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Early CBC Screening for Detecting Subclinical Anemia in Adolescent Females

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ABSTRACT

This cross-sectional study sought to assess the prevalence of subclinical anemia in adolescent females. It recruited a total of 118 adolescent females from 3rd-5th April 2024 via convenient sampling. The females who appeared healthy and had no known prior medical condition were screened for anemia. Demographics, medical history, and vital signs were recorded and CBC and peripheral blood smear tests were performed at Husaini Diagnostic Laboratory. Using SPSS v.25, frequency and percentages for prevalence and Chi-square for association were employed with $p<0.05$ as significant. A substantial part of girls, 35 out of 118 (29.7%) were anemic. Underweight BMI was associated with a higher risk of anemia. Anemia severity was generally mild, with only 8 (6.8%) exhibiting moderate anemia. Microcytic hypochromic RBCs were observed in 23 out of 35 (65.7%) anemic cases, suggesting iron deficiency as the primary cause. However, serum ferritin and hemoglobin electrophoresis were recommended to confirm iron deficiency or thalassemia respectively.

Keywords: Anemia, Thalassemia, Iron Deficiency

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INTRODUCTION

Anemia is a significant medical condition characterized by a deficiency in the quantity or quality of RBC or hemoglobin. It occurs due to multiple causes, ranging from nutritional deficiencies to genetic disorders1. Its prevalence differs by region, age, sex, and specific populations across the world. It affects about 5.6% of the U.S. population and 6.5% of the European population[1, 2] . In the Indian subcontinent, anemia prevalence is higher, ranging between 28%-30% among three of its highly populous countries; India, Bangladesh, and Pakistan. Women are significantly more affected than men in these countries. In Bangladesh, 45% of anemic women belong to this age group, while in Pakistan, the figure is approximately 50% [3].

Anemia can have serious consequences, ranging from mild to life-threatening. It causes fatigue, and weakness, and affects daily activities. It can strain the heart and worsen existing heart conditions[4]. Menorrhagia, heavy menstrual bleeding, is a common cause of anemia. It also poses significant risks during pregnancy. It increases the likelihood of

complications such as preterm birth, low birth weight, and postpartum hemorrhage, affecting maternal and fetal health. Also, it is a known fact that an anemic woman gives birth to an anemic child[2]. Effective management of anemia through proper diagnosis, treatment, and addressing gynecological issues is crucial for improving women's reproductive health and generalized well-being.

Anemia in Pakistan is often undiagnosed due to poverty, lack of awareness, and limited healthcare access. Screening programs can help reduce anemia. Young girls are at increased risk of anemia during adolescence. Early testing and treatment can prevent serious health problems[5].

Therefore, greater emphasis on interventions is crucial to expedite progress towards achieving Global Nutrition Target 2, which aims for a 50% reduction in anemia among women of reproductive age by 2025, and to mitigate the significant health impacts on children [6]. The best way for this reduction is, by identifying anemia before it is clinically evident, called subclinical anemia. This study hence, sought to assess the prevalence of subclinical anemia among adolescent females, based on CBC screening and peripheral blood smear.

METHODS

This is a cross-sectional study for which ethical approval was acquired from Baqai Medical University (Reference # BDC/ERB/2023/045). It enrolled 118 female students of 10-17 years of age, with parental consent of a trust-funded school via consecutive sampling technique from the period of 3rd-5th April 2024. The sample size was calculated by the formula; n=z×p(1-p)/d2 at 95% confidence interval and 10% margin of error. Those who were 10-13 years of age were considered as early adolescents and middle adolescents were within the age range of 14-17 years.

The data obtained included the demographics, history of any medical condition, and their vitals. For sampling, 2-3ml of blood was collected in an EDTA tube and CBC and peripheral blood smear were performed immediately. The healthy females who had no known medical condition were included in the study. Those who had a fever, recent infections, or any hematological disorder were excluded from the study. The blood tests were performed at Husaini Diagnostic Laboratory and findings were reported by a consultant pathologist.

Females were grouped as anemic or non-anemic, based on their hemoglobin (Hb) concentration. Those with hemoglobin levels below 12 g/dL were classified as anemic[7]. The anemic girls were further grouped as mild, moderate, and severely anemic. Hb value <12 g/dL was called mild anemia, values between 8 and 10.9 g/dL as moderate anemia while Hgb <8 g/dL as severe anemia [5]. RBC morphology, platelet count, and WBC count were compared between anemic and non-anemic groups. Females with abnormal red blood cell morphology were recommended for further testing, like iron profile, vitamin B12, and folate levels. A few females showed signs of thalassemia on blood tests and were referred for genetic testing.

The study evaluated the body mass index (BMI) for the age percentile of the females. Students having <5 percentile, were underweight, those having percentile in the range of 5-85 had a healthy weight, 85-95% were considered as at risk of being overweight and >95% were obese.

For data analysis, SPSS 25 was used. Categorical variables were expressed in frequency and percentages and for the association, a chi-square test was employed. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of Anemic Status with Baseline Characteristics of Females (N=118)

Variables	Total	Anemic Status		p-value
		Anemic (n =35)	Non-Anemic (n= 83)	
Age (years)				**0.058**
Early adolescents (10-13years)	63	14 (22.2)	49 (77.8)	
Middle adolescents (14-17years)	55	21 (38.2)	34 (61.8)	

Body Mass Index (kg/m^2)				***0.037**
Underweight	26	13 (50)	13 (50)	
Healthy weight	84	20 (23.8)	64 (76.1)	
At the risk of overweight	8	2 (25)	6 (75)	
BP (mmHg)				**0.712**
Normal	31	10 (32.3)	21 (67.7)	
Low	87	25 (28.7)	62 (71.3)	

Categorical variables described by frequencies (percentages)
* p-value ≤ 0.05 (Chi-Square test)

The study population consisted solely of females from low socioeconomic backgrounds, with nutrient-poor dietary patterns. Out of 118, 63 (53.3%) were early adolescents and 55 (46.6%) were middle adolescents. Anemia was found in (35) 30% of the females, with a higher prevalence in middle adolescents. There was a significant association between body mass index (BMI) and anemia. Out of 26 underweight females, 13 (50%) were seen as anemic, whereas only 20 out of 84 (23.8%) healthy females were anemic.

Blood pressure was low in approximately three-quarters of the females, especially in those with anemia. Some non-anemic girls also had low blood pressure, often accompanied by abnormal red blood cell morphology. The lowest recorded blood pressure was very low (90/30 mmHg), which could lead to dizziness and fainting, as experienced by some girls during the screening.

Most of the female participants in the study had mild anemia, while a few had moderate anemia. No severe cases were identified. Despite having a healthy weight, many of these women were deficient in essential nutrients like iron, vitamin B12, or folic acid, which are common causes of anemia. This highlights the importance of nutritional assessment even in individuals with normal body weight.

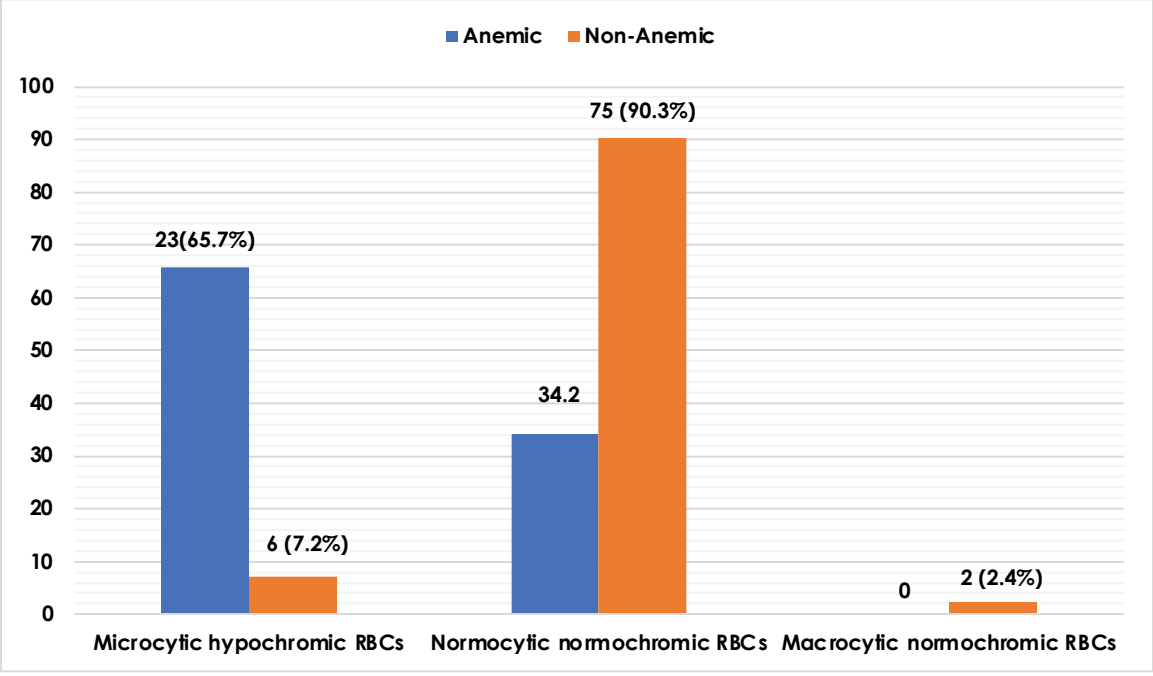

Fig 1: RBC Morphology in Anemic and Non-Anemic Females (N =118)

The majority of anemic females had microcytic hypochromic red blood cells, suggesting iron deficiency or thalassemia. Some non-anemic females also showed this abnormality, indicating a potential risk for future anemia. Two non-anemic females had macrocytic normochromic red blood cells, suggesting vitamin B12 or folic acid deficiency. Nine females were suspected of thalassemia, based on red blood cell morphology, including three non-anemic individuals. Genetic testing was recommended for these cases.

The study compared hematocrit, platelet count, and WBC count between anemic and non-anemic females. Hematocrit levels were significantly lower in anemic females, while no significant differences were found in platelet count or WBC count between the two groups. A few non-anemic females, however, had abnormal WBC and platelet counts (eosinophilia, thrombocytosis, lymphocytosis, leukopenia, or neutrophilia), whereas all anemic females had normal WBC and platelet count.

DISCUSSION

The prevalence of anemia increases with age unexplainably according to different studies, but in this study, anemia was found predominantly in early female adolescents [8]. A greater frequency of microcytic hypochromic RBCs was observed in 65.7% of the anemic females. It indicated a significant deficiency of iron, which is essential for hemoglobin synthesis. The results match the studies done in India and Pakistan [3,4]. In contrast, a study done in Indonesia showed iron deficiency anemia as a mild problem in their study population [9]. The observation that some non-anemic girls also exhibited microcytic hypochromic RBCs is particularly noteworthy. This finding suggests that these girls may be in the early stages of iron deficiency, where the body's iron stores are depleted, but anemia has not yet developed. Non-anemic iron deficiency (NAID) is also termed as 'iron depletion' or 'depleted iron stores' which is less prevalent in the developed world (2-5%) but more common in the developing world, like Pakistan [10]. Its etiological factors include a vegetable diet with less meat content and low-calorie intake as per requirement. The study cohorts met all these criteria, being from a developing country with a low socioeconomic background. Their increased iron needs due to the menstrual cycle were unmet because financial limitations restricted their calorie intake. It reveals the potential for subclinical iron deficiency, which can progress to overt anemia if left unaddressed. While anemia is often associated with hypertension[11], a surprising finding in this study was that a majority of the anemic females had low blood pressure, which in some cases led to dizziness and fainting. These results manifest the importance of screening for RBC morphological abnormalities even in individuals who do not yet meet the clinical criteria for anemia. Such screening can identify early signs of iron deficiency, allowing for timely intervention. Preventive measures might include dietary modifications to increase iron intake, such as consuming iron-rich foods and enhancing iron absorption through vitamin C-rich foods [12].

Underweight individuals are at higher risk of anemia due to nutritional deficiencies. While the link between obesity and anemia is less clear, this study found a higher prevalence of anemia among underweight females. A study done in Bangladesh showed similar results as underweight females were predominantly anemic, whereas overweight ladies had a lower risk of being anemic[13]. Interestingly, the study found that 23.8% of females with a healthy weight were anemic, indicating that malnourishment is not solely confined to underweight status. Rather, individuals with healthy weight or even overweight might lack essential nutrients, necessary for preventing anemia. Anemia in healthy females could also be due to a variety of other factors such as menstrual blood loss, which is a common cause of anemia in adolescent females [4]. There may be undetected genetic abnormalities that may give rise to anemia like Von Willebrand disease, thalassemia, etc. In this study also, we are expecting some undetected cases of thalassemia, based on their RBCs morphology and anemic status, which were referred for genetic evaluation. Overweight girls had a slightly higher risk of anemia compared to healthy-weight girls, but the prevalence was significantly lower than in underweight girls. This suggests that while obesity can pose health risks, it may not be as strongly associated with anemia as underweight status. Overweight individuals might consume more iron-rich foods, helping to reduce the risk of anemia. A study from Mexico indicates that overweight women in developing countries may not be meeting their iron requirements and their intake of other micronutrients might be inadequate [14]. These findings support our results and demonstrate that diet quality remains a significant concern even for women who have sufficient energy intake. The strength of this study holds in the idea that early blood tests can help identify anemia in young females, many of whom don't know that they have it. While this study found many undiagnosed cases, more information about menstrual cycles, diet, and other tests would provide a clearer picture of the type of anemia.

CONCLUSION

Subclinical anemia is common in adolescent females with microcytic hypochromic RBCs as being the most prevalent. The most likely cause of this appearance could be iron deficiency, although it could also be attributed to thalassemia. For these reasons, such females were advised to undergo

tests, including serum ferritin and electrophoresis. Underweight females are at higher risk for anemia. Early detection through regular blood tests can help improve the health of young females.

LIST OF ABBREVIATIONS
CBC: Complete Blood Count
Hb: Hemoglobin
RBC: Red Blood Cells
WBCs: White Blood Cells

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Self-funded

CONFLICT OF INTEREST
None

ETHICAL APPROVAL
Ethical approval was acquired from Baqai Medical University (Reference # BDC/ERB/2023/045).

AUTHOR CONTRIBUTIONS
SS: Substantial contribution to the conception of work analysis and write-up and **RPA:** contributed to the conception and data collection; **UN:** Revised the draft critically; **US:** drafted and revised the draft critically; **AJM:** Final approval of the final draft.

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