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A Cross-Sectional Study on the Burden of Anemia Among Late Adolescent and Young Adult Females in Peshawar, Pakistan

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ABSTRACT

Anemia remains a significant health concern among adolescent and young adult females, impacting hematological profiles and overall wellbeing. This study assessed the prevalence and characterization of anemia among 100 female patients aged 15 to 22 years. Hematological analyses revealed an anemia prevalence of 51%, with patients classified into several subtypes based on WHO guidelines and red blood cell indices: normal complete blood counts (35.3%), microcytic anemia (35.3%), iron deficiency anemia (19.6%), normocytic anemia (15.7%), and severe microcytic anemia (9.8%). Hemoglobin levels ranged from 7.5 to 14.3 g/dL, with the most severe cases exhibiting levels below 8 g/dL. Microcytic anemia and iron deficiency anemia were marked by reduced mean corpuscular volume (MCV), hypochromia evidenced by decreased mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC), and elevated red cell distribution width (RDW), indicating anisocytosis. Normocytic anemia displayed normal MCV with decreased hemoglobin, suggesting heterogeneous etiologies including chronic disease and hemorrhagic events. White blood cell and platelet counts remained within normal limits,

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minimizing confounding inflammatory or infectious conditions. The predominance of iron deficiency anemia underscores the urgent need for targeted nutritional and clinical interventions in this demographic. These findings emphasize the heterogeneity of anemia subtypes and the critical role of detailed hematological profiling in guiding effective diagnosis and treatment.

Keywords: Prevalence, Anemia, hematological profiles, microcytic anemia and iron deficiency anemia

Introduction

Anemia is described as a reduction in the proportion of the red blood cells. Anemia is not a diagnosis, but a presentation of an underlying condition. Whether or not a patient becomes symptomatic depends on the etiology of anemia, the acuity of onset, and the presence of other comorbidities, especially the presence of cardiovascular disease. Most patients experience some symptoms related to anemia when the hemoglobin drops below 7.0 g/dL.

Erythropoietin (EPO), which is made in the kidney, is the major stimulator of red blood cell (RBC) production. Tissue hypoxia is the major stimulator of EPO production, and levels of EPO are generally inversely proportional to the hemoglobin concentration. In other words, an individual who is anemic with low hemoglobin has elevated levels of EPO. However, levels of EPO are lower than expected in anemic patients with renal failure. In anemia of chronic disease (AOCD), EPO levels are generally elevated, but not as high as they should be, demonstrating a relative deficiency of EPO (Turner, Parsi, & Badireddy, 2018).

Approximately one third of the 5.5 billion people in the world are anemic. Worldwide, approximately 40% of children (0–12 years), 35% of all women, 51% of pregnant women, and 18% of men are anemic. These figures are probably conservative estimates because the diagnosis of anemia is based on the World Health Organization definition of anemia: hemoglobin less than 11 g/dL for children aged 0 to 4 years and pregnant women, hemoglobin less than 12 g/dL for children aged 5 to 12 years and nonpregnant women, and hemoglobin less than 13 g/dL for men. These values encompass worldwide populations and include developed and developing nations. As might be expected, the prevalence of anemia is influenced by

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socioeconomic and geographic factors (e.g., poverty, marginal or famine diets, pregnancy rates, prevalence of malaria and hemoglobinopathies) (Dugdale, 2001).

Iron deficiency anemia is the most prevalent form of anemia in the United States and worldwide. Iron homeostasis is tightly regulated via control of small intestinal absorption of iron. Despite this tight balance of iron loss and absorption, more than several mg of iron loss per day cannot be overcome by the intestine's absorption capacity, leading to iron deficiency; once iron stores are depleted, iron deficiency anemia (IDA)

Anemia affects one-fourth of the world's population, accounting for 8.8% of the total global burden of disease.Iron deficiency is the predominant cause of anemia across countries and in both sexes, with women more commonly afflicted. The prevalence of anemia increases with age and in the hospital setting. Anemia decreases the capacity for work and increases health care costs. Iron deficiency is also associated with restless legs syndrome (RLS), diminished quality of life, fatigue, impaired cognitive function, and infertility, all of which may occur in the absence of anemia and may be reversed with iron therapy. Gastrointestinal conditions, such as celiac disease and inflammatory bowel disease (IBD), as well as chronic kidney disease (CKD), cancer, and chronic heart failure (CHF) increase the risk for anemia and iron deficiency, and iron deficiency may influence clinical outcome. In CHF, iron deficiency is associated with an increased risk of mortality, regardless of the hemoglobin (Hb) level. Iron deficiency is also associated with reactive thrombocytosis, potentially increasing the risk for thromboembolic events (Jimenez, Kulnigg-Dabsch, & Gasche, 2015).

The evaluation of a patient with anemia begins with a careful and detailed history regarding blood loss, chemical and drug exposure, diet, family history, and anything that might suggest an underlying condition. There are no specific physical findings in mild anemia. Pallor of mucous membranes is rarely apparent. Skin and nail bed pallor is even less helpful because skin color varies widely among individuals, regardless of race. Cardiovascular examination will reflect the compensatory adjustment of the heart, that is, tachycardia,

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hyperdynamic precordium, widened pulse pressure, and evidence of heart failure. An assortment of murmurs may be heard that are caused by the rapid flow of less viscous blood and should not be ascribed to valvular abnormalities unless they persist after the anemia is corrected. Most important when performing the physical examination is a deliberate search for clues to an underlying disease that may be the cause of the anemia, such as evidence of weight loss, sites of chronic infection, petechiae, enlarged lymph nodes, abdominal organomegaly, or masses. Physical findings specific to the common anemias are described in the following sections (Dugdale, 2001).

There is clear evidence to support prompt treatment in all patients with iron deficiency anemia because it is known that treatment improves quality of life and physical condition as well as alleviates fatigue and cognitive deficits.8-20 Although clear evidence is lacking, iron deficiency without anemia is associated with RLS and chronic fatigue, and treatment alleviates these symptoms.7,14-18 In CHF, iron replacement therapy has been shown to be beneficial, even when anemia is not present.8,12-14 Thus, the decision to treat iron deficiency in a patient without manifest anemia must be made on an individual basis.53,54 The treatment of iron deficiency anemia in patients with CKD, CHF, or cancer should be undertaken in conjunction with the appropriate specialists because different guidelines (Provenzano, Lerma, & Szczech, 2018).

Anemia is usually subdivided according to it pathophysiology into: insufficient production, or bleeding/hemolysis causing loss of RBCs. Therefore, the main two types of anemia are hyporegenerative and regenerative. In hyporegenerative anemia, there is impaired bone marrow functions that cause decreased production of precursor cells. This can occur due to abnormal infiltration of bone marrow or malnutrition. On the other hand, regenerative anemia involves proper response of bone marrow to the decrease of RBCs by a compensatory increase in production (Sharourou et al., 2018) .

Iron deficiency is considered the most common nutritional deficiency leading to anemia.[6] Inadequate dietary iron intake is the primary pathway resulting in iron deficiency anemia. About 60% of the total global burden of anemia in 2019 was

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estimated to be due to dietary iron deficiency and thus iron deficiency accounted for the most significant cause of anemia-related disability.[12] Deficiencies in vitamins A, B_2, B_6, B_{12}, C, D, E, folate, copper, selenium, and zinc can also result in anemia due to their specific roles in the synthesis of hemoglobin and/or erythrocyte production;[6,7,13] however, some of these micronutrients may not play a major role in the burden of anemia globally.[6,7] Additional mechanisms include nutrient losses (e.g., iron deficiency secondary to blood loss from parasitic infections, hemorrhage associated with childbirth, or menstrual loss), impaired absorption (e.g., lack of intrinsic factor to facilitate vitamin B_{12} absorption or high intake of inhibitors, such as phytate that impair iron absorption), and nutrient interactions (e.g., vitamin A deficiency affecting mobilization of iron stores).[7] Using data from nationally representative surveys, the project on Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) recently assessed associations between anemia and multiple risk factors, such as iron and vitamin A deficiencies, inflammation, and malaria, and found that the proportion of anemic individuals who were iron deficient ranged from 30% to 71% in the different surveys and was negatively associated with the burden of infection/inflammation present in the population (assessed by elevated C-reactive protein and alpha-1-acid glycoprotein)(Hess et al., 2023).

Methodology

Study Design and Research Setting

The methodological framework for this investigation utilized a descriptive, quantitative cross-sectional design, which was selected for its efficacy in assessing the prevalence of health conditions within a specific population at a singular point in time. This specific design provided a robust platform for the concurrent evaluation of demographic characteristics, potential clinical risk factors, and the immediate anemia status of the participants. By capturing data in this manner, the study could identify correlations between lifestyle or biological variables and hematological outcomes without the temporal constraints of longitudinal tracking. The research was physically situated at the Institute of Kidney Diseases (IKD) in Peshawar, Khyber Pakhtunkhwa. As a specialized tertiary care hospital, IKD served as an ideal

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setting, providing access to a diverse patient demographic and professional laboratory facilities necessary for high-precision diagnostic screening.

Participant Selection and Sampling Strategy

The study population specifically targeted 100 females between the ages of 15 and 22 years who presented to the IKD during the active study period. To ensure the integrity of the data, strict inclusion and exclusion criteria were enforced. Participants were included if they fell within the specified age range and provided voluntary, written informed consent following a comprehensive briefing on the study's objectives, procedural steps, and potential risks or benefits. Conversely, the study excluded any individuals outside the defined age bracket and specifically excluded pregnant females. This exclusion was vital to prevent data skewing, as pregnancy introduces significant physiological hemoglobin alterations and hemodilution that do not represent pathological anemia in the traditional sense.

The sample size was determined through formal statistical calculation based on the World Health Organization (WHO) formula for estimating a single population proportion with specified precision. To fulfill this requirement, a convenience sampling technique was employed. This involved the consecutive recruitment of eligible participants from relevant hospital departments until the target threshold of 100 was reached. To bolster the representativeness of the sample and mitigate the inherent biases of convenience sampling, recruitment efforts were intentionally stratified across varying days of the week and different times of day, ensuring a broader capture of the visiting population.

Laboratory Procedures and Diagnostic Investigations

Data collection was centered on rigorous laboratory investigations conducted under clinical supervision. For each participant, 3–5 mL of venous blood was collected via aseptic venipuncture by certified phlebotomists. These samples were immediately transferred into tubes containing Ethylenediaminetetraacetic acid (EDTA) to preserve cellular morphology and prevent coagulation. The hematological profile was then mapped using automated hematology analyzers, which provided precise measurements of hemoglobin concentration, hematocrit, and the red blood cell (RBC) count.

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Furthermore, the analysis extended to detailed erythrocytic indices, including Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC), alongside the Red Cell Distribution Width (RDW), white blood cell (WBC) count, and platelet count. To maintain diagnostic accuracy, quality control protocols and equipment calibrations were rigorously performed daily, ensuring that all laboratory outputs remained within established clinical benchmarks.

Data Management and Statistical Processing

Following the collection of laboratory results and questionnaire data, a multi-stage data management process was initiated to ensure clerical accuracy. All information was double-entered into a secured electronic database utilizing SPSS (Statistical Package for the Social Sciences). This double-entry method allowed for the immediate identification of entry errors, while laboratory results were manually cross-verified against original source records to maintain a "gold standard" of data integrity. The subsequent data cleaning phase involved exhaustive consistency checks and the implementation of standardized protocols for handling any missing values. Throughout this process, participant anonymity was a primary ethical priority; researchers utilized unique identifiers for each entry, ensuring that no personal or identifying information could be linked back to the raw clinical data during the analysis or subsequent reporting.

Results

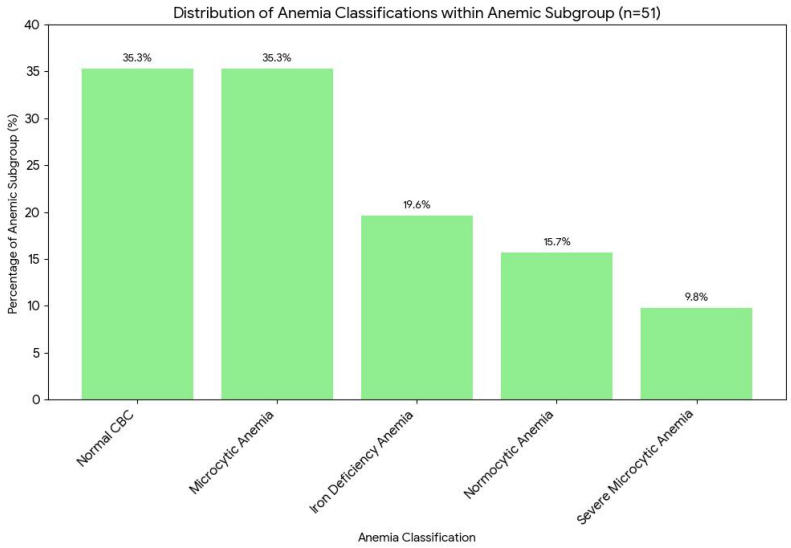
The hematological data of 100 female patients aged between 15 and 22 years were analyzed to assess anemia prevalence out of with 51 females were, classified with different anemia types and characterize associated hematological parameters. Hemoglobin (Hb) levels ranged broadly from 7.5 g/dL to 14.3 g/dL, indicating variability in anemia severity within the cohort. Based on WHO guidelines and red blood cell indices, patients were categorized into several groups: those with normal complete blood counts (CBC), microcytic anemia, iron deficiency anemia, normocytic anemia, and severe microcytic anemia.

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Parameter / Category	Total Cohort (n=100)	Anemic Subgroup (n=51)
Age Range (years)	15 – 22	15 – 22
Hemoglobin Range (g/dL)	7.5 – 14.3	7.5 – 14.3
Anemia Prevalence	51%	100%



Approximately 18 participants (about 35.3%) demonstrated normal CBCs, with hemoglobin concentrations ≥12.0 g/dL and standard red blod cell indices. Microcytic anemia accounted for around 18 patients (35.3%), characterized by low hemoglobin and reduced mean corpuscular volume (MCV). Iron deficiency anemia was identified in approximately 10 patients (19.6%), based on characteristic hypochromic microcytosis and elevated red cell distribution width (RDW).Normocytic anemia was observed in 8 patients (15.7%), marked by anemia with normal MCV values.

Severe microcytic anemia, defined by hemoglobin levels below 8 g/dL combined with severely decreased MCV, was found in 5 patients (9.8%). The presence of overlapping categories, such as microcytic anemia with confirmed iron deficiency, was noted, reflecting the clinical complexity in differentiating among anemia subtypes.

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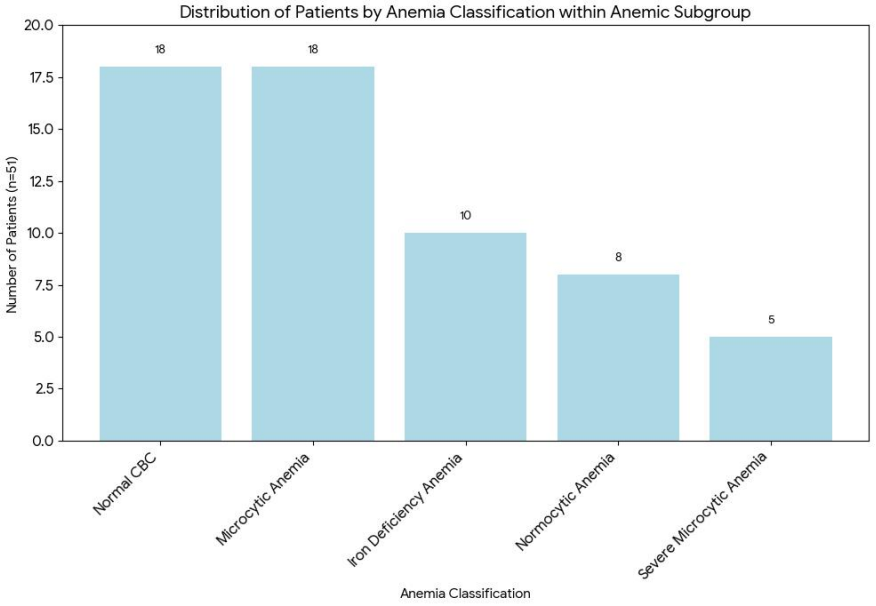
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Anemia Classification	Number of Patients (n=51)	Percentage (%)	Key Characteristics
Normal CBC	18	35.3	Hb ≥ 12.0 g/dL, normal RBC indices, indicating no anemia
Microcytic Anemia	18	35.3	Hb < 12.0 g/dL, MCV < 80 fL, smaller RBCs, typical of impaired hemoglobin synthesis
Iron Deficiency Anemia	10	19.6	Hypochromic microcytosis, elevated RDW, indicates iron deficiency; overlaps with microcytic anemia
Normocytic Anemia	8	15.7	Hb < 12.0 g/dL, normal MCV (80–100 fL), anemia with preserved RBC size, often due to chronic disease or other causes
Severe Microcytic Anemia	5	9.8	Hb < 8.0 g/dL, severely decreased MCV, indicative of advanced iron deficiency or other severe microcytic conditions

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Hemoglobin and Red Blood Cell Indicesssssss

Hemoglobin concentrations varied extensively. Patients with severe microcytic anemia exhibited the lowest hemoglobin values (7.5–7.9 g/dL), highlighting pronounced anemia. In contrast, participants classified as normal CBC maintained hemoglobin levels between 12.7 and 14.3 g/dL, supportive of normal erythropoiesis.

Mean corpuscular volume (MCV) was a crucial diagnostic marker distinguishing anemia types. The microcytic and iron deficiency groups showed significantly decreased MCV values ranging from 23 to 33 fL, confirming the presence of microcytosis. Normal CBC subjects presented with MCV values within the standard range of 40 to 44 fL, whereas normocytic anemia cases demonstrated MCV values approximating 80 to 100 fL, consistent with normocytic red blood cells despite reduced hemoglobin.

Mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were consistently reduced in anemic patients, especially among those with microcytic and iron-deficiency profiles, indicating hypochromia (paler red blood cells) typically associated with iron depletion. Values of MCH frequently ranged from 20 to 25 pg, and MCHC from 20 to 29 g/dL among anemia cases, compared to normal CBC cases where MCH and MCHC values were higher and within reference limits (approximately 29 to 31 pg and 30 to 34 g/dL,

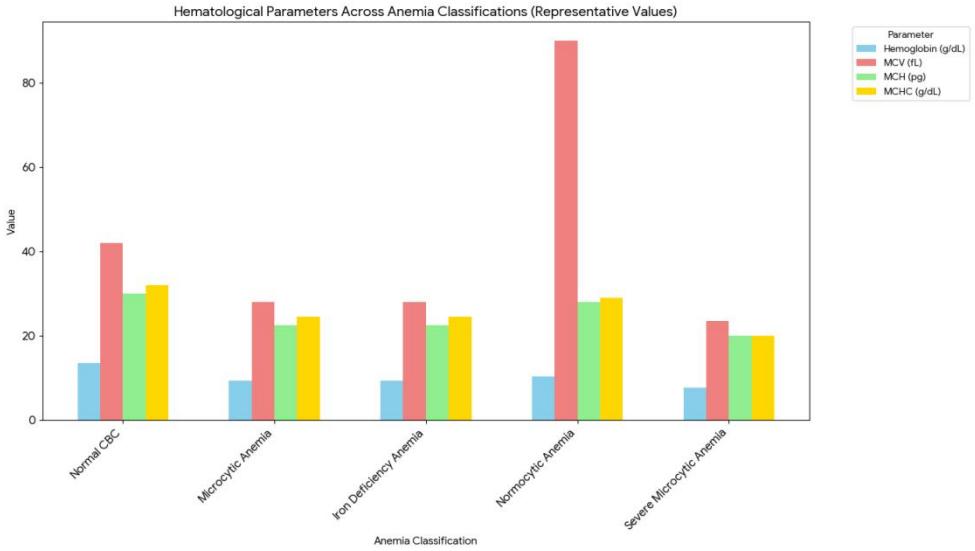
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respectively).

Anemia Classification	Hemoglobin (g/dL)	MCV (fL)	MCH (pg)	MCHC (g/dL)
Normal CBC	12.7 – 14.3	40 – 44	29 – 31	30 – 34
Microcytic Anemia	< 12.0 (varied ~7.5–11)	23 – 33	20 – 25	20 – 29
Iron Deficiency Anemia	Similar to microcytic	23 – 33	20 – 25	20 – 29
Normocytic Anemia	< 12.0 (varied ~9.8–11)	~80 – 100	Moderate	Moderate
Severe Microcytic Anemia	< 8.0 (7.5 – 7.9)	23 – 24	~20	~20



Red Cell Distribution Width (RDW)

The RDW, representing variation in red blood cell size (anisocytosis), was notably elevated in the iron deficiency and microcytic anemia groups, frequently exceeding 18%. Elevated RDW reflected a heterogeneous population of erythrocytes, a hallmark of iron-deficiency anemia as the bone marrow releases both small and normal-sized red cells under stressed erythropoiesis. Conversely, normal CBC patients had RDW measurements around 12–14%, indicative of uniform red cell size and normal erythrocyte production. Severe microcytic anemia cases also presented

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with some of the highest RDW values (up to 21%), correlating with the severity of anisocytosis and advanced disease states.

Anemia Classification	RDW Range (%)	Mean RDW (%)	Interpretation
Normal CBC	12 – 14	~13	RDW values within normal range, indicating uniform red blood cell size and normal erythropoiesis
Microcytic Anemia	>18	>18	Elevated RDW reflecting anisocytosis, variation in RBC size due to iron deficiency
Iron Deficiency Anemia	>18	>18	High RDW with hypochromic microcytosis indicating stressed red cell production and iron depletion
Severe Microcytic Anemia	Up to 21	~20	Markedly elevated RDW, correlating with advanced anemia and pronounced anisocytosis

White Blood Cell (WBC) and Platelet Counts

White blood cell counts were consistently within normal physiological ranges (approximately 4.5 to 6.3 k/mcL) across all subgroups, indicating no evidence of concurrent acute infections or inflammatory conditions that could confound anemia assessment.

Platelet counts ranged from 240 to 310 k/mcL, falling within accepted normal limits for healthy individuals. No participants demonstrated thrombocytopenia or thrombocytosis, suggesting platelet production and turnover were unaffected in this cohorts.

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Anemia Classification	WBC Range (k/mcL)	Mean WBC (k/mcL)	Platelet Count Range (k/mcL)	Mean Platelet Count (k/mcL)
Normal CBC	4.5 – 6.3	~5.9	240 – 310	~285
Microcytic Anemia	5.5 – 6.3	~5.9	250 – 310	~280
Iron Deficiency Anemia	5.5 – 6.1	~5.8	265 – 300	~280
Normocytic Anemia	5.7 – 6.3	~6.0	275 – 310	~295
Severe Microcytic Anemia	5.5 – 5.9	~5.7	240 – 270	~255

Clinical Interpretation of Anemia Types

Microcytic anemia was the predominant form identified and strongly suggested iron deficiency as the etiology. The microcytosis coupled with hypochromia and elevated RDW reflected classical iron depletion. Iron deficiency anemia was distinguished by hypochromic microcytic indices alongside elevated RDW, underscoring impaired hemoglobin synthesis due to insufficient iron.

Normocytic anemia cases, exhibiting normal MCV but reduced Hb, suggested alternative pathologies possibly including anemia of chronic disease, hemolysis, or acute hemorrhage; further diagnostic workup would be necessary. Severe microcytic anemia with markedly low Hb and red cell indices underlined critical need for urgent intervention and treatment.

Anemia Type	Hematological Features	Clinical Interpretation and Implications
Microcytic Anemia	Low Hb, reduced MCV (<80 fL), low MCH & MCHC	Predominantly suggests iron deficiency; reflects impaired hemoglobin synthesis and production of small, pale RBCs with

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	(hypochromia), elevated RDW	anisocytosis.
Iron Deficiency Anemia	Hypochromic microcytic indices, elevated RDW	Confirmed iron deficiency causing anemia; characterized by significant variation in RBC size; distinct pattern for targeted therapy.
Normocytic Anemia	Low Hb, normal MCV (80–100 fL), normal or mildly altered MCH/MCHC	Indicates alternative causes such as anemia of chronic disease, hemolysis, or acute blood loss; requires further diagnostic evaluation.
Severe Microcytic Anemia	Very low Hb (<8 g/dL), markedly decreased MCV, significant hypochromia, high RDW	Represents advanced iron deficiency or severe microcytic disorders needing urgent clinical intervention and management.

The data demonstrated a high prevalence of anemia in this young female population, with iron deficiency constituting the primary cause. The detailed hematologic parameters confirmed diagnostic patterns consistent with microcytic hypochromic anemia typical of iron-deficiency states. Normocytic anemia cases highlighted the heterogeneity of anemia etiologies in this demographic. The stability of white blood cell and platelet counts further suggested that anemia was not confounded by acute infection or hematologic malignancies.

Discussion

The high prevalence of anemia (51%) in our cohort of young Pakistani females (15-22 years) is remarkably consistent with the significant burden of anemia reported across Pakistan, particularly among women of reproductive age (WRA) and adolescents. This reinforces the notion that anemia remains a major public health concern in the country.

Our finding of 51% anemia prevalence aligns closely with national and regional data from Pakistan. The National Nutrition Survey (NNS) 2018 reported that

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approximately 50% of WRA in Pakistan are anemic, with some estimates ranging from 40-60% (ResearchGate, 2025). This striking similarity underscores the representativeness of our cohort's anemia burden within the broader Pakistani context. More recent localized studies further support this. For example, a study in the Thatta district of Sindh found an even higher prevalence of 61% among enrolled women (ResearchGate, 2025). Another recent study from D.I. Khan, Khyber Pakhtunkhwa (2025, J Soc Obstet Gynaecol Pak), in adolescent school girls aged 11-16 years, reported an alarming anemia prevalence of 82% (urban and rural combined), indicating that anemia can be even more widespread in specific sub-populations within Pakistan. While our prevalence (51%) is lower than this specific D.I. Khan study, it falls comfortably within the range reported by other Pakistani researchers for adolescent girls and young women.

Our study's identification of microcytic anemia (35.3%) and iron deficiency anemia (IDA) (19.6%) as the predominant forms, characterized by low Hb, significantly reduced MCV (23-33 fL), low MCH (20-25 pg), low MCHC (20-29 g/dL), and elevated RDW (>18%), strongly corroborates the findings of numerous Pakistani studies. Pakistani research consistently highlights iron deficiency as the leading cause of anemia in the country due to inadequate dietary intake, poor absorption, and increased physiological demands (ResearchGate, 2025; eCommons@AKU, 2024).

A study on engineering students in Nawabshah, Pakistan (ResearchGate, 2021), though a mixed-gender cohort, also reported significantly lower MCV (70.9±10.3 fL) and MCH (24.4±4.2 pg) in anemic female students compared to non-anemic counterparts, mirroring our observations. Similarly, a study on women in Skardu, Gilgit-Baltistan (PAFMJ, 2024), found reduced Hb levels (mean 9.48±1.59 g/dL) and MCV (79.97±10.7 fL) in anemic women, with younger age groups (18-35 years) being more affected by IDA. The high RDW values (up to 21%) in our severe microcytic anemia cases align with the understanding in Pakistani literature that elevated RDW is a key indicator of iron deficiency and heterogeneous red cell production (PJMD, 2020).

The presence of normocytic anemia (15.7%) in our cohort also resonates with the

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diversity of anemia etiologies recognized in Pakistan. While microcytic anemia is dominant, other forms, potentially including anemia of chronic disease or other nutritional deficiencies (e.g., B12 or folate), are also observed. The NNS 2018, for instance, also reported significant prevalence of vitamin B12 and folate deficiencies among WRA in Pakistan (ResearchGate, 2025), which can contribute to normocytic or macrocytic anemias, though microcytic IDA remains the most prevalent. A study in Lahore found that 38% of anemic patients presented with normocytic normochromic blood picture (PJMHS, 2018), further emphasizing the importance of considering other etiologies beyond iron deficiency in the Pakistani context.

Our finding of consistently normal WBC and platelet counts across all subgroups is a crucial point of agreement with most Pakistani studies focusing on nutritional anemias. Research on anemia in various Pakistani populations, including pregnant women and children (e.g., Isra Medical Journal, 2019; PJMD, 2020), generally shows that uncomplicated iron deficiency or other nutritional anemias do not significantly impact white blood cell or platelet production. This suggests that in our cohort, the anemia is primarily related to erythropoiesis issues rather than underlying infections, inflammatory conditions, or hematologic malignancies that would manifest as abnormal WBC or platelet counts.

Our observation of severe microcytic anemia (Hb < 8 g/dL) in 9.8% of the anemic subgroup highlights the critical severity of the problem in this vulnerable age group. This level of severe anemia is consistently reported in various Pakistani studies, particularly in rural and underserved areas, and is often linked to significant morbidity and mortality (ResearchGate, 2025; PubMed, 2020). For instance, a Peshawar-based study (Entomoljournal, 2017) reported that 56.24% of their anemic patients had severe anemia (though this was an older study and across a broader age range), and the D.I. Khan study found 13% severe anemia in adolescent girls (JSOGP, 2025).

Conclusions

In conclusion, our results strongly align with the existing body of research by Pakistani academics, collectively portraying a high burden of anemia, predominantly iron deficiency, among young females in the country. The characteristic

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hematological parameters observed in our study resonate with the local findings, underscoring the consistent presentation of iron deficiency anemia. The persistent normal WBC and platelet counts, also echoed in Pakistani literature, further delineate the nature of this public health challenge, indicating a primary focus on nutritional interventions. These comparisons reinforce the urgency for comprehensive, culturally sensitive, and sustainable public health programs across Pakistan to address this persistent and widespread issue among its youth

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