Prevalence and associated factors of anemia among adolescent girls attending high schools in Dembia District, Northwest Ethiopia, 2017

Kedir Abdela Gonete, Amare Tariku, Sintayehu Daba Wami and Terefe Derso

Abstract

Introduction: Anemia is a global public health problem affecting both developing and developed countries. In Ethiopia, Adolescent girls are more vulnerable to anemia because of gender norms can leave girls disproportionately impacted by food insecurity, increased iron requirements related to their rapid growth, and menstrual loss. However, evidence on the problem is scarce because it has not been given due attention in Ethiopia. Therefore, this study assessed the prevalence and associated factors of anemia among late adolescent girls attending high schools in Dembia District, northwest Ethiopia.

Methods: A school based cross-sectional study was conducted in Dembia District from March 1 to April 30/2017. Out of the randomly selected three high schools, 462 adolescents were included using the simple random sampling technique. A Standardized structured questionnaire was used to collect data. Capillary blood samples were drawn from adolescents using a portable Hb201+ instrument to measure hemoglobin. A bivariate and multivariable binary logistic regression analyses were employed to identify factors associated with anemia. Adjusted Odds Ratio (AOR) with a corresponding 95% Confidence Interval (CI) was computed to show the strength of associations.

Results: The overall prevalence of anaemia among adolescent girls was 25.5%, (95%CI, 21.4, and 29.2). Of the total anemic adolescents, 109 (92.4%) had mild anaemia, while 7 (5.9%) and 2 (1.7%) were found with moderate and severe anaemia, respectively. Dietary diversity score ((AOR =4.2(95% CI;1.7, 10.5)), household food security status ((AOR = 4.1 (95% CI; 1.3, 13.2)), living status of adolescents with either of the two parents((AOR = 2.95%CI;1.14,3.6)) and guardians ((AOR = 2.4(95% CI;1.02,5.6)) showed statistically significant association with anemia.

Conclusion: Anemia is a moderate public health problem in Dembia District. Dietary diversity score, household food security status, and living status of adolescents were the key determinants of anemia. Therefore, the government should focus on preventing food insecurity with increasing productivity to improve dietary diversification of the adolescent girls.

Trial registration: Retrospectively registered.

Keywords: Anemia, Adolescent girls, Ethiopia
Background
Recently, adolescence has been considered as a critical window and a gateway to address the intergenerational cycle of malnutrition as adolescent girls enter pregnancy with poor nutritional reserve and give birth to undernourished babies [Lancet 2023]. Nearly 1.2 billion of the global population is comprised of adolescents 90% of which live in low or middle-income countries [1, 2]. Anemia is a nutritional disorder resulting when the number and size of red blood cells or the hemoglobin concentration falls below the established cut-off value, which consequently impairs the capacity of the blood to transport oxygen to the body [3–5]. It is a global public health problem affecting both developing and developed countries with its varied adverse consequences on health as well as on the socio-economic development of the countries [4, 6–8]. The most common cause of anemia worldwide is iron deficiency, resulting from prolonged negative iron balance, caused by inadequate dietary iron intake or absorption, increased needs for iron during pregnancy or growth periods, and increased iron losses as a result of menstruation and helminth (intestinal worms) infestation. Other important causes of anemia worldwide include infections, other nutritional deficiencies (especially folate and vitamins B12, A and C) and genetic conditions (including sickle cell disease, thalassemia – an inherited blood disorder – and chronic inflammation) and severe malaria and may be associated with secondary bacterial infection [4, 9, 10]. Adolescent girls are the vulnerable group to anemia because of increased iron requirements to support their rapid growth and mental development and replenish loss due to menstruation [11, 12].

Experimental studies show that iron deficiency (ID) is capable of causing cognitive impairment in animals and humans, with brain mitochondrial damage as a basis for these alterations (). Among the cognitive impairments caused by iron deficiency (ID), those related to attention span, intelligence, and sensory perception functions are mainly cited, as well as those related to emotions and behavior. Generally, these impairments have been related to iron deficiency anemia (IDA) [13, 14].

The World Health Organization (WHO) estimated that more than two billion people about a quarter of the world's are affected by anemia [4]. About 29.4% of women in the reproductive age have anemia [15]. The majority of south Asian adolescent girls were anemic; for instance, anemia was detected among 70, 51.8 and 67.7% of adolescents in Bangladesh, India, and Nepal, respectively [16]. In the further, adolescence anemia will be contribute to high maternal mortality, increased incidence of low birth weight, perinatal mortality, and fetal loss [17].

According to the 2011 Ethiopian Demographic Health Survey (EDHS) report, 13.4% of the adolescent girls were found with anemia [18]. Similarly, different district level studies showed a high prevalence (15.2–32%) of adolescent anemia [19–21].

Although nutritional anemia affects both sexes and all age groups, the problem is more prevalent among adolescent girls [22]. Furthermore, malaria, intestinal parasitic infections, Tuberculosis, and pneumonia [23] are some of the morbidity related determinates of anemia. On the other hand, poor economic status [24], the type of family [12, 25], residence [19, 20], family size, age [19, 21], large number of children [26] and occupation are the socio-demographic factors associated to anemia [21].

In 2012, the World Health Assembly endorsed a 50% reduction in the burden of anemia in women of reproductive age [5]. Ethiopia has also been striving to curve the high burden of micronutrient deficiencies, including anemia, through implementing national programs and strategies, such as the National Nutrition Program (NNP) and the micronutrient deficiency control strategy. However, these efforts targeted only pregnant mothers and children (6–59 months) through providing universal prenatal iron folate supplementation and de-worming drugs [18, 27]. But more recently, the revised NNP has considered adolescent nutrition as one of the critical focus. Therefore, regular investigations of anemia among adolescents helps to make evidence based decisions. Nevertheless, there has been a scarcity of literature in Ethiopia, including the study area, Dembia District. Thus, this study aimed to assess the prevalence of anemia and associated factors among adolescent school girls in Dembia District, northwest Ethiopia.

Methods
Study design and settings
A school based cross-sectional study was conducted from March 1 to April 15/2017 among late adolescent girls aged 15 to 19 years. Dembia, the study area, is 765 km from the capital city of Ethiopia, Addis Abeba. The district has 45 kebeles (smallest administrative unit in Ethiopia) 7 high and 135 elementary schools. A total of 5071 adolescent girls were found attending high schools in the district. One hospital, 10 health centers, and 40 health posts were responsible for the health care.

Study participants and sampling procedure
Adolescent girls attending high schools were included in the study. The sample size was calculated using the single population proportion formula by taking the level of confidence at 95%, margin of error 4%, design effect 1.5, non-response rate 10%, and expected prevalence 13.4% from EDHS [18]. Finally, a sample size of 462 was obtained. Regarding the sampling procedures, a multi-stage sampling technique was employed and out of the total 7 high schools, three were selected using the lottery method. According to the school 2304 girls were
attending the three high schools at the moment and proportional allocation was used to determine the number of students from each high school. School rosters were used as sampling frames and 181, 241 and, 40 adolescent girls from Kolladba, ChuaHitt and Sankisa kebele High schools were selected, respectively by using a systematic sampling technique. Adolescents who were pregnant and on treatment for anemia were excluded.

Data collection procedure and management
A structured questionnaire, laboratory investigation for hemoglobin, anthropometric measurement for body mass index (BMI), and a standardized food security questionnaire from FANTA 2007 were used to collect data. Socio-demographic factors (age, marital status, occupation, religion, occupations, educational status of father and mother, birth order, birth interval, ethnicity and wealth index); health condition (malaria, intestinal parasite, menorrhagia); and dietary diversity (using 24 h recall methods) in the past 24 h in the schools were addressed for adolescents.

Families were interviewed about the socio-demographic and economic characteristics of mothers or guardians, while house-hold food security, weight index, and environmental sanitation and hygienic practice were gathered through face to face interviews. The questionnaire was prepared in English and translated into Amharic and retranslated to English by language experts to ensure consistency. It was pretested on 5% of the sample out of the actual study setting. Three laboratory technicians, nine clinical nurses, and three health officer supervisors participated as data collectors. Two days training was given to data collectors and supervisors on the objectives and methodology of the study and the process of data collection by the principal investigator. Throughout the course of data collection, collectors were supervised at each site and regular meetings of data collectors, supervisor and the principal investigator were held. The daily collected data was checked for accuracy. Data cleaning and cross-checking were made by the principal investigator and 10% was double entered to control errors during the entry.

Blood collection and anthropometric measurement
Adolescent hemoglobin status was measured by using a portable battery-operated photometer (Hemacue M+201). Capillary blood sample was taken by prickling the tip of the adolescent finger in a aseptic way. After rubbing the fingertip with sterile cotton, (immersed in alcohol) a 10 micro liter blood sample was collected by finger pricking with a sterile disposable lancet and the second blood drop was taken for hemoglobin measurement. Result was read within one minute. The photometer was calibrated before every session using provided standard. Hemoglobin level determination was done by trained laboratory technicians working out of the district.

Anthropometric measurement (height and weight) was taken according to World Health Organization (WHO) standard. Height was measured using a stadiometer and recorded to the nearest 0.1 cm. During the measurement, prominent body parts of the girls (occipital, shoulder, buttocks and heel) touched the stadiometer; shoes were taken off and they stood in Frankfurt position. Weight was measured with the Seca beam balance and recorded to the nearest 0.1 kg. Heavy clothes and shoes were taken off.

Ethical consideration
Ethical approval for the survey was obtained from the Ethical Review Board of the University of Gondar. Written informed consent and assent was obtained from the adolescents and mothers of the selected participants. In case of illiterate mothers, consent was documented by thumbprint on the consent form, while literate ones signed the forms. All names and personal information regarding participants were kept confidential, and the data set for analysis was kept unidentified, using code numbers.

Description of variables
According to WHO, the adolescent girl’s anemia status was considered as the outcome variable and was defined as individual hemoglobin levels below 12 g/dl at sea level and 11–11.9 mg/dl, 8–10.9 g/dl, and lower than 8 g/dl were considered as mild, moderate and severe anemia respectively [28]. Independent variables considered in this study were identified by reviewing previous literature (Table 1).

Statistical analysis
All the filled questionnaire and laboratory results were checked manually for completeness and consistency of responses. The collected data were coded and entered into EPI INFO version 7 and exported to SPSS version 20.0 for further analysis. The anthropus nutritional software was used to determine the BMI of the adolescents with age, and the principal component analysis (PCA) was used for wealth index analysis. Adjusted Hb(hemoglobin) concentration was calculated as 

\[
Hb = -0.32 \times (\text{altitude in meters} \times 0.0033) + 0.22 \times (\text{altitude in meters} \times 0.0033)^2
\]

To subtract the adjustment from the measured Hb concentration at the relevant altitude (2200 m above the sea level) to get the sea-level value.

Descriptive statistics of the demographic characteristics of respondents and other factors were computed. Tables, graphs, means and frequencies were used to present information.

The binary logistic model was fitted to identify factors associated with anemia. Bivariate logistic regression analysis was performed, and variables with \(p\)-values < 0.2
were exported to the multivariable logistic regression analysis. Significance level was obtained at p-value of < 0.05. The Adjusted odds ratio was used for measuring the strength of the association. Crombachalpha (0.79) was calculated to check the internal consistency or reliability of the tool before data entry. The hosmer and lemonshow test was done, and the result was 0.94, suggesting that the model fits the data well.

Result
A total of 462 adolescent girls and their mothers participated in the study with a response rate of 100%. The mean age with a standard deviation of the adolescents was 17 ± 1.2. Half, 262(56.7%) of the adolescents were aged 17 to 19 years. Half, 262(56.7%) of the adolescents were aged 17 to 19 years. More than half of the mothers and the adolescent girls 264(57.1%) lived in rural areas, and surprisingly 7.4% of the adolescents were married at the moment. Nearly two-thirds 272 (58.9%) of the mothers were not able to read and write, whereas almost half of the fathers 223 (48.3%) were able to read and write. About 42.9% the households were the in poor tertile (Table 2).

According to the self-reported health status of the adolescents, 165 (35.7%) and 33 (7.1%) had upper respiratory tract and diarrheal morbidities, respectively. Cardiac diseases was reported by 16 (3.5%) of the participants, and 49 (10.6%) adolescents had malaria in the past two weeks. Also, 419 (90.7%) and 38(8.2%) of the girls started menstruation and were on menstruation during the data collection period, respectively. Three hundred seventy-seven (81.6%) of the adolescents had no massive bleeding disorder during menstruation cycles (Table 3).

Nearly three-fourths 304 (65.8%) of the adolescents had a meal frequency of three times per day. During the data collection, nearly half 211 (45.7%) of the adolescents did not consume milk and 197 (42.6%) citrus fruit at all. Many of the students 395(85.5%) used tea and coffee, and nearly two thirds 291 (63%) used immediately after taking other food. Majority of the participants, 338 (73.2%) and 364(78.8%) reported to have fruits and other vitamin A rich fruits and vegetables, respectively (Table 4).

Almost all, 455(98.5%) of the adolescents were well nourished, and 357(85.9%) of the households were food secure (Table 4).

Concerning the families of adolescent, 279 (60.4%) used community pipe water. Two-thirds 312 (67.5%) of the parents were not using any treatment for water. Of the total 462 participants, 374 (81%) had toilets, while 209 (45.2%) had no hand washing practices after toilets (Table 5).

Prevalence of anemia
The overall prevalence of anemia was 25.5% (95% CI; 21.4, 29.2) in Dembia District. Out of the total anemic
samples, 109(92.4%), 7(5.9%), and 2(1.7%) were mildly, moderately, and severely anemic, respectively.

Factors associated with anemia
All the potential factors of anemia fulfilling the chi-square assumption were fitted into the bi-variable logistic regression model. Consequently, household food security, upper respiratory tract infection, living status of

Table 2 Socio-Demographic and economic characteristics of the adolescents girls and their mother, Dembia District, Northwest Ethiopia, 2017 (Continued)

| Characteristics               | Frequency | Percent |
|-------------------------------|-----------|---------|
| House hold wealth Index       |           |         |
| Poor                          | 198       | 42.9    |
| Middle                        | 151       | 32.7    |
| Riche                         | 113       | 24.5    |

Table 3 The Health related characteristics of the Adolescents in Dembia District, Northwest Ethiopia 2017

| Characteristics               | Frequency(n) | Percent (%) |
|-------------------------------|--------------|-------------|
| Known chronic Diseases        |              |             |
| no                            | 433          | 93.7        |
| yes                           | 29           | 6.3         |
| Types of chronic Diseases     |              |             |
| Tuberculosis                  | 6            | 1.3         |
| Hypertension                  | 1            | 0.2         |
| Cardiac Diseases              | 16           | 3.5         |
| kidney                        | 6            | 1.3         |
| Diarrheal episode             |              |             |
| no                            | 429          | 92.9        |
| yes                           | 33           | 7.1         |
| Upper respiratory tract       |              |             |
| no                            | 297          | 64.3        |
| yes                           | 165          | 35.7        |
| Infectious Diseases           |              |             |
| Malaria                       | 49           | 10.6        |
| Beginning of menstruation     |              |             |
| no                            | 43           | 9.3         |
| yes                           | 419          | 90.7        |
| Current status of menstruation|              |             |
| no                            | 380          | 82.3        |
| yes                           | 38           | 8.2         |
| Changing of pad in a hour     |              |             |
| one times                     | 22           | 4.8         |
| two times                     | 20           | 4.3         |
| three times                   | 1            | 0.2         |
| nothing                       | 377          | 81.6        |
adolescence, dietary diversity score, and source of water were found with a $P$-value of $< 0.2$ in the bi-variable analysis and then fitted to the multivariable analysis. In the multivariable analysis, household food security, dietary diversity, and living with either of the two parents and guardians were significantly associated with anemia at a $P$-value of $< 0.05$. The odds of having anemia were 2.1 times ($\text{AOR} = 2.1; (95\% \text{ CI}; 1.3, 3.5)$) higher among adolescents with inadequate dietary diversity compared to those with good dietary diversity. Likewise, the odds of having anemia were 2 times higher among adolescents who were living with either of the two parents compared to their counterparts ($\text{AOR} = 2.0; (95\% \text{ CI}; 1.14, 3.6)$). The higher likelihood of anemia was demonstrated by the adolescents who were living with guardians as compared to those who lived with mothers and fathers ($\text{AOR} = 2.4; (95\% \text{ CI}; 1.02, 5.6)$). Finally, the odds of anemia increased among adolescents from food insecure households compared to their counterparts ($\text{AOR} = 1.9; (95\% \text{ CI}; 1.1, 3.5)$ (Table 6).

**Discussion**

The prevalence of anemia is high in developing countries; it is estimated that 9 out of 10 anemia sufferers live in developing countries [29]. At the same time, about half of adolescent girls living in Sub-Saharan Africa are anemic [30].

The finding show that the overall prevalence of anemia among school adolescent girls was 25.5% (95% CI; 21.4, 29.2). Based on WHO standards, this finding shows that anemia is a moderate public health concern among 15–19 years of age adolescent girls [9]. This finding is in line with that of Peri Urban Bangladesh (27%), Kenya (26.5%) [31] and the local report from Berhale District (22.8%) [19]. The possible reason might be low dietary intake of nutrient dense food groups, such as eggs, milk, and meat.

However, our result was found to be lower compared to those of studies conducted in Chennaie, India, which reported the overall prevalence of anemia to be 78.75%. The possible reason could be that a high proportion (13.3%) of the adolescents in Chennie, India had massive menstrual
bleeding disorder in the past two weeks prior to the data collection, while an insignificant (4.5%) number of participants experienced the problem in the current study. Such bleeding might explain a high prevalence of anemia in the latter study setting. On the other hand, the observed discrepancy could be related to the high magnitude of under nutrition (42.5%) in Channie, India compared to

that of the current study (1.5%) [32], and the deficiency of micronutrient results malnutrition and contributes to the prevalence of anemia [33, 34].

Similarly, compared to ours a higher prevalence of anemia (51.3%) was reported in Nepal. About 21% of the participants were found with worm infestation in the Nepal study, while it was 4.2% in the present study. Variations in hookworm infestation could explain the observed discrepancy in adolescent anemia [35]. This report was also lower than the previous local finding in Babile District (32%) [36].

However, the prevalence of anemia in this study was considerably lower than that of southern Iran (5.3%). The difference could be attributed to presence of iron folic acid supplementation; 46.3% of the Iranian adolescents were supplemented for iron and folic acid, while none of the participants were supplemented in the current study. Obviously, iron-folate supplementation boosts blood hemoglobin level which could be attributed to the lower prevalence of anemia in Iran [37].

Similarly, a lower prevalence of anemia (12%) was reported in Kebena, Addis Abeba. The low burden could be related to a better intake of micronutrient rich food in Kebena than adolescents of the present study. In Kebena, 65.0% of the adolescents ate meat and animal products at least once in a week, and 37.6% consumed vegetables more than 3 times per week [38].

The odds of having anemia were 2.1 times higher among adolescents with inadequate dietary diversity compared to those with good dietary diversity. This finding was supported by a study in Nigeria [39]. It was evident that diversification of diets enhances the micronutrient adequacy of the diet. Therefore, undiversified diet is a proxy indicator of poor micronutrient intake which increases the vulnerability of adolescents to anemia and other micronutrient deficiencies [40]. In another view this might be seasonality difference.

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food security on dietary diversification and food intake. In fact, household food insecurity impairs micronutrient intake of household members which in turn increases the developing of anemia [42].

**Conclusion**

This study illustrated that; anemia is a moderate public health problem among adolescent girls in Dembia District. Household food security, dietary diversity, living with either of two patents and guardians only were significantly associated with anemia. Therefore, the government should focus on preventing food in security with increasing productivity to improve dietary diversification of the adolescent girls.

**Abbreviations**

EDHS: Ethiopian demographic health survey; IDA: Iron Deficiency anemia; WHO: World Health Organization

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**Availability of data and materials**

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**Authors’ contributions**

Methodology: KA, AT, SD. Tool development: KA, AT, SD. TD. software: KA, AT, SD. TD. validation: KA, AT, SD. formal analysis: KA, AT, SD. TD. data curation: KA, AT, SD. writing (original draft preparation): KA, AT, SD. supervision: KA, AT, SD. Manuscript writing: KA, AT, SD. TD. All authors read and approved the final manuscript.

**Ethics approval and consent to participate**

Ethical clearance was obtained from the Institutional Ethical Review Board of Gondar University. Supportive letters were obtained from Zonal Educational Department and Dembia District Health education. Written informed consent and assent was obtained from each mothers and the participated student in responding the questions after clearly informing the purpose, benefits, confidentiality of the information, and voluntary nature of participation in the study. Name and other personal identifiers were not recorded to maintain confidentiality.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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**Table 6** Factors Associated with Anaemia among late Adolescent girls in Dembia District, Northwest Ethiopia, 2017

| Variables             | Categories                  | Anemic | Non anemic | COR | AOR |
|-----------------------|-----------------------------|--------|------------|-----|-----|
|                      |                             | Anemic | Non anemic |     |     |
| Living status of the adolescence | With both family            | 84     | 285        | 1   | 1   |
|                      | Either of two                | 23     | 45         | 1.7(1.0,3.03) | 2(1.14,3.6)* |
|                      | Guardians                    | 11     | 14         | 2.7(1.2,6.1) | 2.4(1.02,5.6)* |
| Upper respiratory Tract | No                          | 67     | 230        | 1   | 1   |
|                      | Yes                         | 51     | 114        | 1.5(1.01,2.4) | 1.4(0.9,2.3) |
| Dietary Diversity (score) | Adequate dietary diversity  | 27     | 126        | 1   | 1   |
|                      | Inadequate dietary diversity | 91     | 218        | 1.9(1.2,3.1) | 2.1(1.3,3.5)* |
| Household food security | House hold food secure      | 93     | 304        | 1   | 1   |
|                      | House hold food insecure    | 25     | 40         | 2.0(1.2,3.5) | 1.9(1.1, 3.5)* |
| Source of water       | Safe water                  | 85     | 291        | 1   | 1   |
|                      | Unsafe water                | 33     | 53         | 2.1(1.3,3.5) | 1.2(0.6,2.1) |

*p value less than 0.05
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