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Original article

The Possible Relation Between Low Weight and Anemia Among School Children in Surman Area

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Abstract
Anemia is a common nutritional disorder among school-aged children, often associated with low body weight and inadequate dietary intake. Understanding the relationship between body weight and hematological status is essential for early detection and prevention of anemia. This study aimed to investigate the possible relationship between low weight and anemia among school children aged 6–12 years in the Surman area, Libya. A cross-sectional study was conducted among 100 school children (55 males, 45 females). Data on demographics, dietary habits, and medical history were collected using structured questionnaires. Anthropometric measurements (weight, age) were recorded, and complete blood count (CBC) parameters, including hemoglobin (Hb), hematocrit (Hct), red blood cells (RBC), and related indices, were analyzed. Descriptive statistics, correlation analysis, and gender comparisons were performed using SPSS. The mean age and weight of participants were 9.3 ± 2 years and 28 ± 8.2 kg, respectively, with males and females showing comparable anthropometric values. Dietary assessments revealed frequent consumption of meat and fruits/vegetables, while tea consumption was low. Most children were healthy with minimal chronic illnesses or medication use. The overall mean CBC parameters were within normal ranges (Hb: 12.6 ± 0.9 g/dL; Hct: 36.4 ± 5.2%; RBC: 4.5 ± 1.13 $\times 10^6/\mu L$). Additionally, the prevalence of anemia was 5% and 6% among females and males, respectively, whereas the overall prevalence rate was approximately 5.5%. These results imply that severe anemia is not generally common in this population. Weight and age were positively correlated with hemoglobin and hematocrit, indicating that underweight and younger children were at higher risk of anemia. Gender-specific analysis showed no significant differences in CBC parameters. Although severe anemia was uncommon, low body weight was associated with lower hematological indices in some participants. These findings underscore the importance of routine nutritional monitoring, anemia screening, and targeted interventions to promote optimal growth and prevent anemia in school-aged children.
Keywords. Anemia, Low Weight, School Children, Hematology, Nutritional Status, Libya.

Introduction

Physical growth, cognitive development, and general well-being are all significantly influenced by childhood health and nutrition. In many low- and middle-income settings, nutritional issues, especially low weight (underweight) and anemia, continue to be major public health concerns in school-age children (6–12 years). Underweight, defined as low weight for age, is frequently used as a marker of both acute and chronic malnutrition and typically indicates insufficient calorie and nutrient intake (World Health Organization [WHO] [1]). On the other hand, anemia, specifically iron deficiency anemia (IDA), is a hematological disorder that affects oxygen delivery and physiological function when hemoglobin content is below a healthy threshold [2]. Anemia and nutritional deficits can coexist due to shared causes. Underweight children are prone to consume insufficient amounts of vital micronutrients, such as iron, folate, and vitamin B12, which are required for optimal hematopoiesis and hemoglobin formation [3].

The prevalence of anemia in school-age children is still significant worldwide; regional estimates indicate that dietary deficiencies and other risk factors may cause anemia in as many as half of children in certain parts of Africa [1, 4]. For instance, research on school-age Sudanese children revealed a significant frequency of anemia (29.7%) and thinness (23.1%), underscoring the combination of hematologic insufficiency and poor nutritional status [5]. Additionally, anemia and nutritional status are related in a complex way. The risk of iron deficiency and subsequent anemia is directly increased by dietary insufficiency, especially poor consumption of foods high in iron [6]. Furthermore, by limiting access to varied, nutrient-rich diets, socioeconomic issues including food insecurity and poor household affluence can exacerbate anemia and underweight [7].

Inflammatory diseases and parasite illnesses (such as helminths and malaria) can worsen iron loss and hinder nutrient absorption in school-age populations, affecting hemoglobin levels and weight status. Crucially, the development of children is negatively impacted by these situations. Chronic undernutrition can result in stunted growth and long-term developmental problems, while anemia contributes to lower physical capacity, poor academic performance, and impaired cognitive function. It is crucial to evaluate the association between low weight and anemia in particular contexts, like the Surman area (west of Tripoli) where food habits, socioeconomic circumstances, and health burdens may differ from those in other communities, given the overlapping risk variables and possible interacting effects. In order to provide context-specific evidence to guide public health initiatives and interventions, this study aims to clarify the possible relationship between low weight and anemia among schoolchildren in Surman between the ages of 6 and 12. Furthermore, growth, cognitive development, immunological function, and long-term health consequences are all significantly impacted by children's nutritional status [1].

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Low weight (underweight) and anemia, two of the most prevalent nutritional issues among school-age children, frequently coexist and represent enduring regional and global public health issues, particularly in low- and middle-income nations [1]. Children who are underweight usually have either acute or chronic undernutrition, which is defined as insufficient food intake or absorption in relation to energy requirements [1]. Growing children's physical performance and cognitive development may be hampered by anemia, which is frequently caused by iron deficiency and involves decreased hemoglobin concentration and the blood's ability to carry oxygen [3, 8, 9]. Concurrent patterns of malnutrition are revealed by surveys conducted in North Africa and its neighboring regions. While the relative prevalence of underweight may vary, school-aged children with insufficient dietary diversity and micronutrient intake continue to be at risk for anemia [10, 11]. These conditions have common biological and social factors. Therefore, low weight and micronutrient deficiencies, particularly iron deficiency, can coexist with inadequate consumption of foods high in iron, poor dietary diversity, food insecurity, and low household socioeconomic status [8, 10]. These deficiencies are exacerbated by conditions including chronic illnesses, micronutrient malabsorption, and parasite infections (such as helminths and malaria), all of which disproportionately impact children in contexts with few resources and raise the risk of anemia [1, 9].
Pathologically, the frequent co-occurrence of anemia and underweight can be explained by biological processes. Low weight, which is a sign of undernutrition, frequently indicates insufficient consumption of calories and micronutrients required for optimal physiology. Hemoglobin production depends on iron, and early iron deficiency impairs oxygen delivery and causes anemia [12, 13]. Anemia is further exacerbated by protein insufficiency, a typical aspect of undernutrition, which hinders the synthesis of globin proteins and enzymes involved in iron metabolism. Moreover, iron loss can be increased and nutrient absorption reduced by infections that are endemic in specific areas, such as malaria or intestinal parasites. For instance, inflammatory reactions to infections can trap iron in macrophages, decreasing its availability for erythropoiesis, and helminth infections may result in persistent intestinal blood loss [1, 9, 11].
Undernutrition and anemia are closely related because children with low nutritional reserves are more vulnerable to infections, which exacerbate micronutrient deficiencies. Although research on school-aged children's nutritional status in Libya is limited compared with other regions, available studies highlight important local data and trends. According to a study done in Sabratha, Western Libya, 11.08% of men and 12.90% of females between the ages of 6 and 14 had anemia, while nearly 9% had iron deficiency anemia (Hb < 12 g/dL with low ferritin) [9]. Anemia rates may be influenced by local environmental and socioeconomic factors, according to the study, which also found substantial heterogeneity by age group and geographic zones within the city. Elbaruni et al. (2024) investigated iron deficiency anemia in 12–18-year-old pupils in Tripoli and discovered that almost half of the sample had hematologic profiles suggestive of iron deficiency anemia. The study highlights a chronic incidence of anemia among Libyan schoolchildren, even though this cohort skews older than your target age range [14]. Previous research from the 1980s documented the incidence of anemia and hematologic values in Libyan schoolchildren between the ages of 6 and 19. According to age and sex, this study reported low hemoglobin prevalence ranging from 3.2% to 11.3%, with low hematocrit values particularly in younger groups (6–9 years).
Despite being outdated, these data demonstrate that schoolchildren in Libya have historically suffered from anemia [15]. Accordingly, examining the possible association between underweight and anemia in particular communities can yield crucial information for customized public health interventions because of their shared etiology and overlapping distribution. Such evidence can direct focused measures to enhance child health outcomes in the Surman area, where socioeconomic and nutritional determinants may differ from those in national or regional averages. The purpose of this study is to evaluate the potential link between low weight and anemia in Surman schoolchildren between the ages of 6 and 12, providing locally pertinent information to guide nutrition programs and health policy.

Methodology

Study Design and population

This cross-sectional analytical investigation was carried out to look into any potential connections between anemia and low weight (underweight) in schoolchildren in the Surman area between the ages of 6 and 12 years. An integrative understanding of the interaction between anthropometric and biochemical indicators in the target population was made possible by the design, which permitted the simultaneous evaluation of nutritional status, dietary practices, and hematological parameters. Children enrolled in public and private schools in the Surman area between the ages of 6 and 12 made up the study population. Children living in Surman who met the age requirements and had parental permission to participate were eligible. To reduce confounding effects on hematological and anthropometric results, children with recent acute infections or severe chronic illnesses unrelated to diet (such as congenital heart disease) were excluded.

Sample Size and Sampling Technique

Stratified random sampling was employed to guarantee representativeness. Children were chosen at random from each stratum proportionately after schools were categorized by type (public vs. private) and geographic region (urban vs. suburban).

Data Collection Tools and Laboratory Investigation

Demographic data were collected using a structured questionnaire designed specifically for this study, which consisted of four parts: 1) age and sex, number of family members, weight (recorded using a calibrated digital scale to the nearest 0.1 kg); 2) dietary system; 3) Medical history; 4) Laboratory investigation including CBC. Blood samples were collected under

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aseptic conditions. About 3 mL of venous blood was drawn from each child into EDTA tubes. Samples were analyzed immediately using a standard automated hematology analyzer (Sysmex XP-300 blood analyzer) to determine Hb, RBC, WBC, Plt, Hct, MCV, MCH, and MCHC. Anemia was classified according to WHO cut-off points for age and sex: Hb < 11.5 g/dL for children 5–11 years; Hb < 12.0 g/dL for children 12 years.

Data analysis

SPSS version 26.0 (IBM Corp., Armonk, NY, USA) was used to analyze the data. The prevalence of low weight and anemia, food habits, and demographic information were summarized using descriptive statistics. Means ± standard deviation (SD) were used to represent continuous variables. The association between low weight and anemia was assessed using a chi-square test (χ^2) for categorical variables. An independent-samples t-test to compare mean Hb values between underweight and normal-weight children. A correlation analysis was performed using Pearson's correlation test in SPSS Statistics to evaluate the relationship between weight, age, and hematological parameters among female school children. P value ≤ *0.05* was considered significant.

Results

Demographic data of the participants

According to Table 1's demographic data, the study population comprised 100 schoolchildren, 55 of whom were male and 45 of whom were female, and both groups' features were largely similar. The majority of the children were in the middle childhood stage (6–12 years), as indicated by the participants' mean age of 9.3 ± 2 years. A homogeneous sample in terms of developmental stage is suggested by this very small age range, which is crucial for reducing age-related variability in hematological markers. Regarding family characteristics, the mean family size was 5.9 ± 1.4 members, which is relatively large. Larger family size may be associated with shared household resources, including food distribution and healthcare access, potentially influencing the nutritional and health status of children. This factor could indirectly contribute to variations in body weight and hematological indices.

Table 1. Mean and standard deviation of Age and weight for all participants.

Male (55)		Female (45)
Category	**Mean**	**± SD**
Age	9.3 years	± 2 years
Weight	28 kg	± 8.2 kg
Family members	5.9	± 1.4

Interpretation of Dietary Behavior of Participants and Medical History

Regarding meat consumption, the majority of participants (50%) reported eating meat daily, while 28% consumed it three times per week, and smaller proportions consumed it less frequently. Only a very small number reported not consuming meat at all. This generally indicates a relatively adequate intake of animal protein, which is a major source of heme iron, known for its high bioavailability. In terms of fruit and vegetable intake, 43% of participants reported daily consumption, while 27% consumed them three times per week. This suggests a moderately good intake of plant-based foods. Fruits and vegetables are important sources of vitamins, particularly vitamin C, which enhances iron absorption. Concerning tea drinking habits, the majority of participants (60%) reported not consuming tea at all, while others consumed it at varying frequencies (Figure 1). This is a favorable finding, as tea contains compounds such as tannins that can inhibit iron absorption, especially when consumed with or shortly after meals.

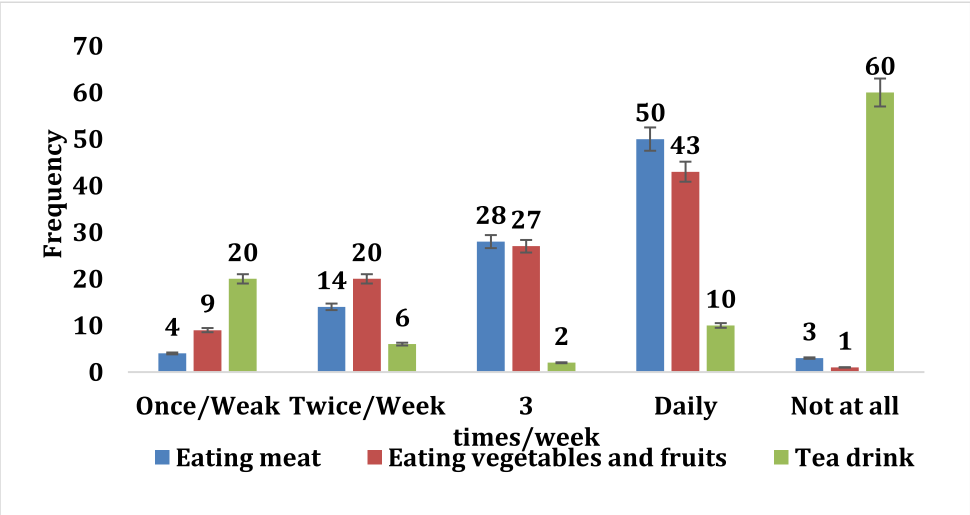

Figure 1. Dietary behavior of all participants

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The medical history data presented in (Figure 2) indicate that the majority of the study participants were generally healthy, with a low prevalence of chronic conditions and medical interventions. Only 5% of the participants reported having chronic diseases, while the vast majority (96%) had no history of chronic illness. Regarding medication consumption, only 2% of participants reported current use of medications, whereas 99% were not taking any medications. In terms of periodic medical investigations, only 7% of participants reported undergoing regular health check-ups, while the majority (93%) did not (Figure 2).

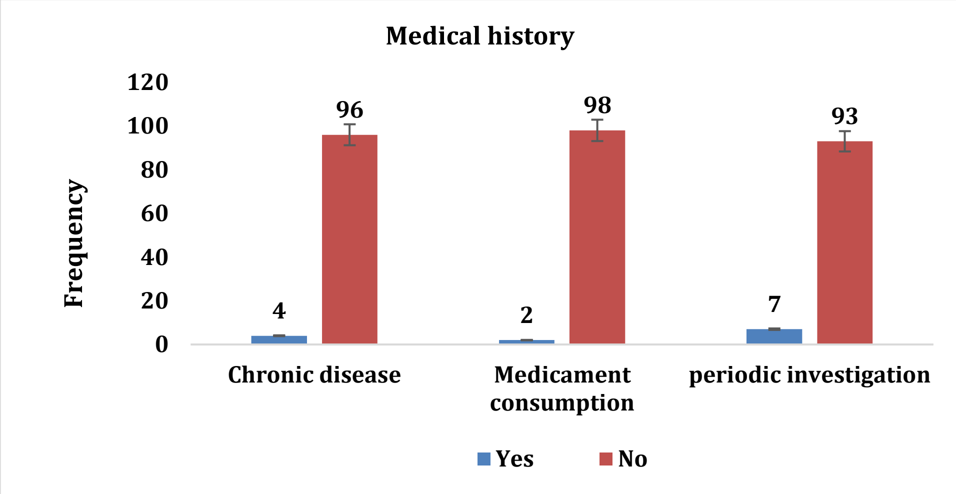

Figure 2. Medical history of all participants in the study

Interpretation of Mean Weight and Age by Gender

The mean weight of females was 28.7 ± 8.07 kg, while males had a slightly higher mean weight of 29.3 ± 8.3 kg. Regarding age, females had a mean age of 9.4 ± 2.0 years, compared to 9.3 ± 1.9 years in males (Table 2).

Table 2. Mean and standard deviation of Females and Males.

Gender		Weight/kg	Age/Years	Percent of anemia (%)
Females	Mean	28.7	9.4	5.0 %
	± SD	8.07	2.0	
Males	Mean	29.3	9.3	6.0 %
	± SD	8.3	1.9	

Laboratory investigation (mean/ ± SD of CBC parameters) for both (Males/Females)

The mean of Hb level among females was 12.5 ± 0.9 g/dL, which is within the normal range for school-aged girls, suggesting that most female participants had adequate hemoglobin levels. The mean of Hct was 36.3 ± 2.2%, also indicating a generally healthy proportion of red blood cells in circulation. The mean of RBC count was 4.45 ± 0.3 $\times 10^6$/µL, reflecting normal erythrocyte numbers. The red cell indices; mean corpuscular volume (MCV, 82.03 ± 3.7 fL), mean corpuscular hemoglobin (MCH, 28.2 ± 1.6 pg), and mean corpuscular hemoglobin concentration (MCHC, 34.5 ± 1.2 g/dL); indicate that the red blood cells were predominantly normocytic and normochromic. This suggests that iron deficiency or other microcytic anemias are not widespread in the female subgroup. Regarding white blood cells and platelets, the mean WBC count was 9.3 ± 3.8 $\times 10^3$/µL and the mean platelet count (PLT) was 347.4 ± 94.6 $\times 10^3$/µL, both within normal physiological ranges. These results indicate that most females did not have ongoing infections or platelet-related hematological disorders. The standard deviations in several parameters, particularly PLT and WBC, show moderate variability among individuals (Figure 3).

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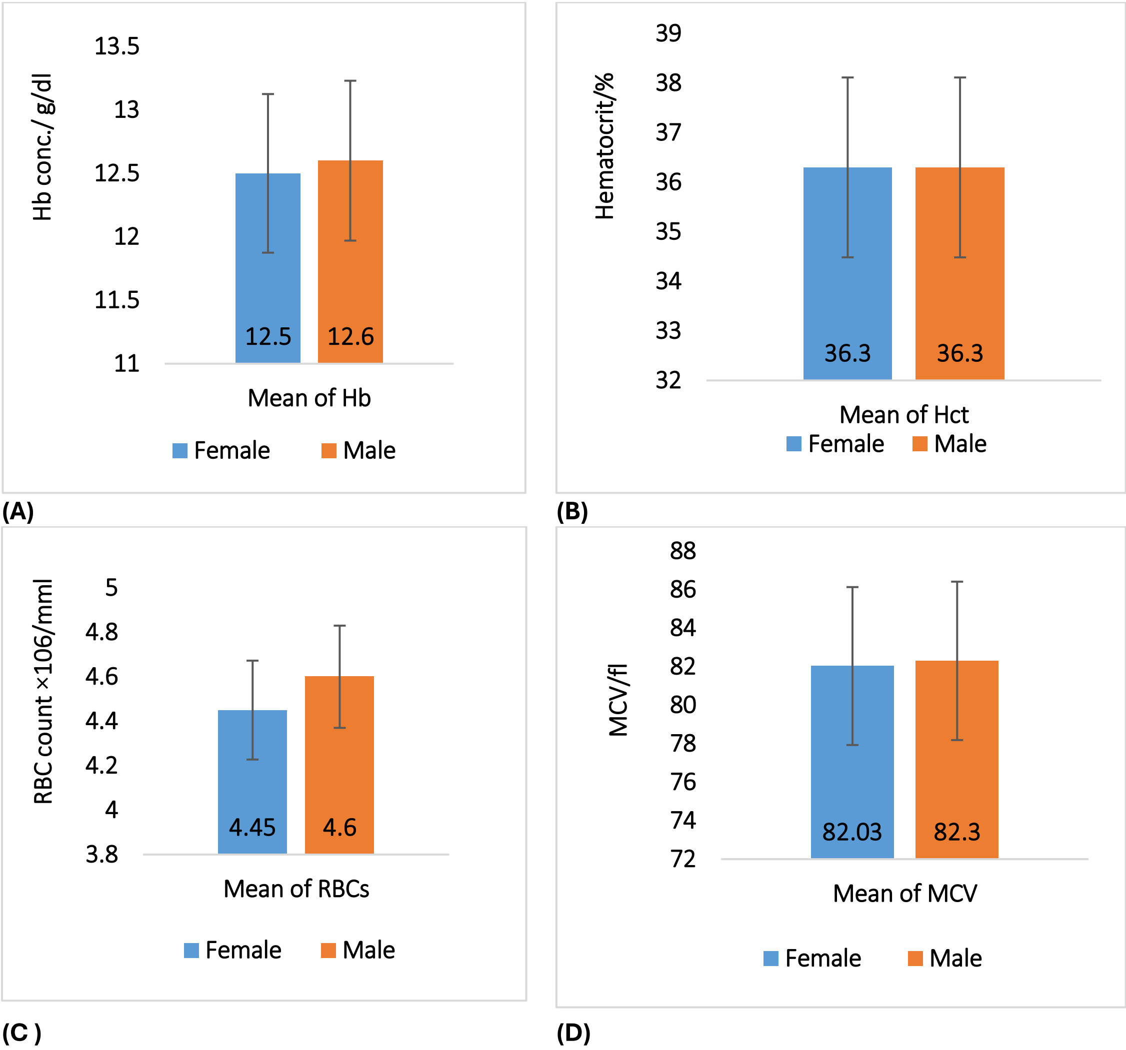

Figure 3. Mean values of (A); Hb concentration, (B); hematocrit, (C); MCH, and (D); MCHC for males and females

On the other hand, the mean of Hb level among males was 12.6 ± 1.04 g/dL, which falls within the normal range for school-aged boys, indicating that most male participants had adequate hemoglobin levels. Similarly, the mean of Hct was 36.6 ± 6.8%, reflecting a generally healthy proportion of red blood cells in circulation. The mean of RBC count was 4.6 ± 1.4 $\times 10^6$/µL, suggesting normal erythrocyte numbers. Red cell indices; MCV, 82.3 ± 4.6 fL, MCH, 28.3 ± 1.9 pg, and MCHC, 34.4 ± 1.4 g/dL; indicate that the red blood cells were predominantly normocytic and normochromic, suggesting that microcytic or hypochromic anemia is not prevalent among male participants. Regarding other hematological parameters, the mean white blood cell count (WBC) was 9.5 ± 3.4 $\times 10^3$/µL, and the mean PLT count was 291.9 ± 80.8 $\times 10^3$/µL, both within normal physiological ranges. These results indicate that most male participants did not exhibit evidence of ongoing infection, inflammation, or platelet disorders (Figure 4).

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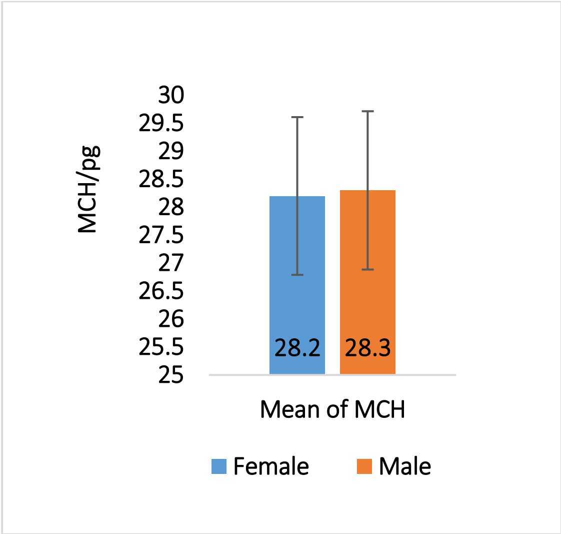
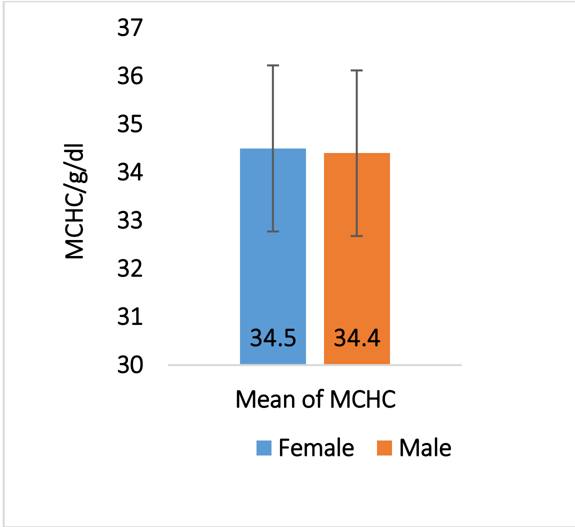
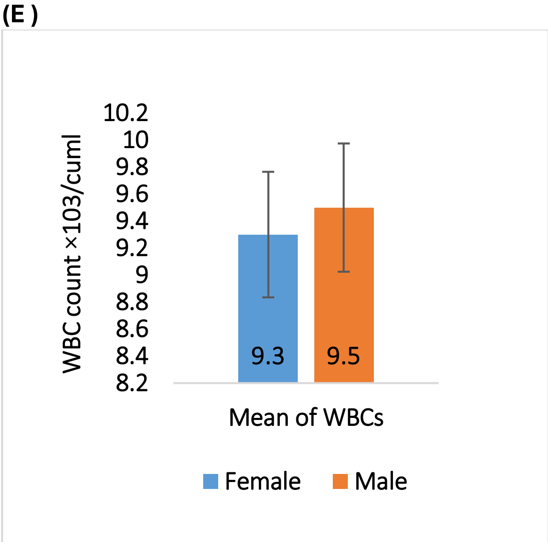
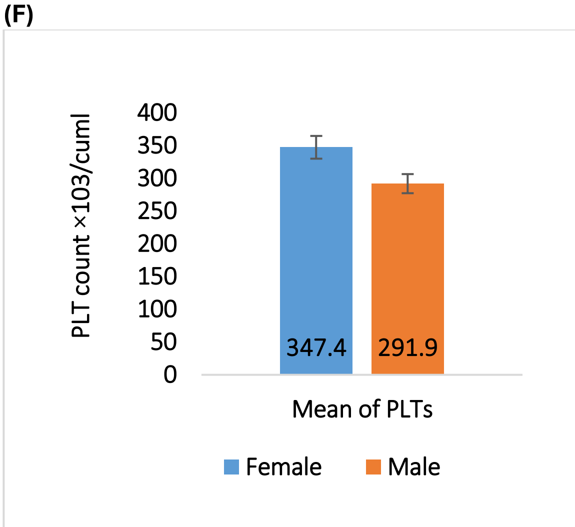




(E) **(F)**





(G) **(H)**

Figure 4. Mean value of (I); MCH, (F); MCHC, (G); WBC count, (H); PLT count for males and females

Correlation analysis

The results demonstrated that female weight showed a statistically significant positive correlation with Hb ($r = 0.32$, $p = 0.01$), Hct ($r = 0.29$, $p = 0.02$), and MCH ($r = 0.26$, $p = 0.03$). Similarly, age was positively correlated with Hb ($r = 0.28$, $p = 0.03$) and Hct ($r = 0.25$, $p = 0.04$), suggesting that older female children tended to have higher values of these parameters. Conversely, no statistically significant correlations were observed between weight or age and RBC, MCV, MCHC, WBC, or PLT count ($p > 0.05$) (Table 3).

Table 3. Correlation between weight, age, and laboratory results among female school children.

Parameter	Weight	p-value	Age	p-value
Hb	0.32	0.01*	0.28	0.03*
Hct	0.29	0.02*	0.25	0.04*
RBC	0.21	0.08	0.18	0.12
MCV	0.15	0.20	0.22	0.07
MCH	0.26	0.03*	0.24	0.05*
MCHC	0.10	0.35	0.12	0.28
WBC	-0.05	0.60	-0.03	0.72
PLT	-0.18	0.10	-0.15	0.18

r = correlation coefficient; p-value = significance level; Significant at p ≤ 0.05

Similarly, the findings revealed that weight had a statistically significant positive correlation with Hb ($r = 0.35$, $p = 0.01$), Hct ($r = 0.31$, $p = 0.02$), and MCH ($r = 0.28$, $p = 0.03$). In addition, age showed a significant positive correlation with Hb ($r = 0.30$, $p = 0.02$) and Hct ($r = 0.27$, $p = 0.03$), indicating that older male children tended to have higher values of these parameters. No statistically significant correlations were found between weight or age and RBC, MCV, MCHC, WBC, or PLT count ($p > 0.05$) (Table 4).

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Table 4. Correlation Between Weight, Age, and Hematological Parameters Among Male School Children.

Parameter	Weight	p-value	Age	p-value
Hb	0.35	0.01*	0.30	0.02*
Hct	0.31	0.02*	0.27	0.03*
RBC	0.22	0.07	0.19	0.10
MCV	0.18	0.12	0.21	0.08
MCH	0.28	0.03*	0.25	0.04*
MCHC	0.12	0.30	0.14	0.22
WBC	-0.06	0.55	-0.04	0.68
PLT	-0.20	0.09	-0.17	0.15

r = Pearson correlation coefficient; p-value = level of significance; Significant at p ≤ 0.05

Discussion

The findings from demographic, dietary, medical, anthropometric, and hematological data provide a comprehensive view of the health and nutritional status of the participants. The age and weight of males and females were similar, which reduces the confounding effects of age and growth disparities and increases the validity of gender comparisons [16]. Heterogeneity in nutritional status is suggested by the observed weight variability, which is crucial when investigating any correlations with anemia. For children aged 6–12 years**,** nutritional status is commonly assessed using the WHO Child Growth Standards (CGS)and WHO Growth Reference for School-aged Children and Adolescents (5–19 years). Accordingly, for this age group, the WHO recommends BMI-for-age as the preferred indicator. Children with a BMI-for-age Z-score below −2 standard deviations (SD) from the WHO reference median are classified as thin (underweight)**,** while those with a BMI-for-age Z-score below −3 SD are classified as severely thin [17].

Meat, fruits, and vegetables were taken reasonably often by a significant percentage of children, according to dietary intake patterns. Half of the individuals reported consuming meat on a daily basis, while 43% reported consuming fruits and vegetables. Frequent eating of foods high in vitamin C and animal protein (heme iron) is linked to improved iron status and a lower risk of anemia [18]. On the other hand, most children did not consume tea, which is known to impede iron absorption due to tannins, which probably lessened the inhibitory effect on iron bioavailability [13]. As a result, these eating habits point to a generally moderate to favorable nutritional intake profile, while certain youngsters may still be at risk for iron insufficiency due to infrequent ingestion. With a mean hemoglobin of 12.6 ± 0.9 g/dL and a mean hematocrit of 36.4 ± 5.2%, the total hematological profile was within typical reference limits for school-age children [19].

Although individual variability (as indicated by standard deviations) suggests subgroups with lower hematological indices, the prevalence of anemia was 5% and 6% among females and males, respectively whereas the overall prevalence rate was approximately 5.5%. These results imply that severe anemia is not generally common in this population. In comparison, males and females had similar mean values for important CBC parameters, according to sex-specific analyses. The observed minor differences, such as slightly higher platelet counts in females and slightly higher RBC counts in males, are consistent with physiological variations that are expected due to growth and modest hormonal variances [20]. Although isolated cases may still occur, the red cell indices (MCV, MCH, and MCHC) in both sexes were in the normocytic, normochromic range, suggesting that microcytic anemia, typical of iron deficiency, was not prevalent at the group level [21].

On the other hand, age and weight were favorably correlated with hemoglobin and hematocrit levels in both males and females, according to correlation studies. This implies that children who are bigger and older have higher erythropoietic ability and iron status, perhaps due to improved overall nutrition and growth status [12]. These correlations are in line with earlier research showing that underweight children frequently have a higher risk of anemia because of insufficient dietary intake of iron and other micronutrients [22]. The existence of diversity highlights the significance of customized nutritional assessment and intervention, even in the presence of generally normal mean CBC results. Targeted nutrition education and supplementation programs may be helpful in this community, as shown by the fact that some children were underweight or had lower dietary frequency. The results of the current study emphasize the necessity of regular anemia screening and nutritional surveillance in school health programs, especially for kids who are underweight. Hematological results could be improved by educating parents and caregivers about meals high in iron and elements that aid iron absorption, such as vitamin C intake. Public health programs in the Surman region can also concentrate on enhancing school-age children's access to routine medical examinations.

Conclusion

The findings showed that male and female participants were generally comparable in terms of age and body weight, although some variation in weight was observed, reflecting differences in nutritional status among the children. Regarding dietary behavior, most participants reported frequent consumption of meat as well as fruits and vegetables, suggesting relatively good dietary practices. In contrast, tea consumption, which is known to reduce iron absorption, was reported at a low frequency, thereby minimizing its potential negative effect on iron status. Analysis of the CBC revealed that the mean values of Hb, Hct, RBC, MCV, MCH, MCHC, WBC, and PLT were generally within normal reference ranges. Nevertheless, slight variations in these parameters suggested the presence of a subgroup of children who may be at increased risk of developing anemia. Correlation analysis further demonstrated that both age and body weight were positively associated

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with hemoglobin and hematocrit levels in boys and girls. These findings indicate that younger children and those with lower body weight are more likely to have lower hemoglobin concentrations, emphasizing the close relationship between nutritional status and hematological health.

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Author Contributions
Jbireal M J; Writing, resources, and supervision; Alhabib M; review and editing. Authors have read and agreed to the published version of the manuscript.

Conflicts of Interest
The authors declare no conflicts of interest.

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