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Minimum diet diversity-women score and predictors of school adolescent girl stunting and thinness in Northwest Ethiopia

Yajeb Melesse[1†] and Zeweter Abebe[1*†]

Abstract

Background Limited data exist on adolescent nutrition. This school-based cross-sectional study aimed to assess dietary practices, nutritional status, and associated factors among adolescent girls.

Methods Two hundred seventy-nine primary and secondary school girls were selected via multistage sampling. A pretested questionnaire and 24-h recall method were employed to gather data on background characteristics and dietary practices. The questionnaire was pretested with 20 adolescents from nonparticipating schools to assess clarity and reliability. Feedback from the pretest was used to refine the questionnaire. The minimum dietary diversity for women (MDD-W) was used as an indicator of diet quality, where women were considered to have adequate dietary diversity if they consumed at least five of ten food groups in the past 24 h. Key informant interviews were used to explore nutritional problems, while anthropometric measurements were taken to assess nutritional status. Height and weight, combined with age, were used to calculate height-for-age and BMI-for-age z scores via WHO AnthroPlus software. Nutritional status was categorized as stunted (< -2SD), thin (< -2SD), normal (-2SD to + 2SD), or overweight (> + 2SD). A multivariate binary logistic regression model identified predictors of nutritional status. The quantitative data were analyzed via SPSS, and the qualitative data were analyzed via ATLAS.ti.

Results Only 24% of the students met the MDD-W. Predominant consumption of plant-source foods (100%) and low animal-source food intake (< 20%) were observed. Environmental, social, and cultural factors are barriers to nutrition, whereas cultural food preferences act as reinforcing factors. The prevalence rates of thinness, stunting, and overweight were 7.2%, 6.4%, and 5.7%, respectively, with undernutrition being more prevalent in younger adolescents (10–14 years). Adolescents with low fast food consumption and those in late adolescence were less likely to be stunted or thin.

Conclusion Poor dietary practices and undernutrition, particularly among younger adolescents, were observed. Comprehensive programs addressing environmental, social, and cultural barriers are needed to improve adolescent nutrition.

Keywords Dietary practices, MDD-W, Adolescents, Girls, Nutritional status

Introduction

Adolescence is a critical period of growth and development, but in many developing countries, adolescents face significant nutrition-related challenges, including malnutrition, thinness, and stunting [1, 2]. These issues are particularly prevalent among adolescent girls, with studies indicating high rates of poor nutritional status,

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which adversely affects their health, development, and future generations [1, 3]. Malnutrition in this group is exacerbated by poor dietary practices [4], early marriage, gender-based dietary discrimination, and increased nutritional demands due to menstruation and pregnancy [3, 4].

The consequences of adolescent malnutrition are severe and far-reaching [1]. Malnourished girls are at increased risk of complications such as low birth weight, preterm birth, and stillbirth, which affect not only their own health but also the well-being of their children and the broader community [5]. Research on adolescent nutrition is growing [6], with increased recognition in global initiatives such as The Lancet Commission on Adolescent Health and Wellbeing [7] and references in the Sustainable Development Goals [8]. Despite the urgency of addressing this issue, there remains a gap in understanding adolescent nutrition.

For example, while there is growing recognition of the importance of dietary diversity for adolescent girls, particularly in relation to preventing undernutrition and improving micronutrient intake [9], the recently developed Minimum Diet Diversity for Women (MDD-W) metric [10] has not been extensively applied to assess the micronutrient adequacy and overall diet quality of adolescents, although it has been proven to be a reliable and valid measure of adolescent dietary quality, with few [6]. However, it has been widely used to assess the quality of women's diets [11, 12]. Additionally, much of the research on adolescents relies on quantitative data (e.g., height, weight, and BMI) [2, 3], with less focus on qualitative aspects such as food preferences and their associations with nutritional status, barriers and reinforcing factors for adolescent nutrition.

Hence, this study aims to address these gaps by exploring adolescent girls' diet quality via the MDD-W metric, investigating food preferences and their associations with nutritional status, and identifying the barriers and reinforcing factors affecting proper adolescent nutrition in northwestern Ethiopia.

Materials and methods

Study design, setting, and period

This school-based cross-sectional survey combines quantitative (survey) and qualitative (in-depth interviews) methods. The study was conducted from October to December 2021 in Debre-Markos city, which is located in the East Gojam Zone of the Amhara region, Ethiopia, approximately 300 km northwest of the capital. The city includes 16 primary schools (10 government and 6 private) and 4 public high schools, according to the local education office.

Eligibility criteria

Adolescent girls aged 10–19 years who were enrolled in primary or secondary school in the study area were eligible for inclusion. The participants had to be free from significant illness or pregnancy. The exclusion criteria included male adolescents, individuals unable to provide informed consent/assent, and those with illnesses affecting appetite or disabilities that would interfere with anthropometric measurements.

Study participants

The quantitative component included adolescent girls aged 10–19 years from both government and private primary and secondary schools in Debre-Markos city, as well as their caregivers. For the qualitative component, key informant interviews were conducted with health professionals, community leaders, teachers, adolescents and their caregivers. Although the adolescent girls and their caregivers participated in both components, the participants for the quantitative and qualitative studies were distinct.

Sample size determination

The sample size was calculated via a single population proportion formula by considering the following assumptions: proportion of adolescents with thinness (12.7%) from a previous study performed among school adolescent girls in Addis Ababa [13]; margin of error 5%; confidence level 95% ($Z\alpha/2 = 1.96$); and 10% non-response rate. After multiplication of the result with the 1.5 design effect, the final number of students included in the study was 282.

$$n = \frac{\left(\left(z_{\alpha/2}\right)^2 * P(1-P)\right)}{\left(d^2\right)},$$

Sampling procedure

A list of primary and secondary schools was obtained from the Debre-Markos city education bureau. The schools were stratified on the basis of level of education into middle (grades 5–8) and secondary (grades 9–12). Each stratum was further categorized, on the basis of the funding source, into public and private schools (Fig. 1).

Data collection

Background characteristics

From a total of 10 government middle schools, 6 private middle schools, and 4 government high schools, 5, 3, and 2 schools, respectively, were selected on the basis of proportional distribution. To allocate 282 subjects proportionally across the selected schools, 30% of the classes were randomly chosen from each school. The proportion

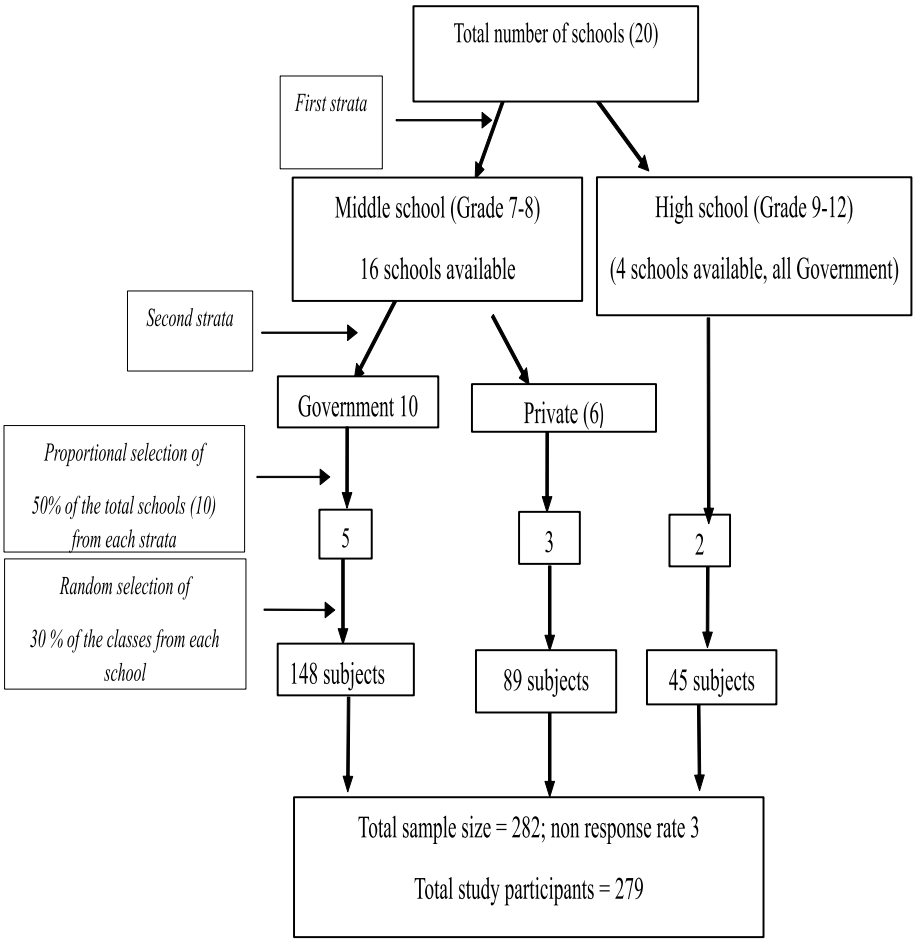

Fig. 1 Diagrammatic representation of the sampling procedure

of each school type was then calculated and multiplied by 282, resulting in 148 government, 89 private, and 45 high school subjects, rounded to the nearest whole number."

A structured, interviewer-administered questionnaire was used to collect data on participants' background characteristics, including age, grade level, school type, religion, marital status, distance from school, caregiver status, residence area, awareness of adolescent nutrition, family size, and occupation. The questionnaire was developed on the basis of a review of the relevant literature.

Anthropometric measurements

Height and weight were measured for each adolescent girl. Weight was recorded to the nearest 100 g via a calibrated digital scale, with participants wearing light clothing and no shoes. Height was measured to the nearest 0.1 cm in a standing position via a vertical board with a detachable headpiece. The scale was recalibrated after weighing every five participants to ensure accuracy.

BMI-for-age Z scores and height-for-age Z scores were calculated using participants' height, weight, and age. The participants' age was taken from the school registrar. WHO AnthroPlus software was used to compute the Z scores [14]. Nutritional status was classified as stunted (height-for-age Z scores < −2SD), thin (BMI-for-age Z scores < −2SD), normal (Z scores between −2 and + 2 SD), or overweight (BMI-for-age and height-for-age Z scores > + 2 SD).

Meal frequency, DDS, and MDD-W

The adolescents' dietary intake was assessed via a single 24-h recall method [15], covering all days of the week. The participants were asked to report all the foods and drinks consumed in the past 24 h, providing detailed information about their intake. The dietary recall test was conducted by the principal investigator and two trained nurses with prior experience in 24-h recall. The interviews were conducted with adolescents and their caregivers on the basis of the adolescent's age and ability to recall their dietary intake. For those who could provide reliable information, interviews were conducted directly with the adolescents. For younger adolescents or those with recall

difficulties, interviews were conducted with their parents or caregivers, who provided information on their behalf.

The dietary diversity score (DDS) was calculated by counting the number of different food groups consumed within the recall period out of ten predefined groups: grains, white roots, tubers, and plantains; pulses (beans, peas, lentils); nuts and seeds; dairy; meat, poultry, and fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits. Each consumed group was assigned a score of 1. The mean DDS was calculated by averaging individual DDS scores across all participants.

For the determination of MDD-W, the foods consumed during the 24-h recall were categorized into 10 predefined groups on the basis of FAO guidelines [10]. These include grains, white roots, tubers, and plantains; pulses; nuts and seeds; dairy; meat/poultry/fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits. Meeting the MDD-W threshold was defined as consuming at least 5 of the 10 food groups within the recall period, indicating a sufficiently diverse and potentially nutrient-rich diet. If fewer than 5 groups were consumed, the participant was categorized as having lower dietary diversity. Meal frequency was assessed by recording the number of meals consumed during the 24-h recall period, and the average meal frequency was calculated and is presented as the mean ± SD.

Fast food and sweetened beverage consumption

The consumption of fast food and sweetened beverages was categorized into two groups on the basis of weekly intake frequency. Adolescents were asked to report the frequency of consumption after the definitions of fast food and sweetened beverages were explained and typical examples were provided [16]. High consumption was defined as ≥ 4 times per week, and low consumption was defined as < 4 times per week [13, 17].

Key informant interview

The key informant interview aimed to assess participants' awareness of adolescent nutrition, understand the challenges and reinforcing factors related to it, and identify potential solutions. Nine key informants (four male and five female) participated, including health professionals, community leaders, teachers, adolescent girls, and parents/caregivers. The interviews were conducted in Amharic, the local language. With participant permission, the interviews were recorded via audio recorders, in addition to taking supplementary notes.

Data quality assurance

The survey questionnaires were pretested in schools outside the study area to ensure clarity and relevance. On the basis of feedback from the pretest, some questions were revised for clarity before the final data collection. Three experienced data collectors, familiar with the community's culture, language, and norms, were recruited and provided with three days of refresher training on data collection procedures.

The translation process for the questionnaire and key informant interview guide followed a standard procedure: translation, back-translation, and harmonization. The instruments were initially prepared in English, then translated into Amharic and back-translated into English to ensure consistency. Any discrepancies between the original and back-translated versions were reviewed and harmonized with the investigators and translators.

The Amharic version was used for data collection. Each data collector interviewed five participants per day to ensure quality. Data completeness was reviewed and entered daily by the principal investigator.

Ethical approval was obtained from the College of Natural and Computational Sciences Institutional Review Board of Addis Ababa University (Ref no: CNCSDO/616/13/2021). Written consent and assent were obtained from the adolescents' primary caregivers in the presence of regional administration office representatives.

Data analysis

The data were coded and entered into SPSS version 20. Categorical variables are presented as frequencies and percentages, whereas continuous variables are summarized as the means ± SDs. Bivariate and multivariate logistic regression analyses were performed to identify factors associated with adolescents' nutritional status. Variables with a p value < 0.25 in the bivariate analysis and those proven to be related to adolescent nutrition in the literature were included in the multivariable analysis. Independent determinants were considered significant at $P \leq 0.05$. Multicollinearity was checked for each independent variable before the analysis. Model fit was assessed via the Hosmer–Lemeshow goodness-of-fit test.

Qualitative data analysis

Qualitative data were analyzed via ATLAS.ti software. The recorded interviews were transcribed in Amharic and then translated into English following standard transcription and translation guidelines [18, 19]. A concept-driven coding approach was employed, with thematic content analysis focusing on four main themes: awareness of adolescent nutrition, challenges and reinforcing factors related to adolescent nutrition, and strategies to overcome these challenges. After the transcripts were reviewed multiple times, the data were grouped under predefined themes. Codes were identified within each

theme, and relevant quotations were extracted. Conclusions were drawn through careful reading and discussion among the investigators, and the results are presented under the four themes.

Results

Background characteristics of the study participants

Two hundred eighty-two participants were included in the study; however, complete data were collected from 279 participants. The age of the participants was between 10 and 19 years, with a mean of 16.81 ± 1.89 years (Table 1). Close to one-fifth (17%) of the subjects were in the early adolescence stage (10–14), whereas the remaining (83%) were in the late stage (15–19). Three-fourths of the participants were from secondary school (75.6%), but more than 90% of the students were single (95%). Almost all (97.5%) students were from public schools; however, nearly a quarter (23.3%) of the subjects had to walk more than an hour daily to reach school, although more than half (61.6%) of the girls were urban dwellers (Table 1).

The parents of the majority of the girls were alive (86.4%); however, 19% and 9.3% of the girls were living either with their relatives or alone, respectively (Table 2). Close to one-third of the girls (32.6%) were not aware of family planning, but 98.9% of the girls had no previous history of pregnancy. The average monthly income of more than half of the households with girls was above 5000 birr, but the family size for 53.3 of the participants was greater than five, and 52.7% of the adolescents' mothers received no formal education (Table 2).

Table 2 Background characteristics of caregivers of adolescent girls in Debre-Markos city, Ethiopia ($n = 279$)

Characteristics	Category	Frequency (%)
Household monthly income	≤ 5,000 birr	136 (48.7)
	5,000–10,000 birr	81 (29)
	≥ 10,000 birr	62 (22.3)
Mother's education level	No formal education	147 (52.7)
	Primary	50 (17.9)
	Secondary/above	82 (29.4)
Father's education level	No formal education	110 (39.4)
	Primary	63 (22.6)
	Secondary/above	106 (38)
Mother's occupation	House wife	127 (45.5)
	Farming	74 (26.5)
	Private/Government employee	41 (14.7)
	Merchant + others	37 (13.3)
Father's occupation	Farming	116 (41.6)
	Private/Government employee	79 (28.3)
	Merchant + others	84 (30.1)
Family size	≤ 5	130 (46.6)
	> 5	149 (53.4)

One-third of the mothers had secondary education or above; however, only 14.7% of those mothers were private/government employees. The rest of the mothers were doing either farming (26.5%) or were housewives (45.5%). On the other hand, 41.6% of the adolescents'

Table 1 Background characteristics of adolescent school girls in Debre-Markos city, $n = 279$

Socio demographic variables	Category	Number (%)	Mean ± SD
Age in years	10–14 (Early adolescence)	46 (16.80)	16.81 ± 1.89
	15–19 (Late adolescence)	233 (83.20)	
Grade level	Primary (7–8)	68 (24.4)	
	Secondary (9–12)	211 (75.6)	
School type	Public	272 (97.5)	
	Private	7 (2.5)	
Religion	Orthodox	272 (97.5)	
	Others	7 (2.5)	
Marital status	Ever married	14 (5)	
	Single	265 (95)	
Distance from school	≤ 1 h	214 (76.7)	
	> 1 h	65 (23.3)	
Caregiver status	Both alive	241 (86.4)	
	One/both died	38 (13.6)	
Residence area	Urban	172 (61.6)	
	Rural	107 (38.4)	
Awareness about adolescence nutrition	Yes	135 (48.4)	
	No	144 (51.6)	

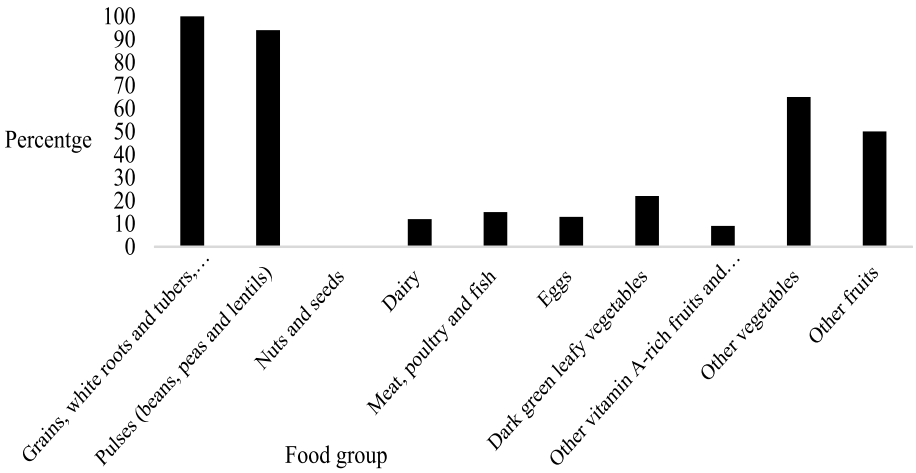

Fig. 2 Proportion of adolescent girls who consumed different food groups during the 24 h recall period in Debre-Markos city

mothers did farm for a living, while the proportions of fathers who were private/government employees, merchants or who did other activities were almost equal (30%).

Dietary intake and meal frequency

All the participants consumed grains, white roots and tubers, and plantains during the 24 h recall period. More than 90% of the participants consumed pulses (beans, peas and lentils). Half of the girls consumed other fruits, while 65% of the participants consumed other vegetables (Fig. 2). The proportions of adolescents who consumed animal source foods such as meat, poultry and fish, dairy products, and eggs were only 15%, 12% and 13%, respectively. Hence, the dietary diversity score of the girls was 3.14, although only 1/3 of the participants consumed ≥ 5 food groups during the 24 h recall period.

On the other hand, sixty-five percent of the participants reported having food two to three times a day, while the remaining reported consuming food more than three times a day over the majority of the weekdays. Similarly, during the 24-h recall period, the meal frequency was only 2 for 10.8% of the girls, while it was three for 53.4%, but 33.7% and 2.2% of those who had eaten 4 and 5 or more times a day, respectively.

However, 90.3% of the participants skipped meals, mostly because of religious fasting (50%). In addition, 3.9% of the participants skipped meals because of a household food shortage. The source of drinking water was tap water for 81.4% of the participants, while the remaining (18.6%) received other sources.

Among the girls, 70.9%, 10.8%, and 18.3% preferred plant-source foods, animal-source foods and sweetened foods and beverages, respectively. However, more than 1/3 of the adolescents had high sweetened beverage consumption, and close to half had high fast-food consumption (Table 3). The consumption rates of low-fast food and sweetened beverages were 54.5% and 64.5%, respectively. However, fewer than half of the participants were aware of adolescent nutrition; 51.6% of the adolescents were unaware of the importance of a balanced diet during adolescence.

Nutritional status of adolescent girls

The overall prevalence of thinness and a low body mass index-for-age z score (< −2 SD) among school-aged adolescent girls was 7.2%. Additionally, the prevalence of stunting, overweight, and obesity was 6.4%. 5.7% and 1.1%, respectively. On the other hand, compared with the late adolescent stage (4.7%), the prevalence of thinness was greater among girls in the early adolescent stage (19.5%) ($p < 0.05$). Nevertheless, the prevalence rates of overweight and stunting were almost equal among girls during the two adolescent stages (< 10%).

Factors associated with nutritional status

Compared with those with high fast food intake, those with low fast food intake were 69% less likely to be stunted [AOR = 0.31 (0.09–0.99)]. Similarly, compared with those in the early adolescent stage, those in the late stage were 85% less likely to be thin [AOR = (0.15, 95% CI: 0.06–0.39)] (Table 4).

Results of the key informant interviews

Awareness of the importance of adolescent nutrition and its consequences

All the participants recognized the importance of adolescent nutrition and its short- and long-term consequences. They identified issues such as defective childbirth, low

Table 3 Food preferences, meal skipping and MDD-W of adolescent school girls in Debre-Markos city ($n=279$)

Variable	Category	Frequency (%)
Food preference	Plant source foods	98(70.90)
	Animal source foods	30(10.80)
	Sweetened foods and beverages	1(18.30)
Sweeten beverage consumption	High	99(35.50)
	Low	180(64.50)
Fast food consumption	High	127(45.50)
	Low	152(54.50)
Source of drinking water	Tap water	227(81.36)
	Other	52(18.64)
Meal skipping	Yes	252(90.30)
	No	27(9.70)
MDD-W	≥ 5 Food groups	67(24.00)
	< 5 Food groups	212(76.00)

Table 4 Multivariable binary logistic regression analysis for determinants of stunting and thinness among school adolescent girls in Debre-Markos city, $n=279$

Variables		Stunted n (%)		COR(95%CI)	AOR(95%CI)
		Yes	No		
Adolescents age (Years)	Early adolescent (10–14)	3(17.64)	43(16.41)	0.16 (0.06–0.42)	0.85(0.22–3.22
	Late adolescent (15–19)	14(82.40)	219(83.60)	-	-
Adolescents awareness about balanced diet	Yes	10(58.82)	125(47.71)	1.44(0.57–3.65)	0.57(0.21–1.57)
	No	7(41.18)	137(52.29)	-	-
Fast food consumption	Low (< 4 days/week)	13(76.47)	139(53.05)	3.02 (1.12–8.09)	0.31(0.09–0.99)*
	High (≥ 4 days/week)	4(23.53)	123 (46.95)	-	-
Drinking water source	Tap water	15(88.24)	212 (80.92)	0.22(0.03–1.64)	0.55(0.12–2.56)
	Other	2(11.76)	50(19.08)	-	-
		Thin n (%)			
		Yes	No		
Adolescent stage (Years)	Late adolescence	10 (4.3)	223 (95.7)	0.16(0.06–0.42)	0.23(0.08–0.59)*
	Early adolescence	10 (21.7)	36 (78.3)	-	-
Source of drinking water	Other	19 (8.40	208(91.6)	0.23(0.03–1.64)	0.36(0.04–2.97)
	Tap water	1(1.9)	51(98.1)	-	-
Awareness about balanced diet	No	8(5.9)	127(94.1)	1.44(0.57–3.65)	1.64 (0.62–4.36)
	Yes	12(8.3)	132(91.7)	-	-
Fast food consumption	High (≥ 4 days/week)	6(3.90)	146(96.10)	3.02(1.12–8.09)	2.56 (0.99–7.15)
	Low (< 4 days/week)	14(11.00)	113(89.00)	-	-

(*Significance marked by * indicates $p < 0.05$*)

birth weight, delayed maturation, poor school performance, and reduced work capacity as outcomes of inadequate nutrition. One participant highlighted:

> *"Failure to obtain adequate nutrition at this stage may lead to delayed maturation, lower school performance, and poor work capacity. Malnourished adolescents are likely to experience complicated pregnancy outcomes, such as low birth weight." (P-3)*

Challenges and reinforcing factors associated with adolescent nutrition

The participants cited financial strain, insufficient knowledge, and lack of access to healthy foods as major barriers to adolescent nutrition. One participant remarked:

> *"I think at this age, there is an increased nutritional requirement, but only what is available and affordable to the family will be provided to the girls..." (P-6)*

Another noted:

"Individuals living in towns with middle or low income are more likely to experience greater financial strain than those in rural areas…" (P-1)

Social, environmental, and cultural barriers

Household chores, often the responsibility of adolescent girls, limit their ability to access nutritious foods. Cultural practices also restrict girls from consuming certain foods, such as meat or hot peppers. One participant explained:

"Teenage girls occasionally eat last, after serving the other family members, so their portions of nutritious foods might be minimal or even nonexistent. Culturally, we have a proverb, 'Ye set lij miraqua weferam new,' meaning that women endure hunger better than men…" (P-7)

Financial constraints also play a role, with families often selling nutrient-rich, homegrown foods for income instead of consuming them. As another participant noted,

"Community members often sell expensive, homegrown foods and buy cheaper alternatives for family consumption…" (P-2)

Despite these challenges, reinforcing factors include the community's preference for fresh, organic foods over processed options, which are deeply embedded in cultural norms. One participant shared:

"In our community, we prefer to purchase fresh, organic foods from the market and avoid processed or sugary snacks. It is part of our tradition…" (P-4)

Possible solutions to adolescent nutrition

The participants proposed several solutions, including the use of digital media, school clubs, and mini-media, to increase awareness.

"Digital media, mini-media, and school clubs can help improve adolescents' attitudes and provide a platform for open discussions with their peer groups…" (P-2)

Community empowerment was also emphasized as a key strategy for improving adolescent nutrition. This includes promoting local food sources, supporting low-income households in accessing nutritious foods, and integrating nutrition education into the formal education system.

"Nutrition should be incorporated into the formal education system or provided as short-term training to raise awareness…" (P-4)

One participant stressed the importance of multisectoral collaboration in addressing the issue:

"Inappropriate dietary practices will not change unless different sectors work together…" (P-6)

Finally, participants underscored the need for context-specific interventions to address the unique challenges faced by different communities.

Discussion

This study integrated both qualitative and quantitative data to investigate adolescent nutrition. This study examined key diet-related variables, such as the MDD-W, DDS, food preferences, fast food consumption, and intake of sweetened beverages, and identified predictors of stunting and thinness. However, owing to the cross-sectional design, causal relationships could not be established. While the results may not be fully representative of girls who were not enrolled in school, the urban setting suggests that schools are a viable target for reaching adolescent girls.

The findings revealed poor dietary practices among school-going adolescent girls and highlighted the coexistence of nutritional deficiencies alongside nutritional excess. While nutritional excess was observed in some participants, the overall evidence of inadequate nutrition among these girls' calls for urgent public health intervention, as these adolescents will become future mothers.

The adolescents in this study were at a greater risk of micronutrient deficiencies, not only because of the low consumption of animal-source foods, which are excellent sources of high-quality proteins and bioavailable micronutrients [20] but also because of prevalent community- and household-level sex and cultural biases, which have been shown to exacerbate adolescent malnutrition [21]. Further evidence of nutrient inadequacy was the lower proportion of adolescents who met the MDD-W threshold [6] and the prevalence of meal skipping reported by a significant number of participants, which may negatively impact their nutrient intake [22].

The overall prevalence of thinness/underweight among adolescents was close to the global average [23] but lower than the current national data (27%) [24]. However, when disaggregated by age, 1 in 5 young adolescents were underweight. The high rate of thinness among young adolescents not only reflects poorer quality of life but also suggests a potential link to the future health and nutrition of their children [25]. In this study, early adolescents were more likely to be thin than their older counterparts were. Previous studies also suggest that late adolescence is less prone to thinness, likely due to increased nutrient demands during the early adolescent growth spurt.

In contrast, the prevalence of stunting in this study is similar to that in previous reports from Addis Ababa [26] but much lower than that in figures from other regions of the country [27] and globally [28]. These variations may be attributed to differences in study settings, dietary patterns, and other socioeconomic factors.

The lower odds of stunting among adolescents with low fast food consumption than among those with high consumption may be due to poor nutrient intake from fast food. Fast foods are often energy-dense but lack essential micronutrients and fiber while being rich in sodium and sugar [29, 30]. This can lead to unmet nutrient requirements, impairing growth and contributing to deficiencies in adolescence [31, 32]. Moreover, the negative effect of fast food on appetite is well documented, which could partly explain the observed positive relationship between high fast food consumption and stunting.

The development of overweight and obesity, along with high intake of sweetened foods and beverages, may reflect the broader global trend of nutrition transition [33]. Overweight in adolescents could lead to premature disability and death due to chronic diseases in the long term. In the short term, adolescents may experience lower self-esteem and be at a greater risk of discrimination [34]. The prevalence of overweight in this study was lower than the 18% global estimate by the WHO in 2016 and the 12.9% reported from southern Ethiopia [35] but higher than figures from northern (2%) [36], western (2.6%) [37], and eastern Ethiopia (3%) [38]. These disparities may be explained by differences in diet and sociodemographic characteristics.

On the other hand, the low meal frequency among most girls (≤3 meals for 65% of the adolescents) may be linked to religious practices common among the participants, which involve skipping meals, especially breakfast, at least twice a week year-round. Key informants identified a lack of awareness about proper nutrition as a primary cause of poor dietary practices. Additionally, food taboos that restrict adolescent girls from consuming certain foods, such as fatty meat and vegetables such as pepper, were noted. Although these taboos aim to delay physical development and puberty, delayed puberty has been shown to negatively impact height and bone mineral density in adulthood [39]. Moreover, restricted foods are nutritious [20] and promote healthy growth and development. This underscores the need for community awareness to address adolescent malnutrition, particularly since cultural norms, taboos, and beliefs may contribute to the problem [40]. The role of food taboos in the observed low consumption (≤15%) and preference for animal-source foods (10.8%) among girls warrants further investigation.

The key informant interviews also revealed that family financial status is a critical factor in determining how well-nourished an adolescent girl is. This aligns with a qualitative study conducted in Jimma [21], which showed that higher family income often leads to better allocation of resources for adolescent nutrition and healthcare.

In the future, longitudinal studies that establish causal relationships between MDD-W and adolescent stunting are recommended. Additionally, studies should include school-going and out-of-school adolescents to obtain a comprehensive picture of the factors affecting adolescent nutrition.

Overall, the findings highlighted the need to improve the dietary diversity of adolescent girls, particularly in regions with a high burden of malnutrition. Interventions aimed at increasing access to diverse, nutrient-rich foods and promoting awareness about adolescent nutrition could help address these issues and improve overall health outcomes.

Conclusions

The adolescents had poor dietary practices, with a predominantly plant-based diet and low consumption of fruits, vegetables, and animal-source foods. The consumption of fast foods and sweetened beverages was substantial, while meal skipping was a common practice among many. Additionally, many adolescents did not experience MDD-W. Additionally, undernutrition and overnutrition coexisted, but undernutrition problems were more common among young adolescents. In addition, fast food consumption and adolescent age predict stunting and thinness, respectively. According to the qualitative study, the main challenges to adolescent nutrition were economic pressure, the unavailability of nutritious foods, and a lack of awareness about adolescent nutrition. In addition, harmful social and gender norms hinder the delivery of nutritious and affordable diets to adolescent girls.

Therefore, the dietary practices of adolescent girls should be improved. This improvement requires the promotion of the importance of adolescent nutrition and the value of a diversified diet to address their low MDD-W and food preferences. In addition, the consequences of fast food consumption on nutritional status and perils of sweetened beverage intake in addition to meal skipping must be reported to teenagers. Although schools could be ideal contact points to reach adolescents, school initiatives also need to be supplemented with interventions that can reach school-aged adolescents. Nevertheless, adolescents could be more challenging to reach through traditional routes, so the incorporation of digital tools such as mobile apps, social media campaigns, and online nutrition education could contribute to adolescent nutrition through strengthening awareness, providing real-time feedback, engaging adolescents and offering personalized guidance. Furthermore, for caregivers and the community to provide proper care for girls,

they should have access to income-generating activities in combination with information dissemination concerning the importance of spending money on teenage nutrition. Additionally, other nutrition stakeholders need to direct resources to adolescents' nutrition in addition to transforming harmful social and gender norms to deliver nutritious and affordable diets to girls. Hence, comprehensive programs are needed in the community, including adolescent nutrition advocacy, in addition to addressing environmental, social, economic and cultural barriers by focusing on the early adolescent stage.

Abbreviations

MDD-W	Minimum Diet Diversity: Women
BMI	Body mass index
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions
All authors involved in study conception and design. Y.M. coordinated and supervised the fieldwork. Y.M and Z.A analyzed and interpreted the data. Y.M. wrote the first draft of the manuscript. Z.A reviewed the manuscript. Y.M and Z.A read and approved the final draft of the manuscript.

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Data availability
Data is provided within the manuscript and supplementary information files.

Declarations

Ethics approval and consent to participate
Before the data collection, an ethical approval letter was obtained from the College of Natural and Computational Sciences institutional review board of Addis Ababa University (Ref no: CNCSDO/616/13/2021). The participants acted anonymously and voluntarily, without payment, and could leave the form incomplete if pertinent. Informed consent was obtained from all the subjects and/or their legal guardian(s).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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