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Iron-Deficiency Anemia and School Functioning among Children and Adolescents in Saudi Arabia: A Cross-Sectional Study

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ABSTRACT: Anemia is common among children and adolescents and is associated with reduced attention and academic achievement. However, evidence regarding its relationship with school functioning in Saudi Arabia remains limited. This study examined the association between reported iron-deficiency anemia (IDA) status and school attendance, academic performance, and academic competence among children and adolescents in Saudi Arabia. A quantitative cross-sectional study used a structured self-administered online questionnaire distributed to parents of children and adolescents aged 6-18 years. The final analytical sample comprised 167 participants. Of the 167 participants, 113 (67.7%) had a reported IDA diagnosis. Pearson's chi-square analysis showed a significant association between reported IDA status and school absence exceeding five days per semester ($\chi^2 = 6.49$, $p = 0.039$). No significant associations were found with late school arrival, overall academic performance, or performance compared with classmates. Total academic competence scores did not differ significantly between children and adolescents with and without reported IDA (22.84 ± 4.10 vs. 23.07 ± 3.46, $t = 0.30$, $p = 0.761$). However, difficulty remembering lessons was significantly associated with reported IDA status ($\chi^2 = 10.49$, $p = 0.033$). These findings require cautious interpretation given the cross-sectional design, non-probability sampling, and reliance on reported measures. Future research should employ representative samples, laboratory-based iron status assessment, validated academic and cognitive measures, and official school records to clarify these associations.

1. INTRODUCTION

Anemia is a condition in which the hemoglobin concentration or number of red blood cells is below the age- and sex-appropriate reference range, reducing the blood's oxygen-carrying capacity [1]. It has multiple causes, including nutritional deficiencies, chronic diseases, infections, and inherited red blood cell disorders [1]. Iron deficiency anemia (IDA) is the most common nutritional cause of anemia and is particularly important among children and adolescents because of its potential effects on cognitive and physical development [2].

Anemia is a major global health concern, particularly among children and adolescents. According to the World Health Organization, roughly 40% of children aged 6–59 months globally have anemia [1]. A multi-center Saudi Arabian study conducted in Riyadh reported a prevalence of IDA of 9.2% among children, with 72.3% of cases classified as mild and 27.7% as moderate; no severe cases were identified [2].

Globally, a multi-country analysis of children aged 5–19 years reported a median anemia prevalence of 16%, with the highest prevalence (24%) among females aged 15–19 years [3]. In Saudi Arabia, anemia remains a significant public health issue, with a reported prevalence of 39.1% among children and adolescents in a study conducted in Khulais [4].

School functioning is a multidimensional concept that may include school attendance, academic performance, academic competence, and other domains of daily functioning [5]. Several studies have examined associations between anemia or IDA and indicators of educational and cognitive performance [5-9]. A large study conducted in India investigated the relationship between anemia and school attendance among adolescents aged 15–18 years using nationally representative data [5]. Conventional regression models showed a small association between anemia and school attendance; however, household fixed-effects models found little evidence of a significant association, highlighting the potential influence of household-level confounding [5].

A study in China examined the relationship between anemia and academic performance among 17,695 fourth-grade students [7]. Students without anemia had higher average scores in Chinese, Mathematics, and English, and multivariable analyses showed a negative association between anemia and academic performance [7].

In Ethiopia, a study of 442 adolescent schoolgirls examined the association between anemia and academic performance [9]. The study reported an association between anemia and poorer academic performance, although the findings were based on a school-based cross-sectional design and therefore did not establish causality [9].

A study conducted in Egypt assessed the relationship between IDA and cognitive function among school-aged children and reported poorer cognitive performance among children with IDA [6]. Similarly, evidence from India has linked IDA with lower scholastic performance, attention, memory, and IQ among adolescent girls [8].

A systematic review of iron status, anemia, and academic and cognitive outcomes among adolescents concluded that the available evidence is mixed and generally of low quality, with associations observed in some settings but not in others [10].

There is a significant lack of studies examining anemia and its association with school functioning among children and adolescents in Saudi Arabia. Therefore, further research is warranted to examine multiple dimensions of school functioning and to identify potentially modifiable factors associated with educational outcomes. The aim of this study was to examine the association between reported IDA status and school attendance, academic performance, and academic competence among children and adolescents in Saudi Arabia.

2. MATERIALS AND METHODS

2.1 Study design and setting

This study used a quantitative cross-sectional design to assess the association between reported IDA status and school functioning among school-aged children and adolescents in Saudi Arabia.

Data collection was conducted through community-based online recruitment. An online data-collection approach was adopted using a Google Forms-based survey distributed through WhatsApp groups and targeted social media platforms across Saudi Arabia.

2.2 Sampling and recruitment

A combination of convenience and snowball sampling methods was employed to recruit eligible parents of children and adolescents with and without a reported diagnosis of IDA. Convenience sampling was selected for accessibility and availability, while snowball sampling allowed participants to share the survey with other potentially eligible families.

Eligible participants were parents of children and adolescents aged 6–18 years. The primary exposure was reported IDA status, categorized as a current, parent-reported diagnosis of IDA or no reported diagnosis of IDA. Diagnostic status was obtained through parent-report and was not independently verified using laboratory records. Because laboratory results were not independently reviewed, the exposure should be interpreted as reported diagnostic status rather than objectively confirmed IDA. Children and adolescents classified as having no reported IDA were not necessarily confirmed to be free of anemia or iron deficiency. Children and adolescents without a reported diagnosis of IDA were eligible for inclusion in the comparison group. Exclusion criteria included age younger than 6 years or older than 18 years, not being enrolled in school, and having chronic conditions that could substantially affect school functioning, including neurological disorders, cancer, sickle cell disease, or thalassemia.

The required sample size was calculated using G*Power (version 3.1.9.7) for an independent-samples t-test comparing school functioning scores between participants with and without reported IDA. Assuming an effect size of d = 0.44, a two-sided alpha

level of 0.05, and 80% power, the required sample size was estimated at 166 participants. The final sample included in this study was 167 participants.

2.3 Data collection and recruitment procedures

A structured, self-administered questionnaire was used to collect data for this study. The questionnaire was developed based on the relevant literature and previously used instruments and was adapted to the objectives of the current study [10,11].

The questionnaire consisted of four sections. The first section collected demographic information, including age, gender, school level, school type, region, nationality, parents' education level, monthly household income, and access to healthcare services. The second section assessed anemia history and included reported IDA diagnosis, reported cause, duration, treatment, laboratory testing, and symptoms.

The third section assessed three domains of school functioning: school attendance, academic performance, and academic competence. School attendance included the number of absent days during the semester (0–2, 3–5, or more than 5 days) and the frequency of late arrivals to school (rarely, sometimes, often). Academic performance was measured by parent-reported performance level (below average, average, above average) and included overall academic performance and performance compared with classmates. Academic competence was assessed using seven Likert-scale items adapted from relevant instruments and literature [10,11]. The items evaluated class participation, lesson understanding, concentration, task completion, fatigue during school, memory, and need for assistance. Three items in the academic competence scale were negatively worded: "Needs frequent assistance," "Has difficulty remembering lessons," and "Appears tired during the school day." Because these items are phrased in the opposite direction of the construct being measured, reverse coding was applied before analysis. The academic competence scale used a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The scores for these three negatively worded items were reversed so that a response of 1 became 5, 2 became 4, 3 remained 3, 4 became 2, and 5 became 1. After reverse coding, higher scores reflected higher academic competence across all items. The total academic competence score was calculated as the sum of the seven items (possible range 7–35) and compared between children and adolescents with and without reported IDA. The internal consistency of the study scale was assessed using Cronbach's alpha. The estimated Cronbach's alpha value of the study scale was 0.81 for the anemia symptom frequency scale, and 0.72 for the academic competence scale indicating good internal consistency.

The fourth section assessed children and adolescents' lifestyle and health-related factors that may influence school functioning and potentially confound the relationship between anemia and school functioning. The section included two variables: average daily sleep duration and level of physical activity. Participants were asked to report child or adolescent's average sleep duration as less than 6 hours, 6-8 hours, or more than 8 hours per day. Physical activity level was assessed using three response categories: low, moderate, and high.

The questionnaire was translated into Arabic using a forward–backward translation procedure to support linguistic and conceptual equivalence. Minor modifications were made to improve clarity and suitability of the target population. Content validity was assessed through an expert review by five nursing specialists: three in Maternal and Child Health Nursing, one in Intensive Care and Emergency Nursing, and one in Psychiatric and Mental Health Nursing. The experts reviewed the questionnaire for relevance, clarity, and comprehensiveness, and revisions were made based on their feedback.

Recruitment was conducted online using convenience and snowball sampling through WhatsApp groups and social media platforms. Parents were encouraged to share the survey link with other eligible participants across Saudi Arabia. The questionnaire required approximately 3–5 minutes to complete.

Protecting parents and children's privacy was considered essential throughout the study. No direct identifiers, such as names or school identification numbers, were collected. Participants were assigned numeric codes, and the dataset was de-identified and securely stored to maintain confidentiality. Parents received a clear explanation of the study purpose, potential benefits, voluntary nature of participation, and the right to withdraw at any time.

Data collection was conducted over six weeks. Reminder messages were distributed through the same electronic platforms to encourage participation. Participant demographic characteristics were monitored during recruitment to support representation across age groups, school levels, and regions.

2.4 Data analysis

Data analysis was performed using the SPSS version 23. Descriptive and inferential statistical analyses were used to examine the study variables. The independent variable was reported IDA status (reported IDA diagnosis vs. no reported IDA diagnosis), and the dependent variables were school attendance, academic performance, and academic competence.

Frequencies and percentages were calculated for categorical variables, while means and standard deviations were calculated for continuous variables. Pearson's chi-square test was used to assess associations between reported IDA status and categorical school-functioning outcomes. An independent-samples t-test was used to compare the overall academic competence score between children and adolescents with and without reported IDA. A multivariable logistic regression model was used to explore factors associated with reported IDA status. The outcome, reference categories, coding of categorical predictors, and rationale for including each predictor were specified before interpreting the adjusted estimates. Statistical significance was set at $p < 0.05$, and Cramer's V was reported as a measure of association for statistically significant chi-square results.

3. RESULTS

A total of 167 participants were included in the analysis. Of these, 113 (67.7%) reported a diagnosis of IDA, whereas 54 (32.3%) did not report an IDA diagnosis. The sample was predominantly female (78.4%), and nearly half of the children and adolescents were aged 16–18 years (49.1%). Most children and adolescents attended secondary school (53.9%), resided in the Western region of Saudi Arabia (79.0%), and were Saudi nationals (76.6%), as shown in Table 1.

Table 1. Distribution of the sociodemographic characteristics of children and adolescents and their parents (N = 167)

Variable	**Number (%)**
Child age	
6–9 years	26 (15.6)
10–12 years	23 (13.8)
13–15 years	36 (21.6)
16–18 years	82 (49.1)
Child gender	
Female	131 (78.4)
Male	36 (21.6)
School level	
Primary	49 (29.3)
Intermediate	28 (16.8)
Secondary	90 (53.9)
Region	
Southern Region	21 (12.6)
Eastern Region	11 (6.6)
Northern Region	3 (1.8)
Western Region	132 (79.0)
Nationality	
Saudi	128 (76.6)
Non-Saudi	39 (23.4)

Mother education level	
Primary	13 (7.8)
Intermediate	10 (6.0)
Secondary	58 (34.7)
Diploma	12 (7.2)
Bachelor's degree	65 (38.9)
Master's degree	3 (1.8)
Doctorate	4 (2.4)
Higher education	2 (1.2)
Father education level	
Primary	8 (4.8)
Intermediate	14 (8.4)
Secondary	54 (32.3)
Diploma	7 (4.2)
Bachelor's degree	60 (35.9)
Master's degree	12 (7.2)
Doctorate	9 (5.4)
Higher education	3 (1.8)
Monthly household income	
Less than 5,000 SAR	38 (22.8)
5,000–10,000 SAR	60 (35.9)
More than 10,000 SAR	69 (41.3)
School type	
Public school	144 (86.2)
Private school	23 (13.8)
Access to healthcare services	
Yes	144 (86.2)
No	23 (13.8)

Among the 113 children diagnosed with IDA, malnutrition was identified as the cause of anemia in 46.0% of participants. The highest percentage had anemia for more than 1 year (46.9%). For treatment adherence, 43.4% reported irregular medication use. The highest percentage had their last laboratory test 6–12 months ago (52.2%). More than half of the children took iron supplements (56.6%), while 62.8% sometimes consumed iron-rich foods. For symptoms, fatigue was reported often by 54.0%, while pallor was reported sometimes by 52.2%. Dizziness was reported often by 52.2%, and difficulty in concentration was reported sometimes by 52.2%. Shortness of breath was most commonly reported as sometimes (53.1%) (Table 2).

Table 2. Clinical characteristics and management of children and adolescents with reported IDA (n = 113)

Variable	Number (%)
For those diagnosed with IDA (no.: 113)	
Reported cause of diagnosis	
Malabsorption	14 (12.4)
Malnutrition	52 (46.0)
Blood loss/anemia	44 (38.9)
Hereditary	3 (2.7)
Duration of anemia (if applicable)	
Less than 6 months	39 (34.5)
6–12 months	21 (18.6)
More than 1 year	53 (46.9)
Treatment adherence	
Irregular	49 (43.4)
No medication	24 (21.2)
Regular	40 (35.4)
When were the results of the last laboratory test? (If available)	
6–12 months	59 (52.2)
N/A	2 (1.8)
Less than 6 months	47 (41.6)
More than 1 year	5 (4.4)
Does the child take iron supplement?	
No	49 (43.4)
Yes	64 (56.6)
Consumption of iron-rich foods (red meat, liver, green leafy vegetables, etc.)	
Sometimes	71 (62.8)
Often	20 (17.7)
Rarely	22 (19.5)
Frequency of the following symptoms [Fatigue]	
Never	8 (7.1)
Sometimes	44 (38.9)
Often	61 (54.0)
Frequency of the following symptoms [Pallor]	
Never	10 (8.8)

Sometimes	59 (52.2)
Often	44 (38.9)
Frequency of the following symptoms [Dizziness]	
Never	14 (12.4)
Sometimes	40 (35.4)
Often	59 (52.2)
Frequency of the following symptoms [Difficulty in concentration]	
Never	9 (8.0)
Sometimes	59 (52.2)
Often	45 (39.8)
Frequency of the following symptoms [Shortness of breath]	
Never	32 (28.3)
Sometimes	60 (53.1)
Often	21 (18.6)

School type was significantly associated with reported IDA status ($\chi^2 = 6.81$, $p = 0.009$), with a higher proportion among children and adolescents attending private schools. No statistically significant associations were observed for the other sociodemographic characteristics examined (Table 3).

Reported IDA status was associated with the number of school-absence days during the semester ($\chi^2 = 6.49$, $p = 0.039$). The proportion reporting more than five days of absence was 46.9% among children and adolescents with reported IDA, compared with 27.8% among those without a reported diagnosis. Difficulty remembering lessons was significantly associated with reported IDA status ($\chi^2 = 10.49$, $p = 0.033$). Although appearing tired during the school day was more frequently reported among children and adolescents with IDA, the association was not statistically significant ($\chi^2 = 9.28$, $p = 0.054$). No statistically significant associations were observed for late arrival, overall academic performance, performance compared with classmates, the other academic competence items, sleep, or physical activity (Table 3). There was no statistically significant difference in total academic competence scores between children diagnosed with IDA and those without (22.84 ± 4.10 vs. 23.07 ± 3.46, $t = 0.30$, $p = 0.761$).

Table 3. Associations between reported IDA status and sociodemographic, attendance, academic performance, academic competence, and health-related characteristics (N = 167)

Variable	**Has the child been diagnosed with Iron Deficiency Anemia (IDA)?**		**χ2**	**p-value**
	No **No. (%)**	**Yes** **No. (%)**		
Child age				
6–9 years	14 (25.9)	12 (10.6)	7.08	0.069
10–12 years	5 (9.3)	18 (15.9)		
13–15 years	11 (20.4)	25 (22.1)		

16–18 years	24 (44.4)	58 (51.3)		
Child gender				
Female	38 (70.4)	93 (82.3)	3.07	0.079
Male	16 (29.6)	20 (17.7)		
School level				
Primary	20 (37.0)	29 (25.7)	2.52	0.283
Intermediate	7 (13.0)	21 (18.6)		
Secondary	27 (50.0)	63 (55.8)		
Region				
Southern Region	4 (7.4)	17 (15.0)	2.2	0.531
Eastern Region	3 (5.6)	8 (7.1)		
Northern Region	1 (1.9)	2 (1.8)		
Western Region	46 (85.2)	86 (76.1)		
Nationality				
Saudi	40 (74.1)	88 (77.9)	0.29	0.587
Non-Saudi	14 (25.9)	25 (22.1)		
Mother education level				
Primary	6 (11.1)	7 (6.2)	5.08	0.650
Intermediate	4 (7.4)	6 (5.3)		
Secondary	18 (33.3)	40 (35.4)		
Diploma	4 (7.4)	8 (7.1)		
Bachelor's degree	21 (38.9)	44 (38.9)		
Master's degree	0 (0.0)	3 (2.7)		
Doctorate	0 (0.0)	4 (3.5)		
Higher education	1 (1.9)	1 (0.9)		
Father education level				
Primary	5 (9.3)	3 (2.7)	7.57	0.371
Intermediate	4 (7.4)	10 (8.8)		
Secondary	17 (31.5)	37 (32.7)		
Diploma	2 (3.7)	5 (4.4)		
Bachelor's degree	18 (33.3)	42 (37.2)		
Master's degree	5 (9.3)	7 (6.2)		
Doctorate	1 (1.9)	8 (7.1)		
Higher education	2 (3.7)	1 (0.9)		

Monthly household income				
Less than 5,000 SAR	16 (29.6)	22 (19.5)	2.39	0.302
5,000–10,000 SAR	19 (35.2)	41 (36.3)		
More than 10,000 SAR	19 (35.2)	50 (44.2)		
School type				
Public school	52 (96.3)	92 (81.4)	6.81	**0.009**
Private school	2 (3.7)	21 (18.6)		
Access to healthcare services				
Yes	46 (85.2)	98 (86.7)	0.07	0.787
No	8 (14.8)	15 (13.3)		
Attendance, academic performance, academic competence, and health-related characteristics				
Attendance				
Number of days absent (during the semester)				
0–2 days	20 (37.0)	25 (22.1)		
3–5 days	19 (35.2)	35 (31.0)	6.49	**0.039**
More than 5 days	15 (27.8)	53 (46.9)		
Frequency of late arrival to school				
Rarely	30 (55.6)	49 (43.4)	2.8	0.246
Sometimes	19 (35.2)	45 (39.8)		
Often	5 (9.3)	19 (16.8)		
Academic performance				
Overall academic level				
Below average	3 (5.6)	3 (2.7)	2.55	0.279
Average	12 (22.2)	37 (32.7)		
Above average	39 (72.2)	73 (64.6)		
Academic performance compared with classmates				
Below average	6 (11.1)	7 (6.2)	1.77	0.411
Average	16 (29.6)	42 (37.2)		
Above average	32 (59.3)	64 (56.6)		
Academic competence				
The child can concentrate during class				
Strongly disagree	3 (5.6)	4 (3.5)	3.18	0.528
Disagree	2 (3.7)	11 (9.7)		
Neutral	17 (31.5)	35 (31.0)		

Agree	23 (42.6)	51 (45.1)		
Strongly agree	9 (16.7)	12 (10.6)		
Completes tasks within the specified time				
Strongly disagree	2 (3.7)	2 (1.8)	7.76	0.100
Disagree	5 (9.3)	18 (15.9)		
Neutral	15 (27.8)	45 (39.8)		
Agree	25 (46.3)	30 (26.5)		
Strongly agree	7 (13.0)	18 (15.9)		
Understands lessons easily				
Strongly disagree	2 (3.7)	3 (2.7)	6.52	0.163
Disagree	2 (3.7)	17 (15.0)		
Neutral	19 (35.2)	33 (29.2)		
Agree	21 (38.9)	48 (42.5)		
Strongly agree	10 (18.5)	12 (10.6)		
Participates in class				
Strongly disagree	3 (5.6)	2 (1.8)	4.96	0.291
Disagree	2 (3.7)	9 (8.0)		
Neutral	12 (22.2)	37 (32.7)		
Agree	21 (38.9)	39 (34.5)		
Strongly agree	16 (29.6)	26 (23.0)		
Requires frequent assistance				
Strongly disagree	10 (18.5)	16 (14.2)	4.14	0.387
Disagree	15 (27.8)	26 (23.0)		
Neutral	20 (37.0)	37 (32.7)		
Agree	7 (13.0)	21 (18.6)		
Strongly agree	2 (3.7)	13 (11.5)		
Has difficulty remembering lessons				
Strongly disagree	12 (22.2)	13 (11.5)	10.49	**0.033**
Disagree	7 (13.0)	26 (23.0)		
Neutral	27 (50.0)	40 (35.4)		
Agree	7 (13.0)	25 (22.1)		
Strongly agree	1 (1.9)	9 (8.0)		
Appears tired during the school day				
Strongly disagree	10 (18.5)	13 (11.5)	9.28	0.054

Disagree	11 (20.4)	17 (15.0)		
Neutral	21 (38.9)	34 (30.1)		
Agree	10 (18.5)	28 (24.8)		
Strongly agree	2 (3.7)	21 (18.6)		
Number of hours of sleep per day				
Less than 6 hours	9 (16.7)	19 (16.8)	0.03	0.981
6–8 hours	27 (50.0)	58 (51.3)		
More than 8 hours	18 (33.3)	36 (31.9)		
Level of physical activity				
Low	9 (16.7)	32 (28.3)	4.56	0.102
Moderate	34 (63.0)	69 (61.1)		
High	11 (20.4)	12 (10.6)		

In the regression analysis (Table 4), two factors were statistically associated with reported IDA. Older children were more likely to have IDA. For each step up in age group, the odds of IDA were 64% higher (AOR = 1.64, 95% CI 1.12-2.41, p = 0.011). Children in private schools were much more likely to have IDA than children in public schools (AOR = 6.60, 95% CI 1.35-32.29, p = 0.020). Region, nationality, parents' education, family income, and access to healthcare were not linked to IDA after adjustment (p > 0.05).

Table 4. Multivariable binary logistic regression of factors associated with IDA

Variable	B	SE	Wald	p-value	Adjusted OR (95% CI)
Child age (per category increase)	0.495	0.195	6.456	**0.011**	1.641 (1.120-2.405)
Region	-0.294	0.187	2.476	0.116	0.745 (0.517-1.075)
Nationality (non-Saudi vs. Saudi)	-0.166	0.511	0.106	0.745	0.847 (0.311-2.305)
School type (private vs. public)	1.886	0.810	5.421	**0.020**	6.596 (1.348-32.285)
Mother's education level	0.167	0.157	1.132	0.287	1.182 (0.869-1.608)
Father's education level	-0.023	0.126	0.034	0.853	0.977 (0.764-1.250)
Monthly household income	0.054	0.278	0.037	0.847	1.055 (0.612-1.819)
Access to healthcare services (no vs. yes)	-0.292	0.550	0.282	0.596	0.747 (0.254-2.196)
Constant	-2.671	1.679	2.531	0.112	0.069

N.B.: B = regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval. df = 1 for all variables. Outcome: IDA (reference: no IDA).

4. DISCUSSION

In this cross-sectional study of 167 children and adolescents, reported IDA was associated with a higher proportion of school absence exceeding five days, whereas no association was detected with late arrival, academic performance, or academic competence. Previous studies from India, Egypt, China, and Ethiopia have reported associations between anemia or IDA and aspects of school or cognitive functioning [5-9].

The demographic characteristics showed that most participants were female (78.4%) and that 49.1% were aged 16-18 years. This convenience and snowball sample may introduce selection bias, meaning that the findings cannot be generalized to the broader population of children and adolescents in Saudi Arabia.

The findings showed a statistically significant association between reported IDA status and school absence of more than five days, but not late arrival. This result should be interpreted cautiously because the cross-sectional design does not establish temporality or causality, and potentially important confounders such as socioeconomic circumstances, family factors, school environment, and comorbid conditions were not comprehensively measured. The finding may therefore indicate an association rather than a direct effect of IDA on absenteeism. It is directionally consistent with the conventional (between-household) estimates from India, where anemia was associated with 2.5 percentage points lower school attendance, but that association became small and non-significant in household fixed-effects models [5], which suggests that unmeasured household factors may explain part of such associations.

No significant association was observed between reported IDA status and overall academic performance or performance compared with classmates. These findings differ from those of a Chinese national survey [7], which reported higher academic scores among students without anemia, and from an Ethiopian study [9], reporting an association between anemia and poorer academic performance. Differences in age, measurement methods, sampling, and contextual factors may partly explain these discrepancies.

Importantly, academic performance in the current study was assessed by parent-reported categories rather than standardized test scores or official school records. This approach may have reduced sensitivity to small differences and introduced reporting bias. The high proportion of participants reported as having above-average academic performance may also indicate selection or reporting bias.

The study found no statistically significant difference in overall academic competence between children and adolescents with and without reported IDA. This finding differs from studies assessing neurocognitive outcomes using standardized cognitive measures [6,8]. In the present study, academic competence was assessed using parent-reported Likert-type items rather than objective cognitive testing. The absence of a statistically significant association may also reflect the small sample size, unequal group sizes (113 vs. 54), and relatively broad age range. In addition, the study did not objectively distinguish IDA from other causes of anemia. Because exposure was based on parent-reported diagnosis, exposure misclassification is possible.

Healthcare providers should be alert to school absenteeism among children with confirmed anemia. Parents and families may benefit from education regarding adherence to prescribed treatment given that 43.4% of participants with reported IDA described irregular medication use and 21.2% no medication. Collaboration among healthcare providers, families, and schools may help identify children experiencing persistent absenteeism and facilitate appropriate support. These implications should be considered preliminary because the present study did not establish causality.

This study has several limitations. First, convenience and snowball sampling may have introduced selection bias and limited generalizability, as reflected in the marked female and older-adolescent skew of the sample. Second, the sample size was small, which may have limited statistical power. Third, reported IDA status was based on parent-report rather than objective measurements of hemoglobin and iron-status, creating the possibility of exposure misclassification or recall bias. Finally, the cross-sectional design precludes conclusions about temporality or causality. Despite these limitations, the study has several strengths, including the examination of multiple dimensions of school functioning, adjustment for potential confounders in the analysis, and transparent reporting of non-significant findings.

5. CONCLUSION

This cross-sectional study identified an association between reported IDA status and school absenteeism among the participating children and adolescents. There were no statistically significant associations observed between reported IDA status and late school arrival, overall academic performance, performance compared with classmates, or total academic competence scores. An association was also observed for the parent-reported item concerning difficulty remembering lessons; however, this individual-item finding should be interpreted cautiously given the number of statistical comparisons conducted. The findings are preliminary because of the non-probability sampling strategy, reliance on reported diagnostic status and school-functioning measures, and inability to establish temporal or causal relationships. The proportion of participants reporting an IDA diagnosis should not be interpreted as the prevalence of IDA among children and adolescents in Saudi Arabia. Future studies should use

more representative samples, laboratory-based assessment of iron status, age-appropriate validated outcome measures, and independently documented school attendance and academic performance.

AUTHOR CONTRIBUTIONS

Fatimah Alsaggaf: Conception, design, analysis, and writing. Salmah A. Alghamdi: Literature search, analysis, critical review and writing. Abeer Alshaikhi, Rahaf Almutairi, Sara Altamimi, and Ghaida Almalki: Data collection and writing. The final version of the manuscript was approved by all authors prior to submission.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

The study received ethical approval from the Faculty of Nursing (FON) at King Abdulaziz University (KAU), IRB number: Ref No 2B.23, on December 11, 2025.

Participant recruitment was conducted electronically after obtaining ethical approval. All study procedures were conducted in accordance with principles of voluntary participation, confidentiality, anonymity, and protection of children and adolescents.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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