**Research Article**

# Anemia and Its Relationship with Academic Performance among Adolescent School Girls in Kebena District, Southwest Ethiopia

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## Abstract

**Background:** Anemia affects more than 2 billion people worldwide. It is a serious public health concern in developing countries and its prevalence is quite high among female adolescents. In this study, we aimed to assess the prevalence of anemia among female adolescents and determine its relationship with their performance at school.

**Methods:** The present school-based, cross sectional study was conducted on 442 female adolescents in Kebena district, Southwest Ethiopia from June 2012 to June 2013. In this study, cluster sampling method was used. The status of anemia was measured, using the HemoCue system (Hb 301 system) and categorized, based on the World Health Organization (WHO) cut-off point. The data were imported to EPI-Info version 3.5.3 and analyzed using SPSS version 16.0. The students' academic performance was assessed, based on the average academic score in 2012 - 2013.

**Results:** The prevalence of anemia was 12% among the participants (95% CI, 9.2 - 15.3), which was categorized as moderate (0.9%) and mild (11.1%) anemia. Younger age (OR = 4.4; 95% CI, 1.9 - 9.9) and frequently walking barefoot (OR = 2.7; 95% CI, 1.1 - 6.8) were significantly associated with anemia. Younger age (OR = 1.7; 95% CI, 1.1 - 3.1), educational status (OR = 2.6; 95% CI, 1.5 - 4.4), absent days from school (OR = 1.6; 95% CI, 1.1 - 2.5), high workload at home (OR = 1.9; 95% CI, 1.3 - 2.5), eating less than 3 times a day (OR = 1.6; 95% CI, 1.2 - 3.0), and anemic status (OR = 1.7; 95% CI, 1.2 - 2.7) were significantly associated with low academic performance.

**Conclusions:** Anemia screening should be directed towards adolescent school girls. Also, iron and folic acid supplementation programs may help improve the academic performance of these individuals.

*Keywords:* Anemia, Adolescent School Girls, Academic Performance

## 1. Background

Anemia is a disorder which is principally characterized by a decline in the concentration of circulating erythrocytes or blood hemoglobin and concomitant impairment of oxygen delivery to meet the body's physiological needs (1). The prevalence of this disorder varies with respect to age, sex, altitude, smoking habits, and pregnancy status (2).

Anemia may be caused by nutritional and non-nutritional factors. Nutritional anemia results from iron, folate, and vitamin B12 deficiencies, whereas non-nutritional anemia is caused by hemorrhage, malaria, hookworm infestation, chronic diseases, or drug toxicity (2-4). Iron deficiency, which is the most common type of nutritional anemia, is responsible for about 50% of all anemic cases (4). It is estimated that approximately half of adolescent girls in sub-Saharan Africa are anemic (5).

The World Health Organization (WHO) defines adolescence as a period of life, spanning between 10 and 19 years (6). This period is considered a nutritionally critical period, as it is a time of intense physiological, psychological, and social growth and development. Protein-energy malnutrition and iron deficiency are major health concerns among adolescents (7). Also, anemia in female adolescents is a serious public health concern, as this population needs extra iron for menstruation, in addition to growth and development (6).

Anemia, commonly resulting from iron deficiency, is associated with reduced oxygen saturation in the blood supply to the brain (8), which is believed to cause silent cerebral infarct (9); this adversely affects cognitive and motor development (10). Impaired cognitive function is likely to present as fatigue, poor memory, attention deficit, poor academic achievement, and/or decrement in problem-solving skills (11, 12). In addition to cognitive and behavioral impairments, anemia among adolescents contributes to high maternal mortality, high incidence of low-weight births, and high perinatal mortality (13).

There is a scarcity of information on anemia among adolescents, especially in developing countries, where social conditions pose serious challenges to female adolescents. Although there are initiatives to prevent anemia

among infants, young children, and pregnant/lactating women, the adolescents' needs remain unmet and the consequences of anemia are still reported in this population (14-16). With this background in mind, the objective of this study was to assess the prevalence of anemia, its determinants, and effects on the academic performance of adolescent school girls.

## 2. Methods

### 2.1. Study Setting, Design, and Population

The present study was conducted in Kebena district, Gurage zone, Ethiopia from June 2012 to June 2013. Kebena is one of the 13 rural districts in Gurage zone. It is located at a 154 km distance from the Southwest of Addis Ababa, the capital city of Ethiopia. Its altitude ranges from 1700 to 2008 m above the sea level, with 1400 mm of annual rainfall. The staple foods in the area include cereal, enset, maize, teff, and vegetables. The population of this region is estimated to be 61 035, of whom 29 907 are male. There are 9 primary (grades 1 - 8) and 1 secondary (grades 9 - 10) schools in the district. In 2012 - 2013, a total of 1429 adolescent girls were enrolled in the schools of the district.

The present school-based, cross sectional study was conducted in the primary and secondary schools (grades 5 - 10). The study population consisted of all female adolescents, attending primary (grades 5 - 8) and secondary (grades 9 - 10) schools in Kebena district during 2012 - 2013. The subjects were attending regular school programs (daytime), were not pregnant at the time of the study, and were 10 - 19 years old.

### 2.2. Measurement of the Sample Size and Sampling Procedure

The sample size was calculated, using OpenEpi version 2.3 by considering an anemia prevalence of 21.1% among adolescent school girls (17), a 95% confidence interval, 5% maximum margin of error, design effect of 2, and 10% non-response rate. Finally, a sample of 460 subjects was calculated.

Cluster sampling technique was employed in this study. Wosherbe secondary school and 4 primary schools were selected via simple random sampling (lottery method). Each selected school was considered as a cluster, ie, all female adolescents in the selected schools, who met the inclusion criteria, were enrolled in the study.

### 2.3. Data Collection Procedures and Study Variables

Data were collected using a questionnaire, which was pretested in a primary school in Wolkite town. The questionnaire consisted of sociodemographic information, socioeconomic status, and psychosocial, nutritional, and environmental factors. The subjects' average scores in the

school semester and absent days from school were obtained from the school records.

After a short period of training by the Ethiopian Health and Nutrition Research Institute (EHNRI) on the sampling procedure and analyzer's operation, the principal investigator collected blood samples from 442 subjects via finger prick, using disposable microcuvettes. The hemoglobin concentration was immediately measured with a portable battery-operated HemoCue (Hb 301) system. Also, the severity of anemia was assessed, based on the WHO cut-off point. All hemoglobin concentration readings were reduced by 0.7 g/dL to correct for altitude, according to WHO guidelines.

The 4 data collectors were trained on the purpose of the study for 1 day, and the students were informed about the purpose and objectives of the study. The questionnaire was pretested and assessed in terms of completeness and errors in field by the principal investigator. Finally, the data were entered to Epi-Info version 3.5.3.

The status of anemia and the academic performance of the subjects were dependent variables, whereas the subjects' sociodemographic characteristics (eg, age, ethnicity, and religion), nutritional status, psychosocial characteristics (eg, relation with their peers and family and punishment at school or at home), socioeconomic status of the parents, and environmental factors were the independent variables.

### 2.4. Ethical Considerations

The study protocols were approved by the Institutional Ethical Review Committee of Addis Ababa University College of Health Sciences. Permission was obtained from the education and health offices of the district, school directors, and parent-teacher associations. Anemic subjects were introduced to the District Health Office to collect iron supplementation.

### 2.5. Data Processing and Analysis

After data collection, the information in the questionnaires was assessed in terms of completeness and consistency. Data were first entered in EPI-Info version 3.5.3 and then exported to SPSS version 16 for analysis. The frequency, central tendency, and dispersion estimates were measured to describe the variables. Variables for which P-value was less than 0.20 in the bivariate analysis were retained for subsequent multivariate analysis. Significance level was determined, using odds ratio (OR) with a 95% confidence interval (95% CI).

## 3. Results

### 3.1. Sociodemographic and Dietary Characteristics of the Participants

Overall, 442 students participated in the present study (response rate, 96%). The mean age of the participants was 14.2 (SD, 1.7) years and the majority were Muslims (82.7%). Ethnically, many of the subjects were from Kebena (61.1%), while some were from Gurage (29.4%). Most of the participants walked or lived barefoot (93.2%). The majority of the participants' parents were married (85.3%), and the average family size was 6 (SD, 2.0) people per household; also, 73.1% of the households had 5 - 8 people. Many of the participants' mothers (75.3%) and some of the fathers (43.0%) were illiterate (Table 1).

More than half of the participants (57.5%) were living in thatched houses. A significant portion of the population (93.0%) used radio as a source of information. Only 14% of the participants had access to electricity. Based on the findings, 26.8%, 28.3%, and 31.0% of the participants' parents earned less than 600 EBR (32 USD), 600-999 EBR (32 - 54 USD), and more than 1000 EBR (54 USD) per month, respectively. Also, the majority of households were male-headed (85.3%). Many of the mothers were housewives (61.1%), and 73.5% of the fathers were farmers (Table 1).

More than half of the participants (54.3%) said that their staple food was enset. Most of the subjects had 3 or more meals per day (85.1%), and about two-thirds of the participants (65.0%) used meat and animal products at least once a week. More than one-third of the respondents (37.6%) used vegetables more than 3 times a week, and 86.9% drank tea or coffee immediately after a meal. Also, two-thirds of the participants (66.5%) had reached menarche.

As the findings revealed, 92.6%, 5%, and 2.5% of the participants used pipe water, protected spring water, and unprotected spring water, respectively. Only 7.7% of the respondents had a history of worm infestation over the past 3 months. In total, 86% of the subjects had access to water within less than 30 minutes. Also, about three-quarters of the participants (73.2%) did not use any type of household water treatment methods. The majority of the subjects (95.9%) had latrines, 94.1% of whom used pit latrines (Table 1).

### 3.2. Determinants of Anemia and school Performance

The prevalence of anemia with a hemoglobin concentration < 12 g/dL was 12% (95% CI, 9.2-15.3; moderate anemia, 0.9% and mild anemia, 11.1%); none of the participants had severe anemia. A higher prevalence of anemia was reported in girls, aged 10 - 14 years (20%), compared to those within the age range of 15 - 19 years (8.3%). Adolescent school girls, aged 10 - 14 years, were 2.7 times more likely to have anemia, compared to those in the age group of 15 - 19 years (COR = 2.7; 95% CI, 1.5 - 4.9). Other factors such as the parents' educational status, head of the household, workload at home, onset of menarche, use of tea/coffee, history of worm infestation, and availability of latrine were not significantly associated with anemia.

In the logistic regression model, young adolescent school girls (10 - 14 years) were 3 times more likely to be anemic (AOR = 3.4; 95% CI, 1.4 - 8.2), compared to their older counterparts (15 - 19 years). The subjects who wore shoes 3 days a week (or less) were 2.7 times more likely to have anemia (AOR = 2.7; 95% CI, 1.1 - 6.6), compared to those who regularly wore shoes (Table 2).

Adolescent girls from grades 7 to 8 were 2.6 times more likely to have low school performance (AOR = 2.6; 95% CI, 1.5 - 4.4), compared to high school girls (grades 9 to 10). Girls who had 4 or more absent days from school per week were 1.6 times more likely to show weaker school performance (AOR = 1.6; 95% CI, 1.0 - 2.5), compared to those who were absent less than 4 days a week. Also, anemic adolescent girls were more likely to show low academic performance, compared to their non-anemic counterparts (AOR = 1.7; 95% CI, 1.2 - 2.7). In addition, high workload at home (OR = 1.9; 95% CI, 1.3 - 2.5) and eating less than 3 times a day (OR = 1.6; 95% CI, 1.2 - 3.0) increased the risk of low academic performance (Table 3).

## 4. Discussion

In the study area, the prevalence of anemia among adolescent school girls was 12%. Overall, 0.9% and 11.1% of the participants were moderately and mildly anemic, respectively. Age range of 10 - 14 years and habit of wearing shoes 3 days a week (or less) were significantly associated with anemia. In addition, age group, educational status, absent days from school, high workload at home, number of meals per day, and anemic status were significantly associated with poor school performance.

The findings of a previous study in an urban area of Iran showed that the prevalence of anemia among adolescent school girls was 5.8% (18), which is lower than the rate reported in the present study (12%). This could be partly explained by the fact that the current study focused on rural areas, and the participants probably had a lower socioeconomic status. On the other hand, other similar studies in Kenya (17) and India (19, 20) reported prevalence rates of 21.1%, 78.7%, and 60%, respectively, which were higher than the present findings. This may be due to the availability of iron-rich foods (such as teff and vegetables) in the area of the present research.

**Table 1.** Sociodemographic and Dietary Characteristics of Adolescent School Girls in Kebena District, Ethiopia in March 2013 (N = 442)[a,b]

| Variables | Anemic, Number (%) | Non-anemic, Number (%) | Total, Number (%) | P value |
|---|---|---|---|---|
| **Age (years)** | | | | 0.001 |
| 10 - 14 | 28 (19.9) | 113 (80.1) | 141 | |
| 15 - 19 | 25 (8.3) | 276 (91.7) | 301 | |
| **Religion** | | | | 0.65 |
| Islam | 42 (11.5) | 324 (88.5) | 366 | |
| Christianity | 10 (13.2) | 66 (86.8) | 76 | |
| **Mode of transport** | | | | 0.34 |
| Foot | 49 (11.9) | 363 (88.1) | 412 | |
| Animal cart | 1 (11.5) | 8 (88.5) | 9 | |
| Vehicle | 2 (9.5) | 19 (90.5) | 21 | |
| **Marital status of the parents** | | | | 0.16 |
| Married | 45 (11.9) | 332 (88.1) | 377 | |
| Separated/divorced | 2 (11.1) | 16 (88.9) | 18 | |
| Widowed | 5 (10.6) | 42 (89.4) | 47 | |
| **Household head** | | | | 0.09 |
| Female | 6 (9.2) | 59 (90.8) | 65 | |
| Male | 47 (12.5) | 330 (87.5) | 377 | |
| **Mother's educational status** | | | | 0.07 |
| Illiterate | 41 (12.3) | 292 (87.7) | 333 | |
| Literate | 10 (12.8) | 68 (87.2) | 78 | |
| Primary school and above | 2 (6.5) | 29 (93.5) | 31 | |
| **Father's educational status** | | | | 0.18 |
| Illiterate | 24 (12.6) | 166 (87.4) | 190 | |
| Literate | 21 (13.2) | 138 (86.8) | 159 | |
| Primary school and above | 8 (8.6) | 85 (91.4) | 93 | |
| **Onset of menarche** | | | | 0.09 |
| Yes | 31 (10.5) | 263 (89.5) | 294 | |
| No | 22 (14.9) | 126 (85.1) | 148 | |
| **History of worm infestation** | | | | 0.19 |
| Yes | 5 (14.7) | 29 (85.3) | 34 | |
| No | 48 (11.8) | 360 (88.2) | 408 | |
| **Meals per day** | | | | 0.31 |
| < 3 times | 10 (15.1) | 56 (84.9) | 66 | |
| $\geq$ 3 times | 42 (11.2) | 334 (88.8) | 376 | |
| **Drinking tea/coffee immediately after a meal** | | | | 0.11 |
| Yes | 47 (12.2) | 337 (87.8) | 384 | |
| No | 6 (10.3) | 52 (89.7) | 58 | |
| **Workload at home** | | | | 0.04 |
| High | 15 (9.3) | 146 (90.7) | 161 | |
| Low | 38 (13.5) | 243 (86.5) | 281 | |
| **Habit of wearing shoes** | | | | 0.007 |
| $\leq$ 3 days per week | 8 (20.5) | 31 (79.5) | 39 | |
| Sometimes | 11 (10.4) | 95 (89.6) | 116 | |
| Always | 34 (11.4) | 263 (88.6 | 297 | |
| **Availability of toilet** | | | | 0.12 |
| Yes | 49 (11.6) | 375 (88.4) | 424 | |
| No | 4 (22.2) | 14 (77.8) | 18 | |

[a] Significant at P < 0.05.
[b] Significant at P < 0.001.

**Table 2.** Determinants of Anemia among Adolescent School Girls in Kebena District, Ethiopia in March 2013

| Variables | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|
| **Age (years)** | | |
| 10 - 14 | 2.7 (1.5 - 4.9) | 4.4 (1.9 - 9.9)[a] |
| 15 - 19 | 1.0 | 1.0 |
| **Household head** | | |
| Female | 0.7 (0.3 - 1.7) | 0.6 (0.2 - 1.5) |
| Male | 1.0 | 1.0 |
| **Mother's educational status** | | |
| Illiterate | 2.0 (0.5 - 8.8) | 1.8 (0.4 - 9.0) |
| Literate | 2.1 (0.4-10.3) | 2.1 (0.4-11.5) |
| Primary school and above | 1.0 | 1.0 |
| **Father's educational status** | | |
| Illiterate | 1.5 (0.7 - 3.6) | 1.6 (0.6 - 4.0) |
| Literate | 1.6 (0.7 - 3.8) | 1.6 (0.6 - 4.0) |
| Primary school and above | 1.0 | 1.0 |
| **Workload at home** | | |
| High | 0.7 (0.3 - 1.2) | 0.7 (0.3 - 1.3) |
| Low | 1.0 | 1.0 |
| **Drinking tea/coffee immediately after a meal** | | |
| Yes | 1.2 (0.5-3.0) | 1.3 (0.5-3.2) |
| No | 1.0 | 1.0 |
| **Onset of menarche** | | |
| Yes | 0.7 (0.4 - 1.2) | 1.7 (0.8 - 4.0) |
| No | 1.0 | 1.0 |
| **History of worm infestation** | | |
| Yes | 1.3 (0.5 - 3.5) | 1.5 (0.5 - 4.2) |
| No | 1.0 | 1.0 |
| **Habit of wearing shoes** | | |
| $\leq$ 3 days per week | 2.0 (0.8 - 4.7) | 2.7 (1.1 - 6.8)[b] |
| Sometimes | 0.9 (0.4 - 1.8) | 1.1 (0.5 - 2.4) |
| Always | 1.0 | 1.0 |
| **Availability of toilet** | | |
| Yes | 2.2 (0.7 - 6.9) | 1.7 (0.5 - 5.9) |
| No | 1.0 | 1.0 |

[a]Significant at P < 0.001.
[b]Significant at P < 0.05.

**Table 3.** Factors Associated with the Academic Performance of Adolescent School Girls in Kebena District, Ethiopia in March 2013 (N = 442)

| School Performance | Below Mean (%) | Above Mean (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|---|
| **Age (years)** | | | | |
| 10 - 14 | 101 (71.6) | 40 (28.4) | 0.7 (0.4 - 1.0) | 1.7 (1.1 - 3.1)[a] |
| 15 - 19 | 188 (62.5) | 113 (37.5) | 1.0 | 1.0 |
| **Grade** | | | | |
| 5 - 6 | 98 (62.8) | 58 (37.2) | 1.6 (1.0 - 2.6) | 1.0 (0.5 - 1.8) |
| 7 - 8 | 133 (76.9) | 40 (23.1) | 3.1 (1.9 - 5.2)[a] | 2.6 (1.5 - 4.4)[a] |
| 9 - 10 | 58 (51.3) | 55 (48.7) | 1.0 | 1.0 |
| **Mother's educational status** | | | | |
| Illiterate | 219 (65.8) | 114 (34.2) | 0.9 (0.4 - 2.0) | 1.2 (0.5 - 2.8) |
| Literate | 49 (62.8) | 29 (37.2) | 0.8 (0.3 - 1.9) | 1.0 (0.4 - 2.5) |
| Primary school and above | 21 (67.7) | 10 (32.3) | 1.0 | 1.0 |
| **Father's educational status** | | | | |
| Illiterate | 119 (62.6) | 71 (37.4) | 0.7 (0.4 - 1.2) | 0.6 (0.3 - 1.1) |
| Literate | 105 (66.0) | 54 (34.0) | 0.9 (0.5 - 1.4) | 0.7 (0.4 - 1.3) |
| Primary school and above | 65 (69.9) | 28 (30.1) | 1.0 | 1.0 |
| **Father's occupation** | | | | |
| Unemployed | 36 (63.2) | 21 (36.8) | 0.9 (0.5 - 1.6) | 0.9 (0.5 - 1.6) |
| Employed | 40 (66.7) | 20 (33.3) | 1.0 (0.6 - 1.9) | 1.0 (0.5 - 1.8) |
| Farmer | 213 (65.5) | 112 (34.5) | 1.0 | 1.0 |
| **Anemia status** | | | | |
| Anemic | 38 (71.1) | 15 (28.3) | 1.4 (0.7 - 2.6) | 1.7 (1.2 - 2.7)[a] |
| Non-anemic | 251 (64.5) | 138 (35.5) | 1.0 | 1.0 |
| **Meals per day** | | | | |
| < 3 days | 49 (74.2) | 17 (25.8) | 0.6 (0.3 - 1.1) | 1.6 (1.2 - 3.0)[a] |
| ≥ 3 days | 240 (63.8) | 136 (36.2) | 1.0 | 1.0 |
| **Absent days from school** | | | | |
| ≥ 4 days | 137 (73.7) | 49 (26.3) | 1.9 (1.3 - 2.9)[a] | 1.6 (1.1 - 2.5)[a] |
| < 4 days | 152 (59.4) | 104 (40.6) | 1.0 | 1.0 |
| **Workload at home** | | | | |
| High | 103 (64.0) | 58 (36.0) | 1.1 (0.7 - 1.6) | 1.9 (1.3 - 2.5)[a] |
| Low | 186 (66.2) | 95 (33.8) | 1.0 | 1.0 |

[a] Significant at P < 0.05.

The present findings revealed that age was significantly associated with anemia. Young age (10 - 14 years) was significantly associated with a greater likelihood of being anemic, compared with older age (15 - 19 years). This finding is similar to a study performed in Saudi Arabia, which showed that the prevalence of anemia was higher among girls, aged 10 - 12 years (21). In contrast, studies conducted in India (22) and Kenya (17) revealed that age was not signif-

icantly associated with anemia.

In the current study, the habit of wearing shoes had a significant association with the prevalence of anemia. The school girls who wore shoes 3 days a week or less had a higher risk of anemia, compared to those who wore shoes more than 3 days a week; this finding is in line with a study performed in Eastern Ethiopia (23). The observed association might be attributed to the fact that walking barefoot

exposes the foot to injuries and can lead to chronic bleeding.

In the present study, two-thirds of the participants had reached menarche, 3.7% of whom had menstrual bleeding for more than 7 days. As the findings revealed, the onset of menarche and longer menstrual bleeding were not significantly associated with anemia; the reported finding was consistent with a study performed in a slum in India ([13]). In contrast, other studies conducted in Kenya ([17]), India ([22]), and Saudi Arabia ([21]) reported that the status of menarche and longer menstrual bleeding were risk factors for anemia. Due to the higher prevalence of anemia in Kenya, India, and Saudi Arabia, the mentioned studies could include 136 - 375 anemic girls, thus resulting in a greater statistical power, compared to the current study, where 53 girls were anemic. In fact, a larger sample size might be needed to elucidate the effect of menstruation on anemia in the study population.

In the present study, there was no significant relationship between anemia and socioeconomic status, the parents' educational status, workload at home, drinking tea/coffee immediately after a meal, frequency of using green leafy vegetables and fruits, or other variables. Some of these findings are in contrast with the results of some studies performed in India ([24]) and Saudi Arabia ([21]), which revealed that consumption of green leafy vegetables and socioeconomic status were significantly associated with the prevalence of anemia.

Moreover, the present study showed that the risk of poor performance at school among anemic girls was 1.7 times higher than non-anemic girls. Similarly, studies conducted in Palestine ([25]), Saudi Arabia ([21]), and India ([20]) showed that anemia had a negative effect on academic performance. This is most likely due to the fact that anemia is associated with reduced oxygen saturation of the blood supply to the brain ([8]), which is believed to cause silent cerebral infarction ([9]) and result in mental impairment of adolescent school girls ([26]). The impairment of cognitive function might present as fatigue, memory and attention deficits, poor academic achievement, and/or decrement in problem-solving skills ([11], [12]).

In addition, in the present study, adolescent school girls of grades 7 - 8 were more likely to have scores below the average, compared to those in grades 9 - 10. The subjects' age was significantly associated with their academic performance; in fact, younger girls had a higher risk of low academic performance. This finding is in agreement with the results of a study conducted in Wolaita Sodo district, Southern Ethiopia ([27]).

A study performed in the Gaza Strip of Palestine indicated a positive association between a fruit- and vegetable-based diet and high academic performance. According to this study, school girls who did not frequently eat vegetables and fruits had fewer achievements at school ([25]). However, the current study did not show a significant association between fruit and vegetable consumption and academic performance. Furthermore, in this study, family size had no significant association with the academic performance of adolescent girls; this finding is in agreement with the study performed in Wolaita Sodo district, Ethiopia ([27]).

The strengths of the present study include the measurement of hemoglobin concentration with a standard portable tool to minimize error, as well as the use of Global Positioning System (GPS) for the measurement of altitude. On the other hand, considering the cross sectional design of the study, it was difficult to assess the direct cause-effect relationship between anemia and school performance. Also, anthropometric measurement of body mass index was not performed to identify the association between malnutrition and anemia. Additionally, malaria and worm infestations were possible risk factors for anemia, which were not assessed via parasitological examinations. There are also other determinant factors which could affect academic performance, such as school environment, quality of education, and use of teaching aids, which were overlooked in the analysis.

### 4.1. Conclusion

Compared to similar studies performed in other countries, the present research revealed the low prevalence of anemia among adolescent school girls. Based on the findings, younger school girls and those who frequently walking barefoot were more likely to have anemia. In addition, age group, the subject's educational status, absent days from school, high workload at home, number of meals per day, and anemic status were significantly associated with low academic performance. Therefore, in addition to iron supplementation programs, anemia screening should be directed towards adolescent school girls.

### Acknowledgments

### Footnotes

**Authors' Contribution:** Mohammed Teni conceived the study, proposed the overall design, executed the study,

and performed data collection and statistical analysis. Solomon Shiferaw critically revised the study design and data collection techniques and contributed to the statistical analysis. Also, Fekede Asefa critically revised the study design and data collection techniques, contributed to the statistical analysis, and drafted the manuscript.

**Conflicts of Interest:** The authors declare no competing interests.

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