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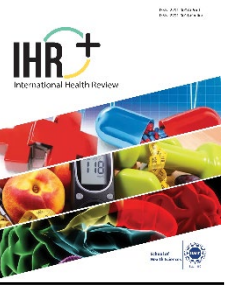

Title:	**Prevalence of Common Haematological Abnormalities Identified in Routine CBC Reports from a Local Pathology Laboratory in Mandi Bahauddin, Pakistan**
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Prevalence of Common Haematological Abnormalities Identified in Routine CBC Reports from a Local Pathology Laboratory in Mandi Bahauddin, Pakistan

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ABSTRACT

The Complete Blood Count (CBC) is an affordable and widely accessible test that plays a crucial role in identifying a variety of blood-related disorders. Understanding how often these abnormalities are observed and how they differ across demographic groups would help shape effective and focused public health strategies. The current research used standard CBC test results from a local laboratory in Mandi Bahauddin (Punjab, Pakistan) to examine the laboratory variations among different demographic groups and assessed the frequency of particular blood disorders. In this cross-sectional retrospective study, 1017 CBC reports of patients of various ages and both genders were received. The blood abnormalities were defined with standard diagnosis criteria, and their occurrence rates were analyzed. The information was also stratified by age (0-20, 41-60 and 21-40 years) and gender. The description statistics were applied to the analysis. Over half (55.5%) of the reports showed at least one abnormality and 44.5% were normal. Iron deficiency was the most frequent diagnosis, followed by normocytic anemia (7.3%) and leucocytosis (8.5%). It was observed that more women were affected by Iron Deficiency Anemia (IDA) (79.5%) and megaloblastic anemia (82.4%) as compared to men. It is highly common in young adults (68.0%) between the age of 21–40 years, IDA was more prevalent than other population groups. Pancytopenia was found to be rare (1.5%) and occurred in all age groups. Iron deficiency was the leading haematological abnormality in the study subjects, especially in women of child bearing age. Even with the CBC test, early assessment is still possible. To reduce the impact of anemia and other blood disorders on the community, it is necessary to implement focused nutritional programs and

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public-health initiatives.

Keywords: complete blood count (CBC), haematological abnormalities, iron deficiency anemia, Pakistan, pancytopenia, prevalence

1. INTRODUCTION

The Complete Blood Count (CBC) is among the most commonly conducted lab tests in both inpatient and outpatient settings [1]. The CBC parameters are classified into three categories: (i) White blood cells (WBC), (ii) Red blood cells (RBC), and (iii) Platelets. CBC results help in evaluating acute or chronic infections if WBC counts are elevated, leukemia when WBC levels are either high or low, anemia when hemoglobin is low, and liver cirrhosis if platelet counts are lowered [2]. Nevertheless, prior research has indicated that the likelihood of cancer, cardiovascular diseases (CVDs), arteriosclerosis, type 2 diabetes (T2DM), and metabolic syndrome can be anticipated through the CBC components listed below, along with secondary outcomes in a particular combination of CBC elements [3]. Anemia is the most frequently identified haematological disorder found in standard screening. Iron deficiency anemia (IDA) is recognised as the most common form worldwide, especially impacting women and children. Anemia is responsible for 78.4% of all blood disorders [4]. It is more prevalent in older women than in men. The prevalence ranges from 18.03% to 31.15 %. Neutropenia is associated with age in a significant way, occurring in 4.9% children and 1.9% adults [5].

Thrombocytopenia can also be observed, particularly in certain disease scenarios. In the COVID-19 pandemic [6], thrombocytopenia has been observed in 13.2% pediatric patients. A total of 63.8% patients with abnormal CBCs have morphological abnormalities of blood cells. Red Cell Distribution Width (RDW) increases are often associated with multiple conditions. A high percentage of patients over 65 years old with diabetes and CVDs have increased RDW levels [7]. RDW abnormalities are considered as the indicators of CVDs and mortality [3]. The CBC test is used to involve manual counting through a microscope and tally the RBC, WBC, and platelet counts. The main goal of the current study was to determine these three numbers. Currently, automated counters allow the CBC report to include additional figures which define characteristics of each cell type. The mean corpuscular weight is the average volume of red cells. The mean corpuscular volume is used to classify anemia as microcytic

or normocytic. Each has a different differential diagnosis. The differential white cell count provides both absolute numbers as well as relative proportions for each type of leukocyte. The absolute neutrophil number is an important indicator of immune capacity [1].

Anemia [8] is a medical condition that results from an imbalance between the production of erythrocytes and their destruction. A CBC should be performed after anemia has been diagnosed. A person is anemic when their haemoglobin level (Hb) falls below 12g/dL in women, and 13g/dL in men [9]. A high WBC count may be due to malignant or non-malignant causes. The results of a repeated CBC count and peripheral smear can provide valuable information, such as the type and maturity of the WBCs and their uniformity [10]. The most common clinical problem is thrombocytopenia [11]. This can be caused by a number of factors, including decreased platelet production, increased destruction in the peripheral blood, and increased sequestration within the spleen and dilution. To determine the cause of thrombocytopenia, it is important to evaluate both clinical and laboratory data [12].

Delays in diagnosing the disease may lead to more severe symptoms, which requires more intensive treatment. This may also affect patient outcomes [13]. Early diagnosis of haematological disorders improves the effectiveness of treatment. Early detection of illnesses can increase the chances of full recovery through surgery or radiation. It is hard to cure a disease that has become systemic or generalised. Treatments can only slow its progression [14]. [15] reported a prevalence of anemia of 96.8% in 128 patients with chronic kidney disease (CKD) who were undergoing hemodialysis. The predominant anemia was normocytic and normochromic, consistent with erythropoietin deficiency. Elevated RDW was found in 40% of stage 5 CKD patients, a statistically significant marker for anisocytosis, malnutrition, and inflammation--factors relevant to broader patient populations. The MCV, though it is within normal limits for most patients, is associated with an increased CKD mortality. In 27.1% of cases, neutrophilic lymphocytosis was observed. This suggests infection and is prognostic. A total of 43.7% of patients had thrombocytopenia. These hospital-based findings are consistent with trends observed at the general laboratory level and underscore the significance of systematic CBC interpretation for prompt diagnosis and patient care [15]. [16] showed that CBC is a valuable screening indicator of subclinical anemia in adolescent

girls (63,7%).

Most cases showed a microcytic, hypochromic morphology, strongly suggestive for iron deficiency. Thalassemia, however, was suspected in some cases. Non-anemic subjects with abnormal morphology and early iron depletion were detected in CBC. This study established a strong link between low BMI and anemia. It also highlighted the importance of nutrition in hematologic health. These results demonstrate that CBC can detect both overt and early-onset anemia. They are especially valuable in resource-poor environments [16]. In a study conducted by Meenakshi Suresh et al., it was observed that anemia (28%) was the most common abnormality, followed closely by leukemia (21%) and thrombosis (1.96%). Advanced statistical methods, including cluster analysis, Pearson correlation, and logistic regression, suggested significant correlations between hematologic parameters and demographic factors. Haemoglobin levels and hematocrit values were strongly correlated ($r = 0.8$), enhancing their diagnostic value. Males were at a higher risk of leukemia and blood clots but females were more likely to develop anemia.

Formerly, teenage-focused research also detected 29.7% subclinical anemia, and many of the non-anemic participants also had abnormal RBC morphology--specifically, evidence of initial hematologic alteration sensitivity of the CBC [17]. [18] conducted a localised assessment of hematology in Erbil, Kurdistan Region, Iraq, on 30 participants. Both microcytic as well as macrocytic anemias showed significant variations in haemoglobin, MCV, and RDW. The white variation in the number of blood cells could be due to an immune or infectious pathogenesis. Platelet indices, such as MPV, PDW, and P-LCR can also reflect thrombocytopenia or inflammation. The study highlighted the importance of population-specific surveillance and localized CBC ranges [18]. These studies confirm that CBC is a valuable diagnostic tool for detecting hematological disorders, however, they have several limitations. [18] did not provide results by sex or age, which may have restricted knowledge of demographic insight. [17] presented statistical correlations but did not provide age-specific analyses or localized clinical context. The studies of adolescent girls were restricted by gender and age, leaving out broader patterns. In order to fill these gaps, the study used a stratified sampling approach to analyze CBC in multiple age categories. This design allows a comprehensive assessment and diagnosis of haematological abnormalities, as well as the creation of

representative ranges. The findings would be used to improve clinical interventions aimed at specific populations and strengthen public health strategies in local healthcare environments.

2. METHODOLOGY

2.1. Study Design and Setting

This was a cross-sectional, retrospective study conducted at the local pathology lab in Pakistan (Aitzaz Lab & Diagnostic Centre), Mandi Bahauddin. This was the first of its kind to be conducted in our laboratory. Although there are other studies from regional laboratories, this is the first systematic evaluation of our lab using the specified equipment for CBC index determination. The Swelab Alfa Plus Standard Hematology analyser (Made in Sweden) was used. Innovative healthcare solution regularly services the machine, which is about three years old. The instrument's model and calibration details are documented in our service logs. The lab follows a strict calibration and maintenance protocol. Monthly cleaning and calibration checks are performed using standard solutions as recommended by the manufacturer. It was designed for determining how frequently routine CBC hematologic abnormalities are detected during a specific period of time.

2.2. Study Population

All of the reports from the CBC conducted during the study period were taken into consideration. Reports from both genders of patients of all ages were potentially eligible. Duplicate reports from the same patient for the same clinical episode during the study period were not considered.

2.2.1. Inclusion Criteria. CBC reports would be included if they meet the following conditions:

- Patients of any age and gender who underwent a CBC test at the selected local pathology laboratory.
- CBC reports generated within the defined study period (e.g., January 2024 to June 2024).
- Reports that included all major haematological parameters, such as:
  - N Normal
  - IDA Iron Deficiency Anemia

- MBA Megaloblastic Anemia
- MDA Mixed Deficiency Anemia
- NCNCA Normocytic Normochromic Anemia
- LYT Leukocytosis
- LP Leukopenia
- TYP Thrombocytopenia
- TR Thrombocytosis
- POL Polycythemia
- PAN Pancytopenia

- First CBC report of each patient during the study period (to avoid duplicate inclusion).
- Reports from patients not on any known haematological treatment before sample collection (based on lab-recorded history if available).

2.2.2. Exclusion Criteria. CBC reports would be excluded if:

- The report is incomplete, missing key haematological parameters.
- The patient has a known diagnosed haematological disorder, such as:
  - Thalassemia
  - Leukemia
  - Aplastic anemia
  - Sickle cell disease *(Based on lab records or referral notes.)*
- Patients currently receiving chemotherapy, radiotherapy, or immunosuppressive therapy, as these can significantly alter CBC values.
- Lab notes indicate samples that are haemolyzed or clotted, or have been improperly processed.
- Reports that are repeated by the same patient during the study period would only be considered the first.
- CBC reports of patients with recent surgery or acute trauma are

recommended, as these conditions may cause transient haematological change.

2.3. Data Collection

The laboratory-computerised records contained CBC results. Each report included haematological measurements, such as haemoglobin, total leukocytes, platelet counts, red blood cell indices and other derived measures. The diagnosis was made using standard haematological terms, such as:

Iron Deficiency (IDA): Characterized by low haemoglobin and microcytosis, hypochromia (low MCH/MCHC), as well as other supporting indices.

Leukocytosis*:* WBC counts above the upper range of reference

Leukopenia*:* WBC counts below the lower reference range

Megaloblastic Anemia: Macrocytosis accompanied by elevated MCV and distinct findings on peripheral smear.

Normocytic anemia: Low MCV with low haemoglobin

Pancytopenia: A simultaneous reduction in haemoglobin count, WBC count, and platelet count

Thrombocytopenia*:* Platelet counts below the lower range of reference

Thrombocytosis*:* Platelet counts above the upper reference range

Other abnormalities are classified according to haematological criteria.

2.4. Data Analysis

IBM SPSS Statistics 22, for analysis, was used to enter the collected data. The frequency and percentages of each haematological anomaly were determined using descriptive statistics. The distribution of these abnormalities was assessed by gender, age group (0-20 years, 41-60 years and >=61. Crosstabulations and bar graphs were used to present trends.

2.5. Ethical Considerations

Anonymising all laboratory records prior to analysis ensured patient confidentiality. The study used existing laboratory data that did not contain any identifying information about patients. Therefore, a formal ethical approval wasn't required. This was in line with the Declaration of Helsinki

as well as local regulations.

3. RESULTS

A total of 1017 CBC reports were examined. In this group, 44.6% of the cases (*n*=454) had normal haematological results, whereas 55.4% of cases (*n*=563) showed at least one abnormality. IDA was the most common finding, observed in 25.5% of cases (*n*=259). This was followed by lymphocytosis (8.5%; *n*=86) and normocytic (or normal) anemia (7.9%; *n*=80). Other abnormalities included megaloblastic (3.4%) and macrocytic (3.2%) anemias, as well as thrombocytopenia (12%), pancytopenia (15%), leukopenia (1.5%), typhoid-associated haematological change (2.7%), and polycythemia (0.4%). The less frequent findings (1%), such as rare platelet count, anomalies, and polychromasia, were isolated variations.

Gender analysis revealed that 27.4% of the cases (*n* = 279) were those of males and 72.6% were of females (*n* = 738). IDA was found to be more common in females than in males. Females accounted for 79.5% versus 20.5%.

Lymphocytosis was also more common in females (74.4%) than in males (25.6%), as was megaloblastic anemia and related variants (77.1% in females). Conversely, leukopenia had a higher male proportion (63.6%).

Regarding age, the largest proportion of cases fell within the 21–40 years group (60.1%), followed by 41–60 years (26.6%), ≥61 years (7.7%), and 0–20 years (5.6%). IDA was most common in people aged 21-40, with 68.0% representing all IDA cases. Lymphocytosis occurred in a relatively even distribution but most frequently in the same group (50%). Pancytopenia was more common among the groups of 21-60 years (60%) and 41-60 years old (26.7%).

Table 1. Frequency Distribution of Haematological Abnormalities

	Frequency	Percent	Cumulative Percent
	1	.1	.1
IDA	259	25.5	25.6
LP	11	1.1	26.6
LYT	86	8.5	35.1
MBA	35	3.4	38.5
MDA	33	3.2	41.8
N	454	44.6	86.4

NC NC A	80	7.9	94.3
PAN	15	1.5	95.8
POL	4	.4	96.2
TR	12	1.2	97.3
TYP	27	2.7	100.0
Total	1017	100.0	

Table 1. Distributions of haematological abnormalities in the population studied. This table displays the percentages and frequencies of each haematological anomaly identified by routine CBC tests. The most common abnormality was iron deficiency (25, 5%), followed closely by normocytic leukocytosis and leukocytosis, (8, 5%) and leukocytosis, (8%). Normal haematological values were observed in 44.6% of cases.

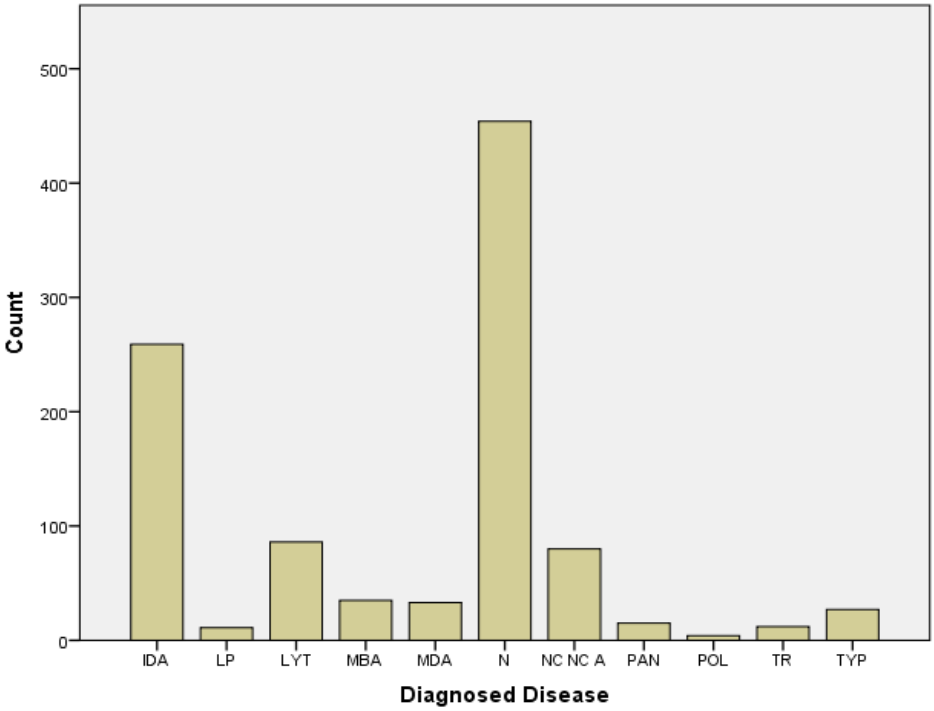

Figure 1. Percentages for Each Haematological Disorder

This bar graph displays the percentages for each haematological disorder observed in CBC reports. Iron deficiency was the most common abnormality, followed by leukocytosis and normocytic. Rare conditions, such as polycythemia and thrombocytosis existed.

Table 2. Distribution of Haematological Disorders in Different Age Groups

	Age Groups	Diagnosed Disease										
		IDA	LP	LYT	MBA	MDA	N	NC NC A	PAN	POL	TR	TYP
0–20	Count	13	2	8	2	1	25	4	0	0	1	1
	% within Age Groups	22.8	3.5	14.0	3.5	1.8	43.9	7.0	0.0	0.0	1.8	1.8
	% within Diagnosed Disease	5.0	18.2	9.3	5.7	3.0	5.5	5.0	0.0	0.0	8.3	3.7
21–40	Count	176	4	43	21	22	257	48	9	4	8	18
	% within Age Groups	28.8	0.7	7.0	3.4	3.6	42.1	7.9	1.5	0.7	1.3	2.9
	% within Diagnosed Disease	68.0	36.4	50.0	60.0	66.7	56.6	60.0	60.0	100.0	66.7	66.7
41–60	Count	59	3	27	5	8	136	23	4	0	2	4
	% within Age Groups	21.8	1.1	10.0	1.8	3.0	50.2	8.5	1.5	0.0	0.7	1.5
	% within Diagnosed Disease	22.8	27.3	31.4	14.3	24.2	30.0	28.7	26.7	0.0	16.7	14.8
61+	Count	11	2	8	7	2	36	5	2	0	1	4
	% within Age Groups	14.1	2.6	10.3	9.0	2.6	46.2	6.4	2.6	0.0	1.3	5.1
	% within Diagnosed Disease	4.2	18.2	9.3	20.0	6.1	7.9	6.3	13.3	0.0	8.3	14.8
Total	Count	259	11	86	35	33	454	80	15	4	12	27
	% within Age Groups	25.5	1.1	8.5	3.4	3.2	44.6	7.9	1.5	0.4	1.2	2.7
	% within Diagnosed Disease	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

IDAs and Normocytic Normochromic Anemias (NCNCAs) were the two most common, followed by Mixed Deficiency Anemias (MDAs) (12.4%), and Megaloblastic Anemias (MBAs) (3.4%). Leukocytosis (2.7%), Leukopenia (1.6%), Pancytopenia (1.4%), Thrombocytopenia (18%), Thrombocytosis (12%), Polycythemia (0.4%), and Thrombocytosis (12%) were the less common disorders.

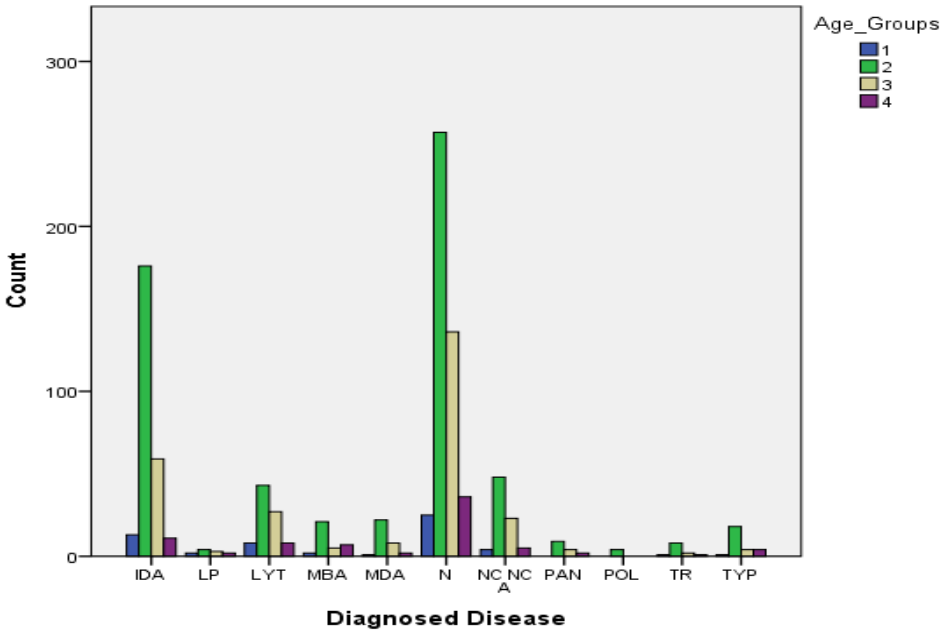

Figure 2. Distribution of Haematological Abnormalities in Different Age Groups. Age Groups (1=0–20, 2=21–40, 3=41–60, 4=61+)

Table 3. Gender-based Crosstabulation of Haematological Diagnoses: Comparative Analysis of Disease Prevalence in Male and Female Patients

Gender of the patient		Diagnosed Disease										
		IDA	LP	LYT	MBA	MDA	N	NC NC A	PAN	POL	TR	TYP
Male	Count	53	7	22	8	4	150	18	6	1	3	7
	% within the Gender of the patient	19.0	2.5	7.9	2.9	1.4	53.8	6.5	2.2	0.4	1.1	2.5
	% within Diagnosed Disease	20.5	63.6	25.6	22.9	12.1	33.0	22.5	40.0	25.0	25.0	25.9
Female	Count	206	4	64	27	29	304	62	9	3	9	20
	% within the Gender of the patient	27.9	0.5	8.7	3.7	3.9	41.2	8.4	1.2	0.4	1.2	2.7
	% within Diagnosed Disease	79.5	36.4	74.4	77.1	87.9	67.0	77.5	60.0	75.0	75.0	74.1

Gender of the patient		Diagnosed Disease										
		IDA	LP	LYT	MBA	MDA	N	NC NC A	PAN	POL	TR	TYP
Total	Count	259	11	86	35	33	454	80	15	4	12	27
	% within the Gender of the patient	25.5	1.1	8.5	3.4	3.2	44.6	7.9	1.5	0.4	1.2	2.7
	% within Diagnosed Disease	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

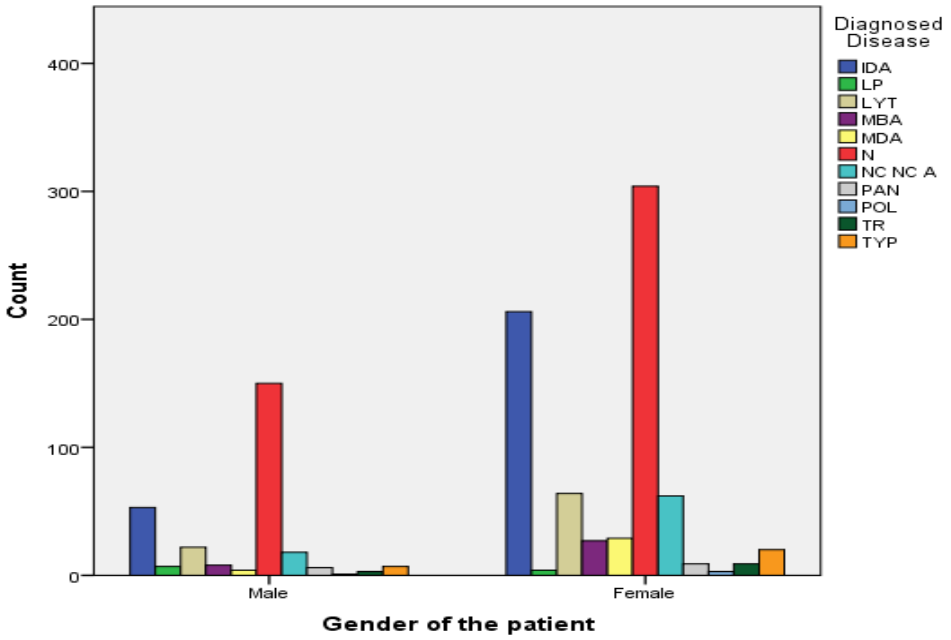

Figure 3. Gender Distribution in Haematological Disorders

This bar chart compares the male and female proportions of each haematological disorder. The prevalence of most conditions was higher in women, especially iron deficiency and megaloblastic ahem.

4. DISCUSSION

Over half of those tested had at least one haematological abnormality, highlighting the importance of routine CBC tests in early disease detection. The prevalence of IDA (25, 5%) is in line with Pakistani research where iron deficiency continues to be a major issue for public health, especially

among women of reproductive age [19]. The factors that contribute to the prevalence of IDA include nutritional deficiencies as well as menstrual bleeding, pregnancy and socio-economic restrictions.

The next most common findings were lymphocytosis (8.5%) and normocytic anemia (7.9%). Lymphocytosis is often caused by acute infections, viral illnesses, inflammation or infection [20]. In contrast, normocytic anemia can be a sign of chronic disease, nutritional deficiencies or early blood loss [21]. The relatively high rates of normocytic anemia suggest that chronic diseases are present in this population.

Similar patterns have been reported in regional studies, with megaloblastic and macrocytic anemias accounting for a significant proportion of pancytopenia [22].

Pancytopenia is found in approximately 1.5% of cases, primarily in those aged between 21 and 40 years. It is rare but its detection during a routine CBC can be critical, as it could indicate life-threatening conditions, such as aplastic anemia [23], marrow invasion, or severe nutritional deficiency.

The higher rate of abnormalities in females is due to both biological susceptibility as well as socio-cultural factors, such as dietary deficiency, limited healthcare access, and an increased demand on the body. Leukopenia is more common in men, which may be due to occupational exposures and drug-induced marrow suppression.

Comparing regional data, the prevalence of IDA in this region is comparable to rural data but higher than in some urban populations. This supports the influence of dietary factors and socioeconomic factors. The proportion of normal CBCs (44,6%) is within the range expected for outpatients.

Limitations include the retrospective design and the reliance on laboratory variables without detailed clinical correlation. The large sample size of 1,017 and the inclusion of both genders as well as all age groups improve the reliability of findings. The high prevalence of IDAs as well as other haematological diseases highlights the importance of CBC screenings.

4.1. Conclusion

The study showed that over half of the people who regularly tested with the CBC were found to have at least one hematologic disorder. IDA was

most common, followed by normocytic and leukocytosis. Probably due to biological and social causes, IDA was found to be more prevalent in women of childbearing age. Less common, pancytopenia, cytopenias, and megaloblastic anemia, were less common and are of clinical significance, requiring prompt diagnosis and treatment. This study validated the CBC as a widely available and affordable test for hematologic disease for both children, adults, symptomatic, and asymptomatic individuals. The prevalence of IDA suggests the necessity for community nutrition interventions, public nutrition education regarding diets rich in iron, and systematic screening of populations at risk, particularly females of childbearing age.

Author Contribution

Alina Riaz: conceptualization, methodology, data curation, formal analysis, investigation, writing – original draft, visualization. **Aitzaz Sajid:** methodology, formal analysis, validation, writing – review & editing, visualization. **Zarfeen Fatima:** data curation, investigation, software, visualization. **Ayesha Nadeem:** resources, project administration, investigation, writing – review & editing. **Mehwish:** validation, formal analysis, supervision, writing – review & editing. **Minahil Mansoor:** conceptualization, methodology, supervision, writing – review & editing. **Pakeeza Rehman:** Data Acquisition, writing – original draft

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

Data supporting the findings of this study will be made available by the corresponding author upon request.

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Generative AI Disclosure Statement

The authors did not used any type of generative artificial intelligence software for this research.

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