquartile range, * statistically significantly at P ≤ 0.05*

In the present study, some donors recorded hematological parameters below and above reference ranges. Similar observations were made by a study on the Tanzanian blood donor population; this variation was attributed to the difference in donor demographic, environmental conditions, and sample size [1]. It is essential to adopt reference ranges that are population or region-specific to improve accuracy in interpreting laboratory reports in the context of blood donor recruitment. In Africa, there is a high burden of malaria, tuberculosis, HIV, non-communicable diseases, and emerging infectious diseases, resulting in an acute blood shortage [20]. As such, the adoption of local population-specific hematological reference ranges is of great importance in diagnosing blood disorders, treatment, and follow-up [1]. This study validates some of the findings done in western Kenya on laboratory reference ranges that observed if US-derived reference ranges were used, more than 58.0% of participants in a clinical trial would have been deemed unfit [21]. Another study on HIV vaccine trials in Nairobi, Kenya, showed that 61.4% of the participants were excluded because of abnormal hematological and biochemical laboratory results, with neutropenia as the leading cause [22].

The current study established that male blood donors had significantly higher hemoglobin concentrations, red blood cell counts, and hematocrit values compared to female donors. Similar findings were reported in other studies worldwide, including African countries [1,23,24,25,26,27]. Comparable reports have been made in studies done in Kenya [17,18,19]. The marked difference in hematocrit, hemoglobin, and RBC counts among male and female donors is mainly attributed to the testosterone hormone's effect on erythropoiesis and menstruation in females [1,19]. A different study reported higher red cell indices in male donors are attributed to body size and mass of muscle fibers. In the early stages of human development, no significant difference can be seen in both genders in hemoglobin or red cell count [21]. It is only after the onset of menstruation that the differences emerge [23].

Female donors had significantly higher lymphocyte count than male donors among white blood cell parameters analyzed. Although not significant other leucocytes subsets were slightly higher in female than male donors. These findings agree with other studies [17,23,24,28,29]. Difference in leucocyte profiles

between women and men may be attributed to innate variability in immune cell behavior [30]. Another study reported women had a greater risk for adverse responses to vaccines, viral infections and autoimmune disorders, while exhibiting cell-mediated and humoral responses as compared to men. The current findings may be a result of contraceptive use among female donors [24]. Hormonal differences and variation in triglycerides, cholesterol, and body fat distribution have also contributed to variation in leucocyte parameters between male and females [31]. Another study observed that Kenyan females had higher monocytes counts than males, a phenomenon that they attributed to exposure to environmental conditions and endemic parasitic infections [18].

The current study observed that female blood donors had a significantly higher platelet count than male donors. Other researchers made similar observations [17,18,24,28]. The platelet count variation can been associated with the difference in hormonal types and their concentration in the different gender. It may also occur due to thrombopoietin release in response to menstruation stimulation [15]. Additionally, some studies have documented an inverse relationship between platelet count and hemoglobin concentrations [32,33]. Some studies done in African countries have reported lower platelet values than those from Western countries. The cause of this variation is unknown, but genetics, malaria, environmental and dietary factors have been suggested as the probable cause [34].

4. CONCLUSION

In conclusion, the observations made in this study are in agreement with findings of previous studies within and outside country (Kenya), which shows significant differences in some analyzed hematological indices between male and female donors. Importantly, it highlights differences in parameters such as red cell count, hematocrit, hemoglobin, lymphocytes and platelets that are crucial in blood component preparation. Some blood donors had hematological parameters below and above the recommended reference ranges, suggesting that some participants could be erroneously enrolled further supporting the need to review donor recruitment criteria.

CONSENT

All eligible study participants consent to a written informed consent detailing the nature of the study.

ETHICAL APPROVAL

The Kenyatta National Hospital –University of Nairobi (KNH-UoN) Ethical Review Committee approved this study (P548/10/2020). Permission to conduct this study was sought from Kenyatta National Hospital management.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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