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Evaluating Indicators and Alterations of Blood Cell Among Individuals Referred to the City Hospital in 2023

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ABSTRACT

Introduction: Changes in blood cell parameters can provide valuable insights into an individual's health status. This study aimed to evaluate blood cell alterations and indicators among individuals referred to a city hospital in 2023.

Materials and Methods: A retrospective analysis was conducted on patients' medical records who visited the city hospital in Kabul, Afghanistan, in 2023. Complete blood count (CBC) data, including red blood cells (RBCs), white blood cells (WBCs), and platelet counts, were collected and analyzed using SPSS (24.0). Deviations from the normal reference ranges were identified, and the prevalence of various blood cell alterations was determined.

Results: The mean RBC, hemoglobin, and hematocrit levels were 1.18 million/cumm, 1.29 g/dL, and 1.51%, respectively. Most participants had normal RBC (84.9%), hemoglobin (71.6%), and hematocrit (56.3%) levels. The mean MCV, MCH, and MCHC were 1.30 fL/red cell, 1.36 pg/red cell, and 1.14 g/dL RBC, with abnormalities observed in 29.0%, 34.1%, and 11.8% of participants. The mean total WBC count was 9,486.50/mm3, with normal differential counts in the majority. The mean platelet count was 286,475.62/mm3, with 85.5% having normal levels.

Conclusion: This study provides insights into the alterations and indicators of blood cells among individuals referred to the city hospital in 2023. The findings highlight the importance of regular blood cell monitoring and the need for comprehensive clinical assessment to identify and manage potential health issues. These results can contribute to the development of targeted interventions and improved patient care.

Keywords: Complete Blood Count, Red Blood Cell, White Blood Count, Platelet

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1. Introduction

The human adult circulatory system contains over 5 liters of blood, which serves crucial functions, including transporting oxygen and nutrients, removing waste, delivering immune cells to fight infections, and forming clots to prevent blood loss. The circulatory system dynamically adjusts blood distribution to meet the body's needs, such as increasing blood flow and oxygen supply during exercise or targeting immune cells to infection sites (1). Specifically, whole blood can be partitioned into distinct cellular and acellular (plasmatic) components (2). The cellular elements of whole blood can be classified into three main categories, each with critical physiological functions. The primary physiological function of erythrocytes, or red blood cells (RBCs), is the transport of oxygen from the lungs to the body's tissues, thereby supplying all cells with the necessary oxygen for cellular respiration. However, within the circulatory system, RBCs are constantly exposed to both endogenous and exogenous sources of reactive oxygen species (ROS), which can potentially damage the RBCs and impair their oxygen-carrying capacity. To mitigate the detrimental effects of oxidative stress, RBCs possess an extensive antioxidant system, comprising not only non-enzymatic low-molecular-weight antioxidants, such as glutathione and ascorbic acid, but also enzymatic antioxidants, including superoxide dismutase, catalase, glutathione peroxidase, and peroxiredoxin-2 (PRDX-2). This multifaceted antioxidant network serves to protect the structural and functional integrity of RBCs, ensuring their continued efficiency in delivering oxygen to the body's cells (3). Leukocytes, or white blood cells, constitute the immune system, encompassing various specialized cell types that defend against pathogens and foreign substances (4). Thrombocytes, also known as platelets, are essential for hemostasis as they aggregate at sites of vascular injury to form clots and prevent excessive blood loss. The ability to fractionate and isolate these distinct blood cell populations facilitates their targeted therapeutic application in clinical settings, leveraging the unique capabilities of each blood cell type to address specific medical needs (5). The cellular and non-cellular components of blood play a multifaceted role in both human health and disease. On the one hand, dysfunctions or abnormalities within the blood system can contribute to the pathogenesis of various conditions, such as malignancies, autoimmune disorders, viral infections, and inflammatory syndromes. However, the inherent properties of blood components also make them valuable targets and vehicles for therapeutic interventions addressing these very same pathologies. In 2022, researchers conducted assessments to evaluate the safety and efficacy of diverse blood-derived therapies as potential treatment modalities for patients experiencing the aforementioned disease states, leveraging the unique capabilities of blood constituents to combat these complex medical challenges (6). This study aims to assess and analyze the changes and markers related to blood cells in individuals who have been referred to the city hospital in Kabul, Afghanistan. Afghanistan, where this research is set, faces significant challenges in human development and economic progress. With a ranking of 171 out of 188 countries on the UN Human Development Index, it has the lowest ranking outside of Sub-Saharan Africa, indicating widespread poverty and a lack of

access to essential services. In 2011–2012, over a third of the population lived below the poverty line, and economic growth has been slow. The country's economy is heavily reliant on agriculture, which accounts for 40% of the labor market and a quarter of GDP, and 80% of the population, including 90% of the poor, resides in rural areas, underscoring the predominantly agrarian nature of Afghan society (7).

2. Methods

2-1. Study Design and Patient Population

This study was conducted in 2023 at the City Hospital in Kabul, Afghanistan, and involved individuals referred for either routine health checks or evaluations of suspected medical conditions. To maintain the integrity of the findings, the researchers excluded participants with a history of chronic diseases, recent blood transfusions, or the use of medications that could affect blood cell parameters, as these factors could have skewed the investigation of blood cell characteristics within the study population.

2-2. Blood sample collection and analysis

Venous blood samples were collected from each participant and placed into tubes containing the anticoagulant EDTA. These blood samples were then analyzed using an automated hematology analyzer, specifically the Model BC-3000 PLUS from Mindray. This analyzer was used to assess a comprehensive panel of red blood cell parameters, including the red blood cell (RBC) count, hemoglobin (Hb) concentration, hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC). Additionally, the platelet (PLT) count was determined. The analysis also encompassed the white blood cell (WBC) count and differential, providing the absolute and relative counts of neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

2-3. Statistical Analysis

Descriptive statistics were calculated for all blood cell parameters, including means, standard deviations, medians, and interquartile ranges, as appropriate. Differences in blood cell indices between male and female participants were assessed using independent-sample t-tests or Mann-Whitney U tests, depending on the normality of the data distribution. All statistical analyses were conducted using SPSS (version 24.0).

3. Results

The study population consisted of 4,373 individuals, for whom comprehensive complete blood count (CBC) parameters were analyzed. The study population's RBC and WBC parameters are summarized in Table 1. The mean total RBC count was 1.18 million/cumm, with a median of 1.00 million/cumm and a standard deviation of 0.452 million/cumm. The mean hemoglobin level was 1.2870 g/dL, with a median of 1.0000 g/dL and a standard deviation of 0.45843 g/dL. The mean hematocrit was 1.51%, with a median of 1.00% and a standard deviation of 0.623%. The mean corpuscular volume (MCV) was 1.30 fL/red cell, with a median of 1.00 fL/red cell and a standard deviation of 0.475 fL/red cell. The mean corpuscular hemoglobin (MCH) was 1.36 pg/red cell, with a median of 1.00 pg/red cell and a standard deviation of 0.497 pg/red cell. The mean corpuscular hemoglobin

concentration (MCHC) was 1.14 g/dL RBC, with a median of 1.00 g/dL RBC and a standard deviation of 0.378 g/dL RBC.

The mean red cell distribution width (RDW) was 1.33%, with a median of 1.00% and a standard deviation of 0.741%. The mean total WBC count was 9,486.50 per cubic millimeter, with a median of 8,600.00 and a standard deviation of 4,745.60. Examining the differential white blood cell percentages, the mean neutrophil percentage was 62.29%, with a median of 63.00% and a standard deviation of 13.71%. The mean lymphocyte percentage was 28.45%, with a median of 28.00% and a standard deviation of 13.25%. Moving to the other white blood cell types, the mean eosinophil percentage was 3.61%, with a median of 4.00% and a standard deviation of 1.35%. The mean monocyte percentage was 5.62%, with a median of 5.00% and a standard deviation of 1.70%. Lastly, the mean basophil percentage was 0.48%, with a median of 0.00% and a standard deviation of 0.14%.

Table 2 presents the frequency and percentage distribution of various RBCs, WBCs, platelets, and related parameters within the study population. For RBC level, the majority (84.9%) had a normal range (4.1–5.9 × 10^12/L), while 12.3% had low RBC levels (<4.1 × 10^12/L) and 2.9% had high RBC levels (>5.9 × 10^12/L). Regarding Hb levels, 71.6% were within the normal range (12–16 g/dL), 28.2% had anemia (<12 g/dL), and 0.3% had polycythemia (>16 g/dL). For HCT percentage, 56.3% were in the normal range (40–54%), 36.8% had low HCT (<40%), and 6.9% had high HCT (>54%). The mean MCV was normal (80–100 fL/red cell) in 70.3% of the population, low (<80 fL/red cell) in 29.0%, and high (>100 fL/red cell) in 0.7%. The mean MCH was normal (27–34 pg/red cell) in 65.0% of the population, low (<27 pg/red cell) in 34.1%, and high (>34 pg/red cell) in 0.9%. The mean corpuscular MCHC was normal (32–36 g/dL RBC) in 87.1% of the population, low (<32 g/dL RBC) in 11.8%, and high (>36 g/dL RBC) in 1.1%. Finally, the red cell distribution width (RDW) was normal (11–16%) in 83.6% of the population and high (>16%) in 16.4%.

The normal range for total WBC count was defined as 4.5 to 11.0 × 10^9 cells/L, and 3,258 individuals (74.5%) were found to have a WBC count within this normal range. However, 70 individuals (1.6%) exhibited a low WBC count below 4.5 × 10^9 cells/L, while 1,045 individuals (23.9%) had a high WBC count above 11.0 × 10^9 cells/L. The normal range for neutrophil percentage was set at 45-75%, and 3,338 individuals (76.3%) were within this reference range. Conversely, 253 individuals (5.8%) had a low neutrophil percentage below 45%, and 782 individuals (17.9%) had a high neutrophil percentage above 75%. For lymphocyte percentage, the normal range was defined as 20–45%. In this population, 2,786 individuals (63.7%) had a lymphocyte percentage within the normal range. However, 1,183 individuals (27.1%) exhibited a low lymphocyte percentage below 20%, and 404 individuals (9.2%) had a high lymphocyte percentage above 45%. Regarding the other WBC subtypes, all 4,373 individuals (100%) had normal eosinophil and monocyte percentages. Additionally, 4,363 individuals (99.8%) had normal basophil percentages between 0.0-0.1%, while 10 individuals (0.2%) had a high basophil percentage above 0.1%.

The mean platelet count was 286,475.62 per cubic millimeter. The median platelet count was 275,000.00 per cubic millimeter. Half the participants had a platelet count above 275,000, and half had a count below 275,000.

The standard deviation of 101,782.87 indicates a substantial degree of variability in platelet counts across the study group. The normal reference range for PLT count is generally considered to be between 150,000 and 400,000 platelets per cubic millimeter (per cumm) of blood. 3,738 participants (85.5%) had a platelet count that fell within the normal range of 150,000 to 400,000 per cm3. 194 participants (4.4%) had a platelet count below 150,000 per cm3, which is considered low. 441 participants (10.1%) had a PLT count above 400,000 per cumm, which is considered high.

4. Discussion

Blood is a vital, specialized circulatory tissue composed of cells suspended in plasma. Its primary function is to maintain homeostasis, the delicate physiological balance essential for proper bodily function. As a complex biological fluid, blood transports critical components throughout the body, regulating fundamental life-sustaining processes. The cellular constituents suspended in the plasma matrix—red blood cells, white blood cells, and platelets—each play distinct roles in preserving the body's internal stability and equilibrium (8). The CBC, or hemogram, is a comprehensive laboratory test panel that examines the cellular components of the blood, including RBCs, WBCs, and PLTs (9). The analysis of blood provides a valuable window into the body's metabolic status, allowing for the investigation of various constituents and metabolites. A blood examination plays a crucial role in elucidating the physiological, nutritional, and pathological conditions of an organism (10, 11). Examining the constituents of blood can furnish critical information for the diagnosis and prognosis of diseases. The composition of blood components varies depending on the physiological state of health or disease (12).

The results of this study show a wide range of values across the different RBC, WBC, and PLT measures examined. Erythrocytes, or RBCs, function as the primary transporters of hemoglobin, the oxygen-binding metalloprotein. This hemoglobin within the red blood cells undergoes a reversible reaction with the oxygen carried in the blood, forming oxyhemoglobin during the respiratory process (13). In this study, the majority of the population (84.9%) had normal RBC counts, while 12.3% had low RBC levels and 2.9% had high RBC levels. This suggests that a relatively small proportion of the population may have underlying conditions affecting red blood cell production or destruction. The hemoglobin and hematocrit levels displayed a similar pattern, with most individuals (71.6% and 56.3%, respectively) falling within the normal range, but 28.2% exhibited anemia (<12 g/dL Hb) and 0.3% exhibited polycythemia (>16 g/dL Hb). Previous studies have found that in Afghanistan, the prevalence of anemia among adults was around 20%, with over half of the anemic women being moderately or severely affected.

Table 1. Median and mean and standard deviation of blood parameters of participants

Parameter	Mean	Median	Standard deviation
Total RBC count million / cumm	1.18	1.00	.452
HB (g/dl)	1.2870	1.0000	.45843
Hct (%)	1.51	1.00	.623
Mcv (fl/red cell)	1.30	1.00	.475
Mch (pg/red cell)	1.36	1.00	.497
MCHC (g/dl R.B.C)	1.14	1.00	.378
Rdw (%)	1.33	1.00	.741
Total WBC count (PER cumm)	9486.5033	8600.0000	4745.60037
Neutrophil (%)	62.2932	63.0000	13.70752
Lymphocyte (%)	28.4546	28.0000	13.25111
Eosinophil (%)	3.6051	4.0000	1.34924
Monocyte (%)	5.6241	5.0000	1.69817
Basophil (%)	.0048	.0000	.13935
Platelete	286475.6231	275000.0000	101782.87170

The prevalence was similar between pregnant (19%) and non-pregnant (20.5%) women. However, when accounting for the higher altitude of the provincial capital where this study was conducted, the adjusted anemia prevalence estimate increases substantially to approximately 30%, indicating a more severe burden of this condition in the study population (15). Studies have found that 12.6% of men in Malaysia are anemic, and the prevalence is three times higher among older men compared to their younger counterparts (13). The prevalence of anemia is reported at 25% among adult men and 31% among adolescent boys (aged 15–19 years) in India. Notably, the prevalence of anemia has increased significantly among adolescent boys (aged 15–19 years) in 23 states, as well as among adult men (aged 15–49 years) in 17 states across the country (16). According to the World Health Organization, if the prevalence of anemia in a population falls between 20 and 39%, the burden of anemia is considered a moderate public health concern (16). Examining the red cell indices, the majority had normal MCV (70.3%), MCH (65.0%), and MCHC (87.1%), indicating most individuals did not have significant abnormalities in red blood cell size or hemoglobin content. However, significant minorities displayed low MCV (<80 fL) and low MCH (<27 pg), potentially indicative of microcytic anemia. The red cell distribution width (RDW) was elevated (>16%) in 16.4% of the population, suggesting increased variation in red blood cell size for these individuals.

Turning to the WBC parameters, 74.5% of the population had a normal total WBC count, while 23.9% exhibited leukocytosis (>11.0 x 10^9/L) and 1.6% had leukopenia (<4.5 x 10^9/L). The differential WBC percentages showed that most individuals fell within the normal ranges for neutrophils (76.3%), lymphocytes (63.7%), eosinophils (100%), monocytes (100%), and basophils (99.8%).

Table 2. Frequency and percentage distribution of various RBCs, WBC, plateles,

and related parameters within the study population.

Parameter	Frequency	Percent
RBC		
Normal (4.1-5.9 × 10^12/L)	3712	84.9
Low (<4.1 × 10^12/L)	536	12.3
High (> 5.9× 10^12/L)	125	2.9
Hb level		
Normal (12-16 g/dl)	3130	71.6
Animia (<12 g/dl)	1231	28.2
Polycythemia (>16 g/dl)	12	.3
HCT percentage		
Normal (40-54%)	2462	56.3
Low (<40%)	1608	36.8
High (>54%)	303	6.9
MCV		
Normal (80-100 fl/red cell)	3075	70.3
Low (<80 fl/red cell)	1268	29.0
High (>100 fl/red cell)	30	.7
MCH		
Normal (27-34 pg/red cell)	2842	65.0
Low (<27 pg/red cell)	1492	34.1
High (>34 pg/red cell)	38	.9
MCHC		
Normal (32-36 g/dl RBC)	3807	87.1
Low (<32 g/dl RBC)	518	11.8
High (>36 g/dl RBC)	48	1.1
RDW		
Normal (11-16%)	3656	83.6
High (>16%)	717	16.4
WBC		
Normal (4.5 to 11.0 × 109/L)	3258	74.5
Low (<4.5 × 109/L)	70	1.6
High (>11.0 × 109/L)	1045	23.9
Neutrophil		
Normal (45-75%)	3338	76.3
Low (<45%)	253	5.8
High (<75%)	782	17.9
Lymphcyte		
Normal (20-45%)	2786	63.7
Low (<20%)	1183	27.1
High (>45%)	404	9.2

Eosinophil		
Normal (0.1-0.4%)	4373	100.0
Monocyte		
Normal (0.1-0.6%)	4373	100.0
Basophil		
Normal (0.0-0.1%)	4363	99.8
High (>0.1%)	10	0.2
Platelete		
Normal (150000-400000 per cumm)	3738	85.5
Low (<150000 per cumm)	194	4.4
High (>400000 per cumm)	441	10.1

However, concerning minorities displayed abnormal percentages, potentially indicative of underlying inflammatory conditions, infections, or hematological disorders. A study has reported that the prevalence of leukopenia, defined as a white blood cell count below 4,000 cells/mm3, is found to be between 22% and 41.8% of the cases examined (18).

Finally, the platelet count analysis revealed that the majority of participants (85.5%) had a normal platelet count between 150,000 and 400,000/cum. However, 4.4% had thrombocytopenia (<150,000/cumm) and 10.1% had thrombocytosis (>400,000/cumm), which could predispose these individuals to bleeding or clotting complications, respectively. The incidence rate of primary thrombocytosis is relatively low, with reports suggesting a range of 1.0 to 2.5 individuals per 100,000 per year (19). Overall, this comprehensive CBC analysis provides valuable insights into the distribution of hematological parameters within the study population. The findings highlight that while most individuals exhibit normal values, non-negligible proportions display abnormalities that may warrant further clinical investigation and management. These results can inform our understanding of common hematological conditions and their prevalence in this population (20).

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