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Exploring hematological diversity, a comprehensive study of CBC variations among the population of Tehsil Kot-Momin Sargodha

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ABSTRACT

BACKGROUND & OBJECTIVE: A complete blood count hematological variations are very crucial for the diagnosis and management of various diseases, which may vary from regional levels in different populations, as in Tehsil Kot-Momin of the Sargodha region of Punjab province, depending upon the environmental, genetic, and lifestyle factors. Although it has distinct population characteristics, comprehensive studies focusing on the hematological profiles of this region are sparse. The purpose of this study is to ascertain the diversity and patterns observed in the complete blood count within the population of Tehsil Kot-Momin, Sargodha.

METHODOLOGY: A comprehensive collection of 401 CBC samples was meticulously acquired from individuals at the Medina Medical Complex in Kot-Momin, Sargodha, subsequent to securing verbal informed consent. An observational cross-sectional study with subsequent research activities was conducted at Rai Medical College, Sargodha, post-receipt of sanction from the institutional ethical review committee. Our data was collected during the month of January and February 2024 and thoroughly analyzed on SPSS version 27.

RESULTS: The association of hematological variables showed significant gender dependence of hemoglobin, RBC, hematocrit, platelets, and MP counts. Males showed raised levels of hemoglobin with RBCs and hematocrit values as compared to females, who had higher platelet counts. There is no significant differential association found in WBC, MCV, and MCH with MCHC, and PCT.

CONCLUSION: The study concludes these findings, which underscore the potential influence of biological and physiological factors on blood profiles, emphasizing the need for personalized approaches in the interpretation of hematological data for clinical or diagnostic purposes.

KEYWORDS: Kot-Momin, Hematology, Anemia, Hematocrit, Population.

INTRODUCTION

Kot-Momin district of the Sargodha Punjab region is known for its diverse demography and vibrant culture. It is situated in the heart of Punjab, Pakistan. Census 2017 described its population as 451978 [1].

Different studies highlighted in surveys and medical research the diversity of hematological CBC variation in different communities, which focused on its importance for public health in this region of Sargodha. CBC is widely used and has an extensive and basic association of blood disorders with normal physiological and pathological conditions. It offers details about red blood cells, hemoglobin, white blood cells, hematocrit, and platelets. Variations in CBC parameters can signal a wide spectrum of health conditions, ranging from nutritional deficiencies to infectious diseases and hematologic disorders. The Complete Blood count (CBC) and differential tests are commonly prescribed in clinical assessments conducted in diagnostic laboratories across all age groups, which include different variables like hemoglobin, red blood cells, white blood cells, and platelet count. CBC with its differential counts demanded for getting particular information regarding white blood cells [2-4].

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Due to the lack of baseline reference range values of CBC in the Pakistani population, the reference ranges from international databases were taken as reference ranges for comparison. [5, 6].

Different countries have made lots of efforts to provide accurate reference ranges for their regions, like Iran and India [7,8]. Multiple factors like diet, lifestyle, genetic predispositions, and environmental exposures display an array of CBC parameter variations also in the Kot-Momin population. Local health authorities charted the reference variations with collaborative efforts with different medical research studies for the Kot Momin population, and in this region, these significant associations have a tremendous effect on health policies. Primary food awareness among the communities of Kot Momin region is required to educate on nutritional deficiencies with iron-rich diets to prevent them from anemia, and thalassemia carrier's high incidence is also required for genetic counseling and screening programs for the benefit of the community. It is also added that to reduce pollution we have to control the usage of agricultural and industrial hazards, which requires strict regulations for a better environment, which leads to better effects on hematological blood cells. It is also pertinent to mention here that for good hematological parameters, the community must have improved their lifestyles and daily routines of exercise with cessation of smoking.

For early detection and prognosis of diseases, which include anemia, infections, and various blood, cardiovascular, and rheumatological disorders, and COVID-19 diseases can be pertinent for genetics, environmental, and public health; hence, given all these facts, this study was initiated to rule out the conditions in specific populations with the importance of CBC [9-13]. Its early detection helps in reducing the disease burden on the community. This study represents the first of its kind within the underdeveloped Kot-Momin region of Sargodha, documenting variations in hematological and biochemical parameters among patients, as well as the severity of diseases observed.

METHODOLOGY

A total of 401 CBC samples were collected from Madina Clinical Laboratory in Kot-Momin, Sargodha. Verbal informed consent was obtained from the patients, and the study was conducted at Rai Medical College, Sargodha. Prior to the commencement of further analysis, the study received approval from the institutional ethical review committee No. RMCS/ERC/09/24 dated January 6, 2024.

The non-probability convenience sampling method was adopted, and its data was collected in January 2024 and February 2024. An automatic analyzer was used for results at Madina Clinical Laboratory within the premises of Madina Medical Complex, located at Kot Momin Sargodha, and samples were taken after obtaining their informed consent in anti-coagulant vials. CBC parameters, including hemoglobin, RBC, and platelet count with HCT, MCV, and MCHC, were analyzed for the early detection of different forms of anemias and nutritional deficiency anemias. An independent t-test was applied by using SPSS version 27, with a 95% confidence interval with a p-value of 0.05 considered significant. Residents of Tehsil Kot-Momin, Sargodha, aged 18 years and above who provided informed consent and are free from chronic illnesses affecting hematological parameters were included in the study, and those who were non-residents, individuals below 18 years, those who did not consent, and individuals with chronic illnesses like anemia, leukemia, or other blood disorders, and pregnant women were excluded from the study.

RESULTS

We divided the dataset of 401 individuals into 176 males and 225 females. This distribution indicates a slightly higher representation of females (56%) compared to males (44%) within the sample. The average age of the individuals is 31.30 years, with a standard deviation of 14.56 years. This indicates a relatively wide age range within the sample. Table 01 of the independent samples t-test reveals significant differences in several hematological parameters between the two groups. Which showed a significant difference in hemoglobin levels between the groups, with a mean difference of 1.22498 p-values < 0.005. Men had higher average hemoglobin levels of 12.39±2.60 compared to women's 11.17±1.79, A highly positive t-value of 5.566 indicated statistically significant results reflecting gender-based physiological differences, and this result proposes that higher hemoglobin levels among one group may be due to differences in oxygen-carrying capacity or an underlying health condition. A stark contrast was observed in WBC counts, with women showing an unusually high mean of 10.03 ± 7.68 due to extreme values, whereas men had a lower average of 9.18 ±3.68. White blood cells showed a negative t-value of -1.345, which indicated no significant modification between the groups (p = 0.179). The t-value is small, which suggests that the difference between the genders is minor. Such results highlighted that the immune response and potential for infection or inflammation are similar across both groups. Men also exhibited higher RBC counts 5.37±0.77 than women 4.91±0.68.

Total Red Blood Cells (RBC) showed a significant difference in total red blood cell count with a mean difference of 0.45299 (p < 0.001) and raised positive t-value t = 6.175, which also supports its significance. This observation helps to understand variations in erythropoiesis, or the body's capacity to produce red blood cells, between the groups. The mean HCT value was higher in men at 39.53±8.38 compared to women at 35.28±5.64. Hematocrit (HCT) showed a significant difference in hematocrit levels (mean difference = 4.25202, p-value = 0.000), along with the raised levels of t-value t = 6.055, which helps to indicate that the proportion of blood volume occupied by red blood cells varies significantly between the groups. Such results of hematocrit may affect the oxygen-carrying capacity and blood viscosity. Mean corpuscular volume (MCV) showed an insignificant mean difference in MCV 72.99 ±10.6 in men and in females 72.00± 8.89 with p < 0.313 and a t-value very close to 1, suggesting a small difference between males and

females, which may also highlight similar average sizes of red blood cells amongst groups and suggest that the results of both groups do not differ in causes of macrocytic or microcytic anemia. Mean corpuscular volume (MCV) was slightly higher in males as compared to women, whereas mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) levels were analogous between the genders.

Table-I: Male and Female Hematological Comparative Analysis.

Variables	Groups	Mean±SD	t	P-value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Hemoglobin	Male	12.39±2.60	5.566	0.001	1.22498	0.22007	0.79234	1.65763
	Female	11.17±1.79						
WBC	Male	9.18±3.68	-1.345	0.179	-0.84546	0.62853	-2.08110	0.39018
	Female	10.03±7.68						
Total RBC	Male	5.37±0.77	6.175	0.001	0.45299	0.07336	0.30876	0.59721
	Female	4.91±0.68						
HCT	Male	39.53±8.38	6.055	0.001	4.25202	0.70220	2.87155	5.63250
	Female	35.28±5.64						
MCV	Male	72.99±10.6	1.011	0.313	0.98874	0.97834	-0.93462	2.91209
	Female	72.00±8.89						
MCH	Male	22.93±3.96	0.618	0.537	0.22878	0.37032	-0.49924	0.95680
	Female	22.70±3.44						
MCHC	Male	31.42±2.75	-0.540	0.590	-0.17310	0.32067	-0.80351	0.45730
	Female	31.58±2.75						
Platelets	Male	262.93±96.6	-2.633	0.009	-24.84152	9.43398	-43.3880	-6.29499
	Female	287.77±91.4						
PCT	Male	0.29±1.26	-0.044	0.965	-0.00531	0.11946	-0.24015	0.22954
	Female	0.30±1.11						
MPV	Male	7.86±0.85	-1.950	0.052	-0.17503	0.08978	-0.35153	0.00146
	Female	8.03±0.92						
Neutrophils	Male	62.44±13.78	-1.541	0.124	-2.07237	1.34464	-4.71583	0.57108
	Female	64.51±13.02						
Lymphocytes	Male	30.34±12.10	1.382	0.168	1.58535	1.14712	-0.66980	3.84051
	Female	28.75±10.81						
Monocytes	Male	6.01±6.7	0.426	0.670	0.28124	0.65989	-1.01605	1.57853
	Female	5.72±6.41						
Eosinophils	Male	1.20±0.65	2.422	0.016	0.16010	0.06611	0.03014	0.29006
	Female	1.04±0.66						
Basophils	Male	0.38±0.56	1.686	0.093	0.08859	0.05254	-0.01471	0.19188
	Female	0.29±0.48						

Mean corpuscular hemoglobin MCH in males was 22.93±3.96 and in females, 22.70± 3.44 with a t-value of 618 with p value of p< 0.537, 0.537which showed t value is low with a very small difference among them, and mean corpuscular hemoglobin concentration (MCHC in males 31.42 ±2.75 and in females 31.58±2.75 with the t-value of -.540 levels with p-value of (p < 0.590), were insignificant between the groups. MCHC levels suggest that the average amount of hemoglobin per red blood cell and the concentration of hemoglobin in a given volume of packed red blood cells are comparable in both groups. Platelet activity of men had a mean value 262.93±96.6 and women 287.77±91.4 with a negative t-value t=-2.633 (mean difference was = -24.84, with p < 0.009), indicating that Statistically noteworthy alterations were observed in platelet count that the male group had lower platelet counts, which suggests differences in platelet activity and

volume, with men displaying a broader range of PCT values and women having a slightly higher average MPV. These results lead to an impact on their clotting ability and their risk of bleeding. Platelet crit (PCT) t value near zero t=-0.044 results did not show any difference or significance (p 0.965) between the genders. Mean platelet volume (MPV) has a marginal significance of p>0.052, which may be due to the little variation of their platelet size amongst the groups that cause the possible disturbance of platelet function.

Men and women had comparable counts, with neutrophil counts slightly higher in women. Neutrophil Count, Lymphocyte Count, and Monocyte Count showed no significant difference among the groups with p values of neutrophil counts with a t value of -1.541 along with (p < 0.124) indicating a statistically non-significant difference. Lymphocyte count t-value = 1.382 with p < 0.168 showed the difference is not statistically significant. Monocyte counts t-value =0.426 with p < 0.670 showed a non-significant difference between males and females. Which indicated similar immune responses to bacterial infections and inflammatory conditions, similar adaptive immune responses, and similar levels of phagocytic activity and response to chronic inflammation or infection. One group showed higher levels of eosinophil count, which may be due to allergic or parasitic infections. The t value = 2.422 with the p-value of 0.016 showed the statistically significant difference in which males had slightly raised levels. Basophil count has no significant difference found t-value (t = 1.686) close to 1.7 suggesting males have higher levels as compared to females and its p-value 0.093 showed results were non-significant.

DISCUSSION

The impact of biological differences between males and females on their blood indicators like red blood cells, hemoglobin, and platelet count cannot be overlooked. Like in males, the raised levels of RBCS and hemoglobin witnessed are due to androgenic effects on the development of RBC levels. In the meantime, among females and children, lower levels of hemoglobin raised the suspicion of a higher occurrence of anemia. A study highlighted the hematological variations between males and females in the Springer link, and those women with low socioeconomic conditions were more commonly visiting clinical settings to cope with their illness or with cancerous conditions [14-16]. For better treatment in blood disorders and cancerous patients, it is important to understand these variations [14]. Anemia and a sort of iron deficiency anemia are much more common in menstruating females, and it is also linked with their nutritional inadequacies, most commonly folate, iron, and B12 [15,17].

It is important to indicate that due to the raised average rate of thalassemia carriers, there is reduced hemoglobin production due to genetic disorders. In spite of multiple instructions and genetic counseling for the screening programs in the Kot-Momin region of Sargodha, The variation in variance of hematological values amongst the male and female population highlighted the importance of gender-specific ranges, as shown in the results that males have higher mean hemoglobin levels (12.39 g/dl) as compared with females (11.17 g/dl), and hematocrit values vary in males (39.58%) as compared to females (35.28%). White blood cells, neutrophil count, lymphocyte count, and monocyte count indicated no significant modification between the groups. The immune response and potential for infection or inflammation are similar, with similar levels of phagocytic activity and responses to chronic inflammation or infection among both groups. Similar studies may support the evidence [18-22], and different results were also found in different regions [23-25].

To understand its important variations arising from lifestyle and biological factors or its disease prevalence, various research studies conducted on different regions, like the African American and Qatar Arab populations, showed that males had higher levels of hemoglobin, hematocrit, absolute neutrophil count, red cell distribution width, lymphocytes, and monocyte values in comparison with females [18,19].The hematological parameters of gender-specific differences highlighted the necessity of finding reference ranges for different sexes [18-20].

Statistical impact and data interpretation of gender variation within a larger proportion of the female population detected hematological variations reflecting better physiological conditions. Careful analysis of data by researchers is necessary to circumvent gender bias, and it is important to understand gender variations in hematological factors to ensure the exact clinical diagnosis for the best treatment and prognosis. Such a raised number of platelets in females (287.77±91.4) as compared to males (262.65 ±96.6) significantly pointed out the effects of bleeding disorders or any thrombotic condition. Its significant implications cannot be overlooked in public health initiatives and policies for the Kot-Momin region.

It also pointed out that the great occurrence of anemia requires alarming attention towards nutritional mediation, counseling with the use of iron-rich diets, and fortification of main food supplies. The great detection of thalassemia carriers' variations pointed out the emphasis of genetic counseling and screening programs amongst the families of the community. It is also worth mentioning that the usage of agricultural chemicals and pollutants is also connected with the variations of white blood cells, which affect the local population's immune system. To reduce pollution, there is greater emphasis on the implementation of regulations for agricultural chemicals. Research on African American patients highlighted the variations in complete blood count with metabolic, lipid, and tumor markers, which also showed the variations due to gender and race [16-25]. For improving hematological conditions, it is mandatory to focus on lifestyle. A conscious focus on diet, sleep, cessation of smoking, and exercise can contribute effectively [26].

LIMITATIONS

Our study also has limitations, which include its observational cross-sectional study and inherent tests with measurement accuracy. Which pointed out the care impact on the general population. In the future, research programs should target these limitations in wider and more

diverse populations with longitudinal designs and advanced methodologies to point out the main causative aspects of observed variations. Further studies may explore the clinical relevance of hematological variations for providing invaluable insights into medical and clinical interventions for improving patient outcomes on individual hematological profiles. Understanding these important hematological variations, which are affected by lifestyle, biology, and the environment, Health care personnel should enhance their diagnostic precision and possible treatment strategies with the provision of personalized and effective care.

CONCLUSION

This study provides a comprehensive analysis of hematological parameter variations across different groups. It highlights significant differences in hemoglobin, total RBC count, hematocrit, platelet count, and mean platelet volume.

These findings underscore the potential influence of biological and physiological factors on blood profiles, emphasizing the need for personalized approaches in the interpretation of hematological data for clinical or diagnostic purposes. The statistical significance observed in specific parameters indicates potential underlying mechanisms that warrant further investigation to fully understand their clinical implications. For instance: The marked differences in hemoglobin, total RBC, and hematocrit levels could reflect variations in oxygen transport capacity and iron metabolism among the studied groups. The differences in platelet count and mean platelet volume might have implications for coagulation and thrombotic risk. By delving deeper into these hematological differences, we can tailor medical interventions and improve patient outcomes based on individual blood profiles.

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Authors' Contribution:

Kamran Arzoo: Substantial contributions to the conception and design of the work.
Muhammad Aslam: The Data Compilation and interpretation of data for the work.
Zafar Latif Awan: Reviewing it critically for important intellectual content.
Mudaser Hussain Abbasi : Data collection and drafting of the work.
Awais Anwar: The acquisition and analysis of data for the work.
Amna Akram : Manuscript writing and final approval of article.

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