



ADOLESCENT NUTRITION

Desk Review of Girls' Nutrition in Ethiopia

December 2023

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SUMMARY

This desk review aims to identify critical nutrition problems of adolescent girls in the age groups of 10 to 14 years and 15 to 19 years in Ethiopia and the associated factors based on recent studies. The information is provided to inform the prioritization of interventions and programs by the Ethiopian government and stakeholders working in nutrition. In addition to compiling the published literature, we conducted a secondary analysis of available indicators for 15- to 19-year-old adolescent girls in the 2016 and 2019 DHS surveys. The results show that the prevalence of stunting is 22.4%, underweight or thinness is 17.7% and overweight/obesity is 10.6%. Anemia prevalence is 23% and the prevalence of iodine deficiency ranges from 31% to 49%. All forms of undernutrition are particularly high in rural areas and among poor households. There are large variations across regions. There is a recent rise in overweight and obesity among adolescent girls, which is concentrated in urban areas and among wealthier households. A prevalence of 3.4% was reported by the EDHS 2016 survey report. The main drivers of adolescent malnutrition are poor access to healthy and nutrient-dense foods, lack of knowledge of healthy dietary practices, low self-efficacy, and insufficient household and social support. Multiple factors at individual, household, community, and institutional levels shape adolescent girls' food choices. Studies show us what factors need to be addressed through interventions; however, knowledge of how to operationalize key interventions is lacking. The available literature provides limited evidence on adolescent girls' community and household environments in the Ethiopian context, their own perspectives on challenges, and the support they need to improve their nutritional status. One rigorously evaluated study conducted in the Southern Nations, Nationalities, and Peoples' Region (SNNPR) and Somali region has proven how nutrition literacy can be achieved through schools to achieve impacts on dietary practices. For comprehensive and sustained impacts on under- and overnutrition, tailored region-specific strategies need to be developed, and further investments are needed in implementation research.

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1. INTRODUCTION

Adolescence is a period of transition from childhood to adulthood, comprised of ages 10-19 years that is characterized by biological, psychological, and social changes. By 19 years of age, adolescent girls are productive members of society and many have initiated childbearing. Growth and development through childhood and adolescence are affected by social, nutritional, and environmental factors at home, at school, and in the community. During school ages (typically 5-19 years), these factors amplify or mitigate adversity in infancy and early childhood and, if healthy, can help consolidate gains from early childhood and correct some nutritional inadequacies (1-3). Therefore, investing in the nutrition of school-aged children and adolescents is crucial for a healthy transition to adulthood. Particularly in adolescent girls, undernutrition can have serious implications for their current health, cognition, schooling, and well-being, as well as for their productivity, long-term health, and the health of future generations.

A substantial focus of health and nutrition programming has been on under-fives and pregnant women; however, the importance of 10- to 19-year-olds is now increasingly recognized as a critical foundation for adult health and nutrition and for the potential of catch-up if infant and preschool years were compromised. About 1 in 4 people in Ethiopia is an adolescent between the ages of 10 and 19 years; approximately 7% of the total population is girls aged 10-14 years numbering over 6.5 million, and 5% are girls 15-19 years of age numbering more than 6.1 million¹. Almost 3 in every 4 adolescent girls live in rural areas. Accelerating coverage of adolescent girls in Ethiopia with proven program and policy interventions to protect and improve their nutritional status is essential for national development goals. Unfortunately, there are critical gaps in our understanding of what is needed nutritionally and programmatically, and what is feasible and scalable in the present Ethiopian context.

Although individual studies have explored nutritional status and dietary practices, they are incomplete for purposes of strategy development. A comprehensive understanding of potential means of addressing this neglected topic is essential. In this review we report on the available literature on Ethiopian adolescent girls' nutrition, and examine current studies on their nutritional status, dietary intake and practices, and their determinants. To complement the published data on adolescent girls' nutrition, we present relevant results of secondary analysis of the few available DHS indicators on older adolescents (15-19 years) as part of the study. The desk review focuses on available studies that are related to national programming priorities as noted in the 2016 National Guideline on Adolescent, Maternal Infant and Young Child Nutrition (4) and draft Implementation Guideline (IG) for adolescent nutrition in Ethiopia.

¹ PMA 2020, Johns Hopkins Univ. (<https://www.unfpa.org/data/adolescent-youth/ET>)

2. METHODS

We based the review on the Lancet conceptual framework on adolescent nutrition (5) and the government of Ethiopia's national food and nutrition policy and strategy (4) and global evidence on the programmable factors associated with adolescent nutrition (6). The desk review aims to define patterns and factors influencing adolescent nutrition in sub-populations in Ethiopia and identifies potential program options based on existing evidence. The review includes recent published papers and reports on policies, guidelines, and programs in Ethiopia and other LMICs, particularly sub-Saharan Africa.

The search terms used to identify information sources were, *Pubmed(Medline)*: Ethiopia* AND (("Adolescent"[Mesh] OR adolesc*[tiab] OR "young"[tiab]) AND (girl*[tiab] OR woman[tiab] OR women[tiab]) OR AGYW[tiab]) AND (nutriti*[tiab] OR micronutri*[tiab] OR diet*[tiab] OR food*[tiab])); *Academic Search Premier, Africa-Wide Information, Education Full Text (H.W. Wilson), ERIC, Global Health, Women's Studies International, APA PsycInfo*: (TI (((adolesc* OR "young") AND (girl* OR woman OR women) OR AGYW) AND (nutriti* OR micronutri* OR diet* OR food*) OR AB (((adolesc* OR "young") AND (girl* OR woman OR women) OR AGYW) AND (nutriti* OR micronutri* OR diet* OR food*)) AND Ethiopia*; *Embase*: ethiopia* AND ((adolesc*:ti,ab OR 'young':ti,ab) AND (girl*:ti,ab OR 'woman':ti,ab OR 'women':ti,ab) OR agyw:ti,ab) AND (nutriti*:ti,ab OR micronutri*:ti,ab OR diet*:ti,ab OR food*:ti,ab) AND [2017-2022]/py; *African Index Medicus (AIM)*: Ethiopia* AND ((adolesc* OR "young") AND (girl* OR woman OR women) OR AGYW) AND (nutriti* OR micronutri* OR diet* OR food*). The initial searches were updated in October 2023 and supplemented with additional searches for identifying gray literature on program evidence in organizational websites including CARE, USAID DEC, Nutrition International, Save the Children, UNICEF, WHO, World Bank, and the World Food Program; and on the use of media from Pubmed, Embase, African Index Medicus (AIM), Cochrane databases.

The desk review includes unpublished studies such as Alive & Thrive's school-based adolescent girls' nutrition implementation research results and region-specific food environments documented through IFPRI's secondary analysis of national nutrition-sensitive agriculture surveys (7)^{2,3}. Several publications contained reference lists with relevant information and those were added to the search. A total of 243 references were found and after removing duplicates, 207 references were examined in detail, with a final set of 94 papers utilized for the review. Preference was given to programmatically valuable information and where there were multiple sources only recent studies, those with regional representation, systematic reviews, and meta-analyses were included in the report.

For the secondary analysis of data from 2016 and 2019 DHS surveys, we disaggregated the group of 15- to 19-year-olds into one-year intervals in age and examined differences in urban/rural, wealth categories, and educational levels. The outcome indicators included prevalence of anemia, underweight, coverage of IFA supplements, counseling on nutrition, and counseling on breastfeeding during ANC. We also explored health services utilization (ANC visits, institutional deliveries), and barriers to the use of health facilities (distance and needing permission to go).

² Briefs. <https://www.aliveandthrive.org/sites/default/files/attachments/Tigray-Region-Making-Agriculture-Nutrition-Sensitive-brief.pdf>. Series covering 6 regions.

³ Full Reports. <https://www.ifpri.org/publication/consumption-production-market-access-and-affordability-nutritious-foods-afar-region>. Series covering 6 regions.

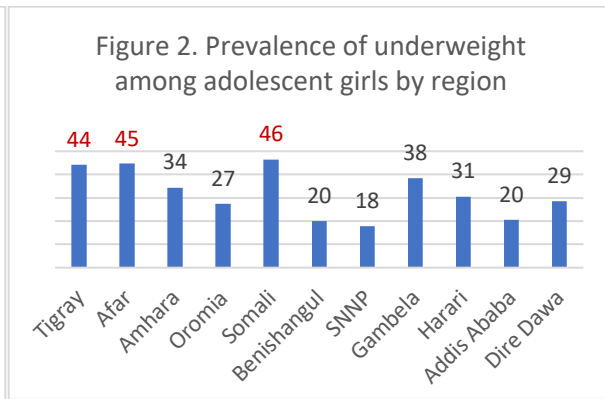
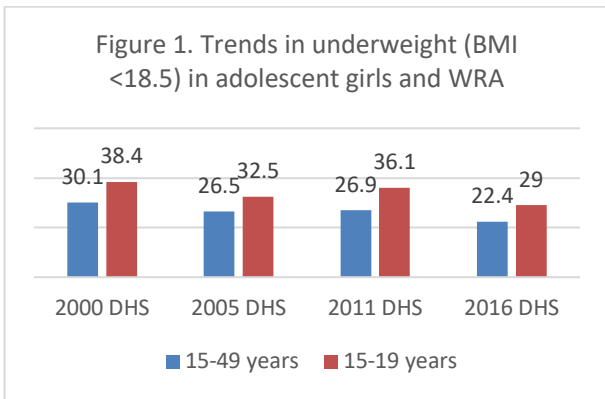
3. RESULTS: Nutritional Status

Stunting, underweight, anemia, and iodine deficiency are widespread and persistent among adolescent girls in Ethiopia and, concurrently, overweight and obesity are rising in urban areas. Ethiopia is among the most seriously affected countries and adolescent girls' nutrition is an important public health concern as evidenced by survey results and the high priority given to adolescent girls' nutrition in national policies (4). A trend analysis of underweight in Ethiopian adolescent girls found that thinness among 15- to 19-year-old girls declined significantly from 34.4% (95% CI: 32.8%, 36.0%) in 2000 to 24.9% (95% CI: 23.4%, 26.5%) in 2016 with an annual average reduction rate of 1.73% (8). However, it remains a major public health issue. Trend analysis of 102 Demographic and Health Surveys between 1993 and 2017 from 35 countries in SSA found no improvement in anemia or underweight among adolescents 15-19 years of age, although there was a significant annual decline in underweight among adult women (9).

Stunting, Underweight, and Overweight

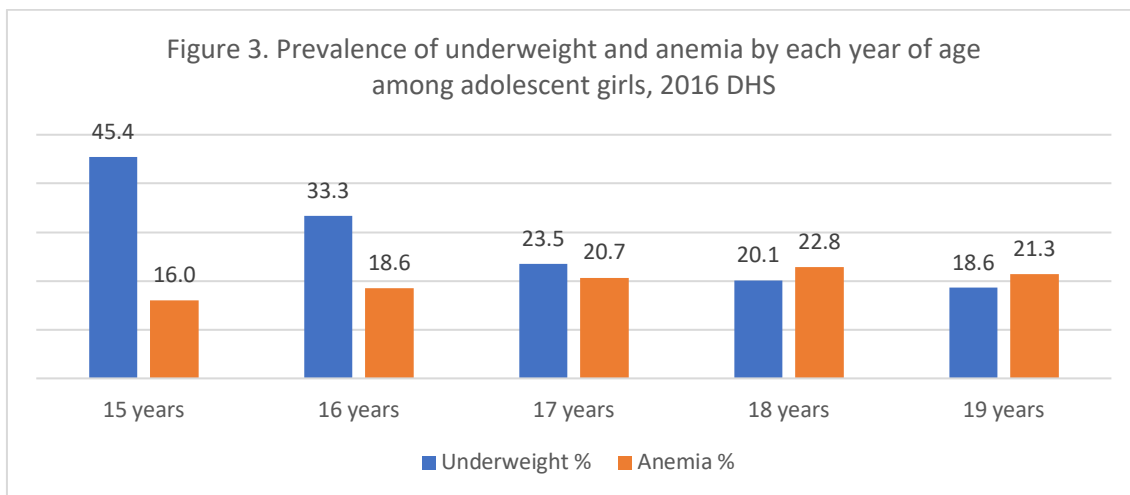
The nutritional status of adolescent girls is critical to improving the intergenerational transmission of health and well-being (10). Prioritizing this age group provides a window for intervention that can yield substantial benefits for health, social development, and economic growth and capacity (11). A systematic review and meta-analysis of the prevalence of adolescent malnutrition in Ethiopia based on 76 published articles and two national surveys found the pooled prevalence of *stunting, thinness, and overweight/obesity* was 22.4% (95% CI: 18.9, 25.9), 17.7% (95% CI: 14.6, 20.8) and 10.6% (7.9, 13.3), respectively (12). The prevalence of undernutrition varied across areas and ranged from 4% to 54% for stunting and from 5% to 29% for thinness. Overweight/obesity ranged from 1% to 17%.

Factors associated with stunting include rural residence, having family size ≥ 5 , households with an unprotected water source for drinking, and household food-insecurity (13). Analysis of stunting in 15- to 19-year-old adolescent girls based on DHS 2016 data found that respondents living in Tigray (AOR = 3.38, 95%CI: 1.47, 7.79), Amhara (AOR = 2.66, 95%CI: 1.18, 6.012), and Addis Ababa (AOR = 4.24, 95%CI: 1.84, 9.79) had higher stunting levels(14). Childhood undernutrition, parental stature, and environmental factors are considered important influences for stunting found during adolescence and adulthood. Factors associated with underweight include belonging to the younger adolescent age group (10-14 years), family size ≥ 5 , food-insecure household, lack of latrine, diet diversity score < 4 , and mothers' low educational status (13). As shown in Figure 1, the national prevalence of underweight among adolescent girls 15-19 years of age declined from 2000 to 2016 but remained higher than that of women of reproductive age (WRA) (15). The 2016 DHS documented that 29% of adolescents 15-19 years of age were underweight and 22% of all WRA were underweight. When comparing mean BMI across countries, Ethiopian adolescents at age 19 years ranked lowest globally in 2019 alongside India, Bangladesh, Timor-Leste, and Chad (16). Underweight can be more readily reversed in the near term through improved dietary and health practices, unlike stunting that is rooted in prior fetal and infant and young child nutrition influences. Analysis of DHS data showed that living in Somali was a risk factor for underweight (AOR = 2.14; 95% CI:1.76, 3.10) and being from SNNP lowered the risk (AOR = 0.35; 95% CI: 0.18, 0.68) (17). **Figure 1** shows the trend in prevalence of underweight among 15- to 19-year-old adolescent girls compared with women of reproductive age (WRA). **Figure 2** identifies underweight in regions; red font shows most affected regions.

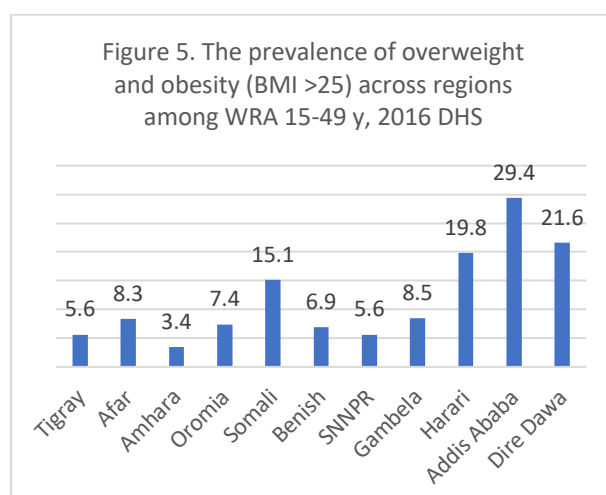
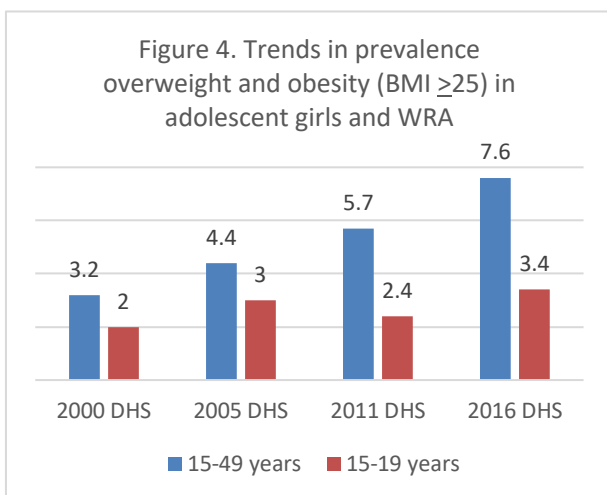


Source, 2016 DHS

While we consider adolescent girls in the 15-to-19-year age group to be a homogenous age group, the data shown in **Figure 3** suggest that nutrition is undergoing major transitions and a 15-year-old adolescent girl is different from a 19-year-old adolescent girl. There is a consistent reduction each year in underweight from age 15 to 19 while anemia can be seen rising from 15 to 19 years of age (DHS 2016).



Overweight and obesity is not as widespread at present as stunting, underweight or anemia but is rising in the East Africa region (18) and in Ethiopia (15, 19). See **Figures 4 and 5**. Among 15- to 19-year-old adolescent girls, underweight was 29% compared with 3.4% overweight or obese in the 2016 DHS (15). However, the situation is changing, and meta-analyses of recent studies show even higher prevalence of overweight and obesity among school children and adolescents. There is wide variation across regions.



A pooled analysis of 18 studies found a prevalence of overweight and obesity among children and adolescents in Ethiopia was 11.30% (95% CI: 8.71, 13.88%) (20). An analysis of 102 Demographic and Health Surveys between 1993 and 2017 from 35 countries showed that overweight is increasing rapidly and capital city residents had a threefold more rapid rise in obesity (AARC=0.47 pp, 95% CI 0.39, 0.55) compared with their rural counterparts (9). Ethiopia and South Africa have the largest gap between adult and adolescent women in underweight (15.4 pp) and obesity (28.5 pp) respectively; underweight higher for adolescents but obesity is higher for adult women. Unhealthy dietary practices associated with urbanization and higher incomes are expected to raise overweight and obesity across Africa due to access to unhealthy food and promotion of unhealthy foods, alongside sedentary lifestyles (16). Taking preventive action may stem the tide of overweight and obesity for adolescent girls in Ethiopian cities by focusing on nutrition literacy in schools and public awareness aimed at reaching parents, school staff, and health providers, and through enabling policies to limit the availability of unhealthy products (6).

Factors Associated with Undernutrition and Overnutrition

Factors associated with stunting and underweight are based on the analysis of findings from DHS surveys, surveillance data, and cross-sectional surveys. Table 1 in the Annex lists the studies and key findings. The results indicate that interventions need to address community, household, and individual level factors, and multiple sectors need to be mobilized to improve conditions that are associated with under- and over-nutrition. At the community level, residence in rural communities significantly increased the odds of stunting (14, 21-23) and underweight (22, 24). At the household level, factors associated with stunting or underweight or both included large family size (25), one or both parent's low educational level (25-28), low income or household food insecurity (14, 21, 23, 25, 28-31), and inadequate water and sanitation facilities (14, 21, 24, 29). At the individual level, seven studies reported associations of stunting and underweight with dietary practices, where dietary diversity (13, 30, 32, 33) meal frequency (22, 28, 31, 33) or meal quantity (32) were specifically noted as key factors. Younger adolescents (10-14 years) were at higher risk of underweight as compared to older adolescents (15-19 years) according to a meta-analysis of 16 studies (13), although individual studies in specific geographic areas vary in the association of age and stunting or underweight. Studies also reported associations of underweight and stunting with illnesses including fever and worm infestation, handwashing practices, and childbearing. Two studies from the Amhara region found significantly lower undernutrition among adolescent girls with greater exposure to media and mobile phone use (21, 27).

The studies on undernutrition do not fully capture the nutritional risks faced by pregnant adolescent girls. The nutrient requirements of growth and development coupled with the heightened nutritional demands needed to support the fetus make them highly vulnerable (34). Along with risks for the newborn, pregnancy in adolescence is associated with several negative health outcomes for the girl herself. Complications related to pregnancy and childbirth are the leading cause of death for girls aged 15-19 years⁴; this is made worse by underlying nutritional disorders and illnesses. Delaying adolescent pregnancy by encouraging continued school attendance in the 15-to-19-year age group and social mobilization through community leaders would have multiple benefits.

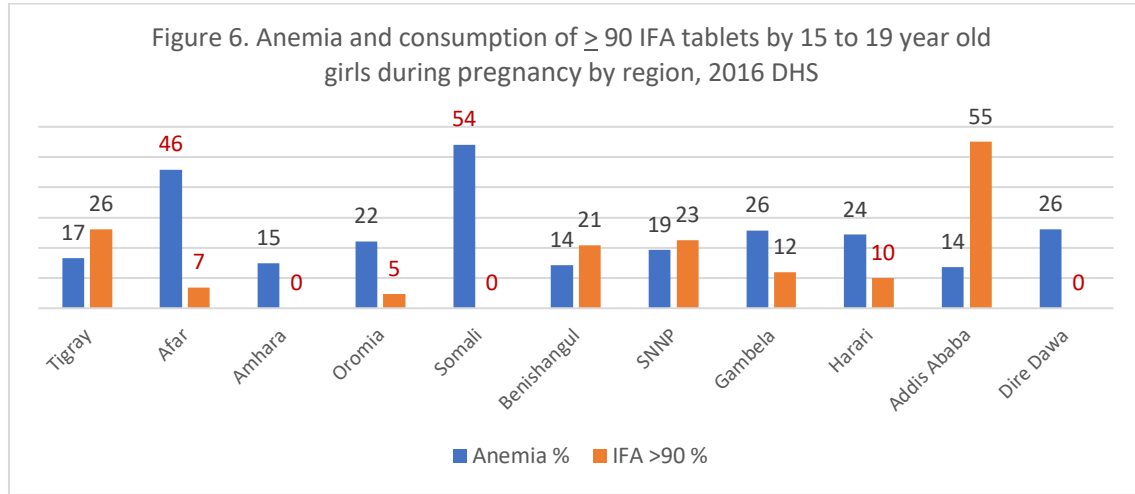
For overweight and obesity, the following factors were associated according to a systematic review and meta-analysis: female gender of the child AOR 3.23 (95% CI 2.03,5.13), high family socioeconomic status AOR 3.16 (95% CI 1.87,5.34), attending private school AOR 3.22 (95% CI 2.36,4.40), physical inactivity AOR 3.36 (95% CI 1.68,6.72), sweet food preference AOR 2.78 (95% CI 1.97,3.93), and low intake of fruits/vegetables AOR 1.39 (95% CI 1.10,1.75) (20). In a study in Jimma town, the prevalence of overweight/obesity was 13.3%; overweight/obesity was significantly associated with being a female

⁴ WHO. *Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000–2015*; WHO: Geneva, Switzerland, 2016.

(AOR=3.57 [95% CI:1.28-9.9]), attending private schools (AOR=7.53 [2.51-22.3]), lack of paternal education (AOR=5.57 [95% CI:1.53-20.26]), and wealthy household (AOR=3 [95% CI:1.09-8.26]) (19). Adolescents who were physically inactive (AOR=3.7 [95% CI:1.06-13.02]) and those with sedentary lifestyles (AOR=3.64 [95% CI:1.39-9.5]) were more obese compared to their peers. The urban rise in double burden of malnutrition with underweight and overweight co-existing in the same area was found in Bahir Dar City, Amhara, where the prevalence of underweight, overweight, and obesity was found to be 15%, 8.4%, and 4.7%, respectively (35). A case-control study with regression analysis found that high socioeconomic status [AOR = 5.8, 95% CI (2.66, 12.5)], consumption of 3 or more soft drinks per week [AOR = 3.7, 95% CI (1.8, 7.3)], physical inactivity [AOR = 4.4 95% CI (1.68, 11.6)], spending 3 or more hours per day watching movies and TV [AOR = 8.6, 95% CI (4.3, 17)], and lack of nutritional knowledge [AOR = 3.4, 95%CI (1.7, 6.9)] were significantly associated with overweight and/obesity (36).

Anemia in Adolescent Girls

The prevalence of anemia among adolescent girls in Ethiopia is estimated at 23% (95% CI: 17.21 to 28.84) according to a pooled analysis published in 2022 that included 5,547 participants from five regions (37). Reduction in the prevalence of anemia among adolescent girls would improve maternal and newborn health and generate productivity gains from improved physical capacity, increased cognitive ability, and intergenerational benefits (38). The benefit-to-cost ratio of supplemental iron interventions from resource savings, improvement in cognitive development and schooling, and physical productivity was estimated to be as high as 200:1 by the 2004 Copenhagen Consensus Panel of eminent economists⁵. Studies show that children 5 to 14 years and adolescents 15 to 19 years in Afar, Somali, Oromia, and Dire Dawa regions have higher anemia and iron deficiency than in other locations (39, 40). **Figure 6** shows the high prevalence of anemia and very low consumption of the recommended doses of IFA during pregnancy among adolescent girls 15 to 19 years of age by region (2016 DHS). Numbers in red fonts indicate most affected regions.



Factors Associated with Anemia

Anemia among adolescent girls is multi-factorial with risk factors at individual, household, and community levels (41, 42). Several studies in Ethiopia have been published on this topic as shown in Table 2. The rapid expansion of iron-containing tissues during adolescent growth spurts, replacement of menstrual blood loss, poor dietary intake and low absorption of iron, high rates of infection and worm infestation, as well as pregnancy predispose adolescent girls to anemia (43). A systematic review of studies of worm infestation in primary school students reported that prevalence of intestinal parasitic infection was high (46%); the studies indicate the need for promoting personal hygiene, latrine utilization, wearing shoes, avoiding

⁵ <https://www.copenhagenconsensus.com/publication/copenhagen-consensus-final-results>

eating raw food, and creating awareness, particularly among mothers who lack formal education (44). A systematic review and meta-analysis of studies from Ethiopia found low dietary diversity (odds ratio: 1.56; 95% confidence interval: 1.05, 2.32), illiterate mothers (odds ratio: 1.45; 95% confidence interval: 1.13, 1.86), household size greater than five (odds ratio: 1.65; 95% confidence interval: 1.14, 2.38), food-insecure households (odds ratio: 1.48; 95% confidence interval: 1.21, 1.82), and menstrual blood flow more than 5 days (odds ratio: 6.21; 95% confidence interval: 1.67, 23.12) were significant factors associated with anemia among adolescent girls (45). Globally, dietary factors and supplements associated with anemia include content of iron in foods, iron inhibitors in the diet, and consumption of iron-containing supplements (IFA tablets/drops, multiple micronutrient tablets/drops, blended foods, and supplements fortified with iron) (46, 47).

A regression analysis using the 2016 DHS survey found that anemia was related to no formal education (adjusted OR (AOR)=1.49, 95% CI 1.05 to 2.12), location in Afar (AOR=3.36, 95% CI 1.87 to 6.05), location in Somali (AOR=4.63, 95% CI 2.61 to 8.23), location in Harari (AOR=1.90, 95% CI 1.32 to 4.10), location in Dire Dawa (AOR=2.32, 95% CI 1.32 to 4.10), and high altitude (AOR=1.37, 95% CI 1.03 to 1.82) were significantly associated with anemia (48). Rural residence is a risk factor for adolescent anemia according to three cross-sectional surveys (40, 49, 50) and a meta-analysis (37). Rural dwellers are twice as likely to develop anemia (OR: 2.05; 95% CI: 1.66 to 2.54) as compared urban dwellers. Adolescent girls residing in the highlands had a relatively higher prevalence (31.6%) than girls residing in the lowlands (23.9%) in a study in three out of ten randomly selected districts located in the regions of Amhara, Oromia, and SNNP (41). At the household level, household family size (51), mother's education (52, 53), low household food security, or family income increased the risk of anemia by 2 to 4 times (51, 52, 54), and parental presence (52, 54) was significantly associated with adolescent girls' anemia. At the individual level, girls who were 15 to 19 years old were more than twice as likely to be anemic (OR: 2.13; 95% CI: 1.52 to 2.96) as compared to those between 10 to 14 years of age. According to WHO, the incidence of anemia in adolescents tends to increase with age and corresponds with the greatest acceleration of growth during adolescence, reaching a peak at around 15 years, when requirements are highest particularly among girls (43). Underweight, dietary intake, knowledge of anemia, intestinal parasites, and menstrual status were significantly associated with adolescent girls' anemia according to various Ethiopian studies. A pooled analysis of 15 studies with almost 10,000 adolescent girls (55) found that low dietary diversity increased the risk of anemia 2.8 times (AOR = 2.81), presence of intestinal parasites by 3.5 times (AOR = 3.51), low body mass index by almost 2.5 times (AOR = 2.49), and menarche (adjusted odds ratio (AOR) = 1.96) particularly ≥ 5 days of blood loss substantially increased anemia risk (AOR = 6.21).

Iodine Deficiency

Iodine is essential for the regulation of a variety of key physiological functions including metabolism and brain development and function, particularly during periods of rapid growth and maturation. Iodine deficiency disorders (IDD) including goiter prevalence is high in Ethiopia with varying levels and in 4 regions (SNNP, Oromia, Benshangul-Gumuz, and Tigray) prevalence was found to be greater than 30% (56). The prevalence of iodine deficiency and associated risk of goiter was found to vary between 40%-52% among adolescents in a review and meta-analysis published in 2023 (12). Adolescents are particularly vulnerable to IDDs because of puberty related changes in thyroid function that may increase the need for iodine. Even subclinical iodine deficiency has implications for growth, cognition, and reproductive function. Additionally, social exclusion is associated with the deficiency in Ethiopia due to the stigma associated with goiter and parents may be reluctant to send goitrous children to schools and goitrous girls are not wanted for marriage (57). Dietary factors can contribute to IDD, as certain foods are good sources of iodine, but others contain natural goitrogens which interfere with thyroid metabolism. Cruciferous vegetables (e.g., broccoli, cabbage, kale, cauliflower) contain glucosinolates that have metabolites (thiocyanate and isothiocyanate) known to compete with thyroid iodine uptake (58).

Another group of goitrogens are found in vegetables such as cassava, sweet potatoes, maize, lima beans, bamboo shoots, linseed, and sorghum (59). In a study in northeast Ethiopia, IDD prevalence was 42.5% in school children and adolescents and associated factors included family history of goiter (AOR = 3.63, 95% CI: 2.31, 5.69), cabbage consumption at least once per week (AOR = 4.6, 95% CI: 2.42, 8.74), not consuming meat at all (AOR = 2.5, 95% CI: 1.17, 5.32), not consuming milk at all (AOR = 2.19, 95% CI: 1.19, 4.03), and inadequate iodine levels in household salt (AOR = 7.05, 95% CI: 3.83, 12.97) (56). A study in the highland areas of central Ethiopia found a prevalence of 50.7% iodine deficiency; knowledge of food sources and benefits of iodized salt was high, however, use of open salt storage containers was significantly associated with the deficiency [AOR 2.001, 95%CI 1.044-3.833](60). The prevalence of iodine deficiency in school children in eastern Ethiopia was 31% and factors associated with being deficient were female gender (adjusted odds ratio [AOR]=3.12, 95% CI: 1.52, 6.39), family size ≥ 5 (AOR=2.24, 95% CI: 1.06, 4.75), having no awareness of a balanced diet (AOR=3.25, 95% CI: 1.37, 7.71), and consumption of a goitrogenic food (cabbage ≥ 2 times per week (AOR=3.01, 95% CI: 1.31, 6.93) (61). The prevalence among adolescents in southern Ethiopia was 48.9% and the deficiency was associated with being female [AOR = 3.526; 95% CI (2.55-4.87)], frequency of iodized salt use [AOR = 0.484; 95% CI (0.317-0.739)], and consumption of cassava [AOR = 4.184; 95% CI (2.6-6.707)] (62). In a cross-sectional study of five randomly selected regions, frequent consumption of cassava and living at high altitudes where iodine intakes are low increased the risk of IDD significantly (57).

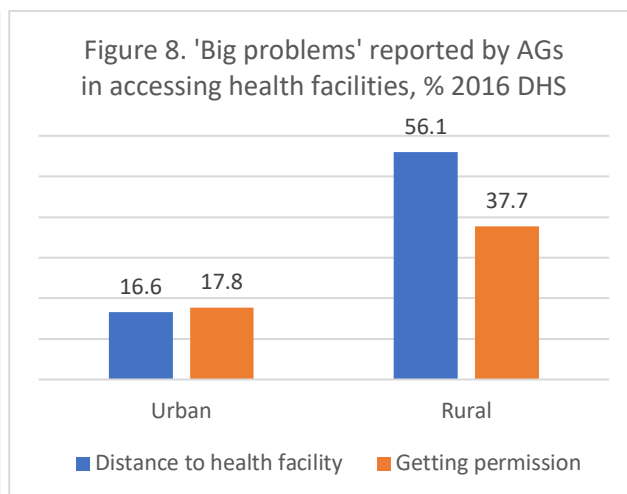
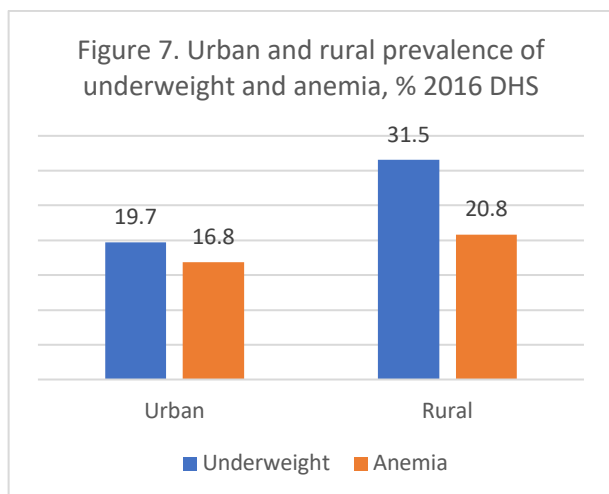
Other Nutrition Problems

The low diversity of food groups consumed by adolescent girls indicates low intakes of several micronutrients and this could lead to different types of micronutrient deficiencies. The national micronutrient survey conducted among under-five children, school children and nonpregnant women of reproductive age showed that the prevalence of zinc deficiency was 36% in school age children and 34% in women of reproductive age; the prevalence of Vitamin B12, serum folate and RBC folate among women of reproductive age was 15.1%, 17.3%, and 32% respectively (40). Belay et al. (63) used geostatistical modeling of blood serum concentrations of several micronutrients (Ca, Mg, Co, Cu, and Mo) based on samples from the Ethiopian National Micronutrient Survey to test spatial variation of these micronutrients for women of reproductive age. The prevalence of Ca, Mg, and Co deficiency was 41.6%, 29.2% and 15.9%, respectively. These data indicate the widespread scale of multiple mineral micronutrient deficiency in Ethiopia and some geographical differences in the prevalence of deficiencies. Analysis of adolescent girls' data is not available separately; however, school age and non-pregnant WRA results suggest that this group is at risk of multiple micronutrient deficiencies. A study in SNNP documented that the prevalence of inadequate intake of iron for early adolescents and late adolescents was 82% and 53%, respectively (64). Most adolescent girls in the study consumed cereals (96.9%) and roots/tubers (75.3%) and fewer consumed other food sources containing micronutrients, essential fats, and high-quality protein. Carbohydrates, protein, and fats in the diet contributed 80%, 10%, and 8%, respectively of total calories, as compared to the recommended ratios of 45%-65% for carbohydrates, 10%-30% for protein, and 25%-35% for fats (65). In a study in Bahir Dar (66), the prevalence of overall micronutrient intake inadequacy in adolescent girls was 44.4% (95% CI: 39.7%-49.6%). Early adolescent age (AOR: 2.75, 95% CI: 1.71-4.42), food-insecure households (1.74, 95%CI: 1.087-2.784), low dietary diversity score (AOR = 2.83, 95% CI: 1.35-5.92), and high peer pressure on eating and body image concerns (AOR = 1.853, 95% CI: 1.201-2.857) were significantly associated with overall micronutrient intake inadequacy. The provision of multiple micronutrient supplements can provide an important safety net for this vulnerable age group.

Inequalities in Adolescent Girls' Nutrition

Urban/rural inequities are seen in data on underweight and anemia and more problems are reported by rural adolescent girls in accessing health services such as distance and needing to get permission. See **Figures 7 and 8**. Studies found that other underlying causes of undernutrition, such as food insecure

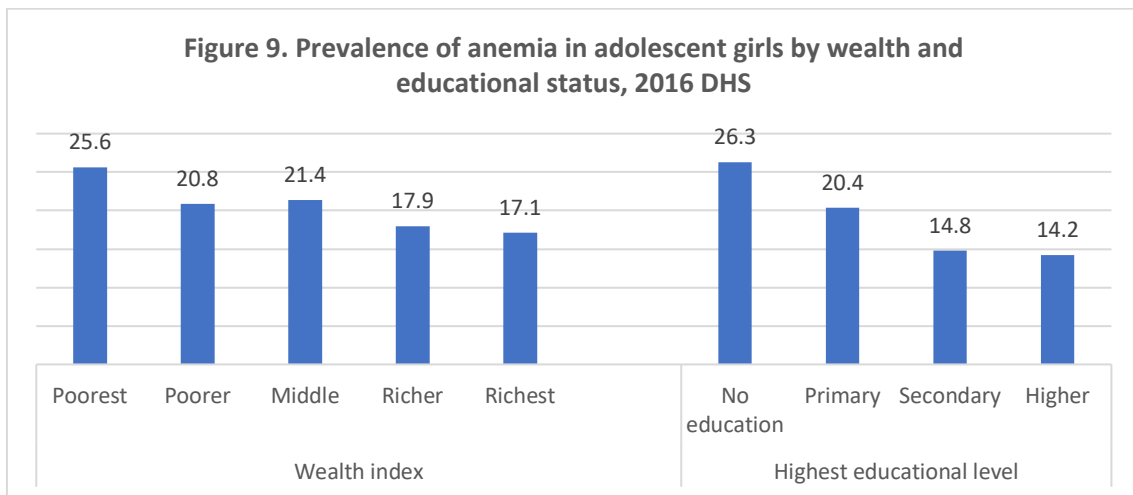
households and low coverage with water and sanitation facilities, are also higher in rural areas. There are inequalities across wealth and education categories, and among regions and in-school and out-of-school adolescent girls.



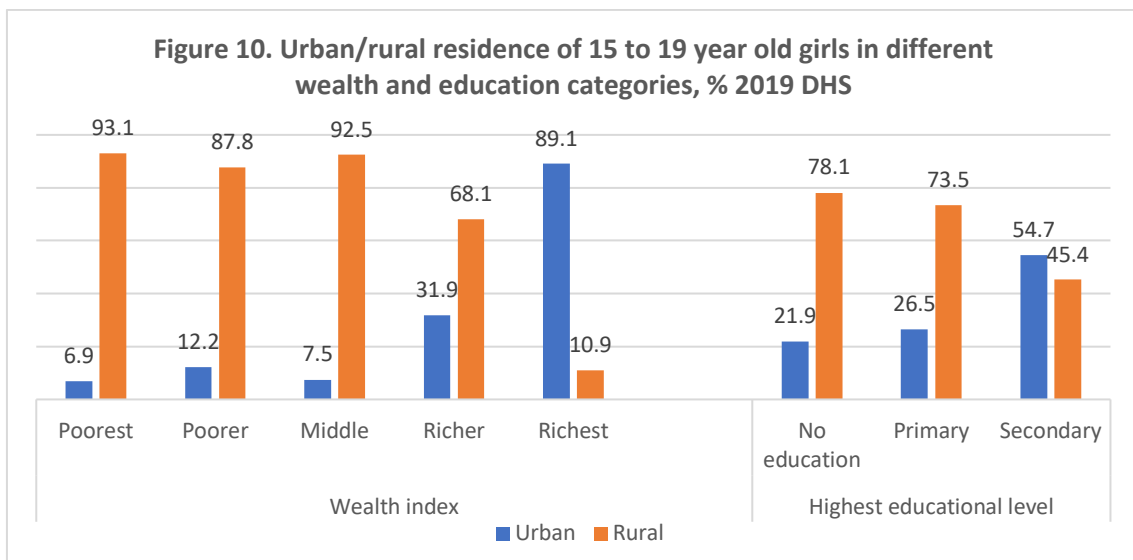
Statistical testing for inequality using the 2016 DHS survey showed the following results:

- Wealth inequality for low BMI among Ethiopian adolescents was significantly pro-poor (higher prevalence of underweight among poorer groups) at national level, rural areas of residence, and among the in-school and out-of-school sub-populations. However, the difference in inequality by area of residence or school-attendance status was not statistically significant.
- Education inequality for low BMI among Ethiopian adolescents was pro-uneducated (higher prevalence of underweight among less educated groups) at national level and urban and rural areas of residence. The difference in inequality by area of residence was statistically significant.
- Wealth inequality for anemia among Ethiopian adolescents was pro-poor (higher prevalence of anemia among poorer groups) at national level, urban and rural areas of residence, and among in-school and out-of-school sub-populations. The difference in inequality by area of residence and school-attendance status was statistically significant.
- Education inequality for anemia among Ethiopian adolescents was pro-uneducated (higher prevalence of anemia among poorer groups) at national level and urban and rural areas of residence.

Figure 9 shows declining anemia levels as wealth and educational levels improve. **Figure 10** illustrates the concentration of adolescent girls in lower wealth and educational categories in rural areas.



Note: Differences by wealth are not statistically significant but significant for education categories.



Note: Differences by wealth and education categories are statistically significant.

4. RESULTS: Dietary Practices

Dietary practices determine the adequacy of nutrient intakes and health risks introduced through unhealthy foods. Diets of adolescents are expected to provide nutrients to meet the demands of physical and cognitive growth and development that vary during the period of 10 to 19 years of age. Diets should provide adequate stores for illness or pregnancy; prevent adult onset diseases related to nutrition e.g., cardiovascular diseases, diabetes, osteoporosis, and cancer; and encourage healthy eating habits and lifestyles (67).

A global review in 2022 reported that modifiable non-communicable disease (NCD) risk factors are becoming increasingly common among adolescents, with high prevalence of four or more NCD risk factors (68). Insufficient vegetable consumption, insufficient fruit consumption, and physical inactivity were three of the four most prevalent risk factors in all regions. Several studies in Ethiopia report dietary gaps in adolescent girls' diets. For example, in south central Ethiopia 61% had inadequate protein intakes, most had low fat intakes, 82% of younger adolescents and 53% of older adolescents had low iron intakes. The prevalence of inadequate micronutrient intakes was folate 84%, zinc 58%, and over 90% for vitamin B12, vitamin C, and calcium (64). In a study in northwest Ethiopia 44% of adolescents were consuming inadequate micronutrients (66). Younger adolescent age (AOR: 2.75, 95% CI: 1.71-4.42), food-insecure household (1.74, 95% CI: 1.087-2.784), low dietary diversity score (AOR = 2.83, 95% CI: 1.35-5.92), and high peer pressure around eating and body image concern (AOR = 1.853, 95% CI: 1.201-2.857) were significant factors associated with inadequate nutrients. A systematic review of adolescent diets in LMICs based on 227 studies found that daily intake of energy was lower in rural settings (1621 ± 312 kcal/day) compared to urban settings (1906 ± 507 kcal/day) and consumption of nutritious foods was low everywhere (69). Only 16% of the girls consumed dairy, 46% consumed meats, 44% consumed fruits, and 37% consumed vegetables. Energy-dense and nutrient-poor foods, like sweet snacks, salty snacks, fast foods, and sugar-sweetened beverages, were consumed four to six times per week by an average of 63%, 78%, 23%, and 49% of adolescent girls, respectively; 40% of adolescent girls reported skipping breakfast.

Based on the nature of nutrition issues found among adolescent girls in Ethiopia, we have focused the desk review on the following practices: dietary diversity, meal frequency, and the consumption of unhealthy foods. We then summarize our knowledge of the drivers of dietary practices from studies in Ethiopia and globally.

Dietary diversity

Low dietary diversity is a predictor of inadequate micronutrient intakes and associated with stunting, underweight, and micronutrient deficiencies globally (70) and in Ethiopia (32). There is no pooled estimated prevalence of inadequate dietary diversity for Ethiopia. Dietary patterns and associated factors in adolescent girls vary substantially across regions. Here we provide examples from different locations in the country. In a study in Somali, the mean dietary diversity of the school-based adolescents 15-19 years of age was 4.2 ± 0.8 ; only 3.8% consumed the minimum recommended dietary diversity (Ahmed, Mohammed). All participants ate cereal-based foods but only half consumed legumes. A high proportion consumed vegetables, fruit, and fresh meat but less than 5% ate fish or eggs. Most adolescent girls had low consumption of animal source foods, particularly organ meat, fish, eggs, and milk. A study of primary school girls (ages 9-14 years) in SNNP and Somali regions found that dietary diversity scores were 3.8 ± 1.6 in intervention areas and 3.6 ± 1.5 in control areas; they increased to 5.4 ± 1.7 and 4.0 ± 1.4 at endline after exposure to nutrition education designed with behavior change principles (71). Minimum dietary diversity (5+ food groups) increased from 29.6% to 67.4% in intervention areas but remained below 30% in control areas.

In a study of adolescents in northeast Ethiopia, 49.1% (95% CI 44.5-53.8) were not consuming a diverse diet (72). Being female (AOR =5.53, 95% CI 3.447-8.859), secondary and above mothers' education level (AOR=0.27, 95%CI 0.153-0.477), living in a family of five or more (AOR= 2.09, 95CI% 1.31-3.34), and poor knowledge about nutrition (AOR=4.56, 95% CI 2.727-7.639) were significantly associated with dietary diversity. In a study of 15- to 19-year-old adolescent girls in Amhara region, only 33% consumed a diverse diet. Meat was consumed regularly but not milk or eggs. In another study in Amhara's Bahir Dar area, 26% of adolescents had a borderline DDS, and only 26% consumed 6 or more food groups (51).

A study in northwest Ethiopia found that 32.3% (95% CI 27.9-36.8) of the adolescents had adequate dietary diversity and household wealth was associated with dietary diversity (73). The odds of having inadequate dietary diversity among underweight adolescents were 3.5 times higher compared to the well-nourished, and the odds of having inadequate dietary diversity were 70% lower among Muslims compared to Orthodox Christians, and 70% lower among adolescents with self-employed fathers compared to farmers.

In a study in Oromia, the dietary diversity score of the study participants was 3.80 ± 2.06 (53). The commonly consumed food group in the past 24-hours by female adolescents in the study area was starchy staple (82.2%) and the least consumed food group was flesh meat and fish (3.3%). Between 30% and 50% of adolescents consumed vegetables, legumes, milk, and eggs in the previous 24 hours. Milk and milk product was the most frequently consumed food group, and 47.2% of the female adolescents consumed it ≥ 3 times per week. Vegetables and eggs were consumed ≥ 3 times per week by 43% and 28% of female adolescents, respectively. Fish was the least frequently consumed food item.

In southern Ethiopia, 72.4% of the study participants had a low dietary diversity score; the main factors associated with low dietary diversity were household income [AOR (95% CI)=15.5 (8.6-28.1)], fathers' [AOR (95% CI)=4.3 (1.8-10.6)] and mothers' educational status [AOR (95% CI)=3.2 (1.5-6.8)], not receiving nutrition education [AOR (95% CI)=2.1 (1.4-3.1)], and low decision-making power [AOR (95% CI)=2.2 (1.5-3.3)] (74).

The typical pattern of food consumption among adolescents across three districts was a high frequency and proportion of carbohydrate and starchy, fiber-rich foods such as cereals, roots, and tubers, and vegetables with relatively low intake of milk and milk products, meat, eggs, and fish (41). Almost half consumed three or fewer food groups. The consumption of animal source food groups was infrequent; the consumption of cereals, vegetables, oils, grains, and roots was relatively higher with 91.3%, 87.2%, 73.1%, 67.0%, and 61.8% of respondents consuming these foods, respectively, in a 24-hour period.

Meal frequency

The risk of undernutrition is associated with inadequate amount of food to cover energy needs (kilocalories) and macronutrients (protein, fat, and carbohydrates) required for various physiological functions. This is commonly measured as the number of meals (breakfast, lunch, dinner, and snacks) per day. A pooled analysis of 39 studies on undernutrition in schoolchildren in Ethiopia found that stunting increased with low meal frequency of less than 3 times a day (odds ratio [OR] = 3.02, 95% CI: 1.90-4.14) (75).

Meal frequency or number of meals and snacks per day among adolescent schoolgirls 9-14 years of age in SNNP and Somali regions in A&T's implementation research areas was 2.5 ± 1.1 in intervention areas and was significantly higher at 4.0 ± 0.9 compared to control areas after exposure to nutrition education (71). In this study, breakfast and dinner were consumed by almost all adolescents at baseline, and the percentage consuming a snack after breakfast, lunch, and an afternoon snack improved after exposure to nutrition education. In Amhara region, a study found that two-thirds of 15- to 19-year-old adolescent girls consumed 3 meals per day but 19% consumed only 2 meals (73). In a study of urban adolescent girls (mean age (\pm SD) 15.49(\pm 1.93) years) in which about 33.7% of respondents were stunted, 74.3% received fewer than 3 meals per day (76).

Healthy food selection

Avoiding ultra-processed foods: As obesity and the risk of non-communicable diseases such as cardiovascular disease, hypertension, and diabetes have accelerated globally, the role of ultra-processed foods⁶ in the diets of various age groups has been examined. A scoping review of the literature on the consumption of ultra-processed foods and health outcomes found associations with obesity, diabetes, cardiovascular diseases, cancer, asthma, depression, gastrointestinal diseases, and mortality (77). ‘Energy drinks’ is a new category of harmful products on the market that usually combine amino acids with high concentrations of caffeine and sugar or sweeteners. They are popular among children—one study suggests that up to half of children worldwide drink them weekly or monthly, and there is growing evidence of links between their consumption by adolescents and higher rates of risk-seeking behaviors such as smoking, alcohol and other substance use, poor mental health, adverse cardiovascular effects, headaches, stomach aches, hyperactivity, and insomnia (78, 79).

Intensifying efforts to improve consumption of healthy, diverse foods by adolescent girls in adequate amounts and meals daily, while removing consumption of unhealthy foods, should be considered a priority component of adolescent girls’ nutrition strategy. The risks from poor diet quality and highly processed foods that contain damaging components may lead to compromised mental health through inflammation, and the gut microbiome particularly during periods of rapid brain development (80). Epidemiological evidence suggests an association between diet quality and mental health across multiple populations and age groups; these do not appear to be explained by other demographic, lifestyle factors or reverse causality.

In Ethiopia, a study in primary school girls of ages 9 to 14 years in Somali and SNNP, at baseline 60% consumed unhealthy foods over a week (71). After exposure to nutrition education, the consumption of candy and chocolates declined significantly from 23% to 14% but did not improve significantly for the whole group of unhealthy foods, including salty and fried food and sweetened beverages, which remained over 50%. Sweetened beverages were the most commonly consumed junk food, including sweetened carbonated drinks and coffee/tea containing sugar. Global evidence from LMICs shows changes over time in dietary patterns and varying combinations of more traditional patterns (e.g., high intakes of cereals and grains, vegetables, nuts, seeds and legumes, and meat) and recent patterns of diets that are high in processed foods, fats and oils, snacks, salty and sugary beverages, and sweets (81).

Avoiding goitrogens: Goitrogenic foods, such as cabbage, increase the risk of goiter according to studies in school children (82). Raw cabbage and other cruciferous vegetables contain isothiocyanates, which block the enzyme that allows the thyroid to use iodine and function normally. Goitrogenic cyano-glucosides in several staple foods, such as cassava, maize, and sweet potatoes, also pre-dispose individuals to goiter particularly rapidly growing children and adolescents. The presence of iodine in the diet, such as through adequately iodized salt, can mitigate this effect.

Use of iodized salt: Salt iodization is one of the success stories of nationally scaled up nutrition interventions with proven impacts on population indicators. In Ethiopia, despite the passing of new legislation in 2011 under the National Nutrition Program and subsequent increase in the availability of iodized salt, eradication remains a significant challenge (83). The total goiter rate in Ethiopia based on results of 24 studies was above 35.8% in women, with rates close to 60% in four regions, and prevalence of IDD ranging from 0.4 to 66.3% depending on region. The pooled estimate of goiter among children in Ethiopia was 40.50% (95% CI: 33.6–47.40) and the regional distribution of goiter ranged from 32.79% (95% CI: 19.86–45.73) in the Benishangul Gumez region to 44.22% (95% CI: 17.44–71) in the SNNP region (84).

⁶ Ultra-processed foods, are food and drink products that have undergone extensive food processing, have poor nutrient quality, high sodium, sugar, and saturated fat levels, and low fiber content that are associated with poor physical and cognitive health.

This systematic review reported that the prevalence of goiter among female children (44.34%) was higher than among male (32.88%) children. Goiter prevalence was also significantly higher among children who consumed vegetables three or more times per week OR = 1.3 (95% CI: 1.02–1.66); those who had family history of goiter, OR = 2.38 (95% CI: 1.9–2.99); and those whose family stored salt near fires, OR = 1.41 (95% CI: 1.1–1.79). Urban/rural and wealth based disparities have been reported in the use of iodized salt globally (85).

Avoiding iron inhibitors: Polyphenols in tea and coffee, phytates present in vegetables, and calcium when consumed in a meal can block the absorption of iron (86). Tea and coffee and calcium supplements or milk can be taken a few hours after or before meals to protect iron in the meal. Increasing vitamin C-rich fruits and vegetables and flesh foods like meat, fish, and poultry in a meal can improve absorption. In Amhara's Bahir Dar area more than half the adolescents in one study reported drinking tea within 30 minutes after a meal (51). In a study of 15- to 19-year-old adolescent girls in northwest Ethiopia (73), coffee and tea were taken after meals regularly. In Oromia 81.3% of participants reported that they consumed tea and/or coffee within 30 minutes after a meal (53). Anemia was high among female adolescents despite a high dietary diversity score, and adolescents who reported always taking tea and/or coffee within 30 minutes after their meals were six times more likely (AOR= 6.19; 95% CI=3.32–11.48) to be anemic compared to their counterparts. Tea and coffee preparations consumed by adolescents are also high in sugar.

Main drivers of dietary practices

Table 3 provides an overview of relevant studies on drivers of dietary practices that affect the key problems of underweight, anemia, and iodine deficiency in Ethiopian adolescent girls. We explored factors ranging from structural determinants that generate disparities in access to economic, food, health, and education resources to proximal determinants or factors related to socio-cultural and community influences. Individual-level factors include experience, knowledge, and perceived social norms and self-efficacy of adolescent girls. Together they establish individual differences in exposure and vulnerability to nutritional risks that generate good nutrition or malnutrition (11, 87). A more detailed understanding can help to identify modifiable and programmable environmental spheres of influence affecting adolescent girls, including family and peer groups, schools, communities, and the wider socio-cultural context.

Based on the available literature, the major factors influencing adolescent girls' dietary intakes are (6):

- Economic drivers associated with household food insecurity, poverty, and inequity
- Knowledge and perceptions
- Enabling environments around adolescent girls

Underlying the influences noted above are rapid biological and social transformations from the age of 10 years to 19 years that need to be better understood. These involve changes in the central nervous and endocrine systems that can affect personality traits and perceptions about normative behaviors and may pre-dispose to adoption of deleterious dietary and health practices. Life stage transitions and changes in autonomy of food choices and social responsibilities (e.g., entering the labor force, getting married) also need to be understood as access to food, health, and education may shift. Unfortunately, there are information gaps in the present literature on Ethiopia on these topics and the global literature are focused on overweight and obesity. Additionally, the lack of representative studies in the available literature using consistent methods allows us to draw only limited conclusions.

Economic drivers, household food insecurity, poverty, and inequity: Access and affordability of foods can determine adolescent girls' ability to consume diverse foods at home in both urban and rural areas in Ethiopia. A study in southwest Ethiopia explored differences in factors associated with chronic food insecurity among adolescents (13-17 years) from low-income urban households as compared with rural households with access to agricultural products (88). High dependency ratio and belonging to poorer households increased the risk (1.69-1.80 as compared with wealthier households), and low educational status in urban areas also increased the vulnerability of adolescents. In a survey of high school adolescent

girls in Addis Ababa, household food insecurity was statistically associated with a low dietary diversity score (adjusted odds ratio = 2.3); in largely rural areas in SNNP and Somali, food availability at home ($\beta = 0.30, P = 0.000$) and household food insecurity ($\beta = -0.12, P = 0.013$) were statistically significant factors (89). A qualitative study in rural Tigray reported adolescent feedback that families consume injera made from sorghum on consecutive days during food shortages (90). Adolescents report participation in the production, acquisition, and preparation of foods for themselves and their families; this may be more evident in poorer households (91). The implication is that social protection designed to safeguard against food insecurity is vital and could be linked to age appropriate and context appropriate education opportunities for young people, including training in agriculture and other skills, and to employment opportunities.

Knowledge and perceptions: Several studies noted the importance of knowledge (89). In a study of nutrition sensitive agriculture across seven regions of Ethiopia, IFPRI found that Amhara (one of the richest regions) WRAs had very low dietary diversity scores and attributed this in part to lack of knowledge and awareness (92). Studies in adolescent girls 10-14 years of age were found to have large gaps in nutrition literacy in SNNP and Somali regions, for example, less than 10% knew 5+ food groups of a diverse diet, less than 15% knew to avoid junk food and salty snacks and sweetened beverages, and less than 50% knew to eat 4+ times each day (93). However, with exposure to carefully designed nutrition education, adolescent girls' knowledge improved significantly to 41%, 44%, and 85% respectively. A qualitative study in Tigray region that included in-school and out-of-school adolescent girls reported that underweight and anemia were perceived by adolescent girls to be more prevalent than stunting, and overweight was not noticeably present according to respondents. Missing breakfast, long working hours under the sun, not eating "blood substituting" vegetables including carrot and red potato, as well as cereals were perceived as pre-disposing to anemia (90). Among food taboos noted in this study, 'eating hot foods was not recommended for adolescent girls; if you want to eat porridge or soup, it should be cold before our consumption. Hot foods arouse sexuality'. Further, 'adolescent girls from households with food shortages are likely to be thin', 'there will be a deficiency of iron not because there is a shortage of foods but because we take the products to the urban areas to get money due to lack of awareness'. A study in Bahir Dar city found that 44.4% of adolescent girls had inadequate micronutrient intakes and younger adolescents (AOR: 2.75, 95% CI: 1.71-4.42), belonging to a food-insecure household (1.74, 95%CI: 1.087-2.784), low dietary diversity score (AOR = 2.83, 95% CI: 1.35-5.92), and high peer pressure on eating and body concern (AOR = 1.853, 95% CI: 1.201-2.857) were significantly associated factors (94).

Systematically designed comprehensive behavior change intervention packages may include appealing and meaningful messaging for adolescent girls through multiple channels that reach them frequently, policy components to remove structural barriers to desired practices (e.g., potential regulations against selling unhealthy foods in the vicinity of schools, adding adolescent girls in eligibility criteria for PSNP), parental engagement to establish supportive household environments (e.g., not keeping unhealthy foods at home, preparing meals or snacks for school recess), and reinforcement by school teachers, priests, and health workers for parents and adolescent girls. Nutrition literacy or reduction in knowledge gaps is a rapidly modifiable category of determinants of healthy practices as shown through implementation research in SNNP and Somali (93), in a handwashing and personal hygiene program in Jimma town in Oromia that used a combination of strategies and contact points to change adolescent behavior (95), and in a malaria prevention program (96). All programs resulted in significant behavior change.

In global studies of LMICs, adolescents asked to identify healthy and unhealthy foods described foods consumed at home, typically including many more fruits and vegetables, as healthier. However, such knowledge did not necessarily translate into consumption of healthier foods. Studies consistently show that food literacy in adolescent diets was low but even in cases where adolescents reported having good knowledge on what constituted unhealthy foods, these items were not commonly consumed (6). Food choices were influenced by adolescents' level of autonomy in making food choices, seasonality and the views or practices of family members, peers and school administrators, and food advertising. The gap between knowledge and practice is well known for behaviors such as dietary practices, handwashing,

physical activity, and others and the SBCC literature emphasizes the importance of individuals' belief and perception of risk, self-efficacy in being able to carry out the behavior, and social norms as intervening factors that can convert knowledge into behavior change (96, 97).

Enabling home, school, social, and market environments: Adolescent girls gain access to knowledge, proximity to healthy and unhealthy foods, and self-efficacy related to food choices at home, in school, in markets, and at social interactions (6, 98-100). Pooled qualitative data combined with published studies provide insights on how adolescent development can interact with sociocultural context and the food environment to influence food choice (6). Schools, markets, and social interactions are highlighted in this review. For example, nearby shops and prepared food outlets selling relatively inexpensive nutrient-poor, energy-dense foods near schools favors their regular consumption. In global qualitative studies, adolescents indicated that their choices are influenced by this proximity. A qualitative study in Addis Ababa, Bahir Dar, and Dire Dawa found that adolescents recognized the importance of diverse diets including fruit and vegetables, but their consumption was deterred by food safety concerns and identified foods high in salt, fat, and sugar, including processed/packaged foods, as unhealthy, but still consumed them frequently due to their taste, affordability, availability, and accessibility in and around schools (101). Consumption of unhealthy foods was high among 10- to 14-year-old adolescents enrolled in government schools in Addis Ababa (sweets and sugar-sweetened beverages 78.6% and deep-fried foods 54.3% at least once a week) (102). However, consumption was not associated with the number of vendors available around the school, but rather by adolescents' misperceptions about healthy food, and their concerns about the safety of foods in the market. Lack of financial resources to purchase food as desired also played a role in their selection of food and eating habits.

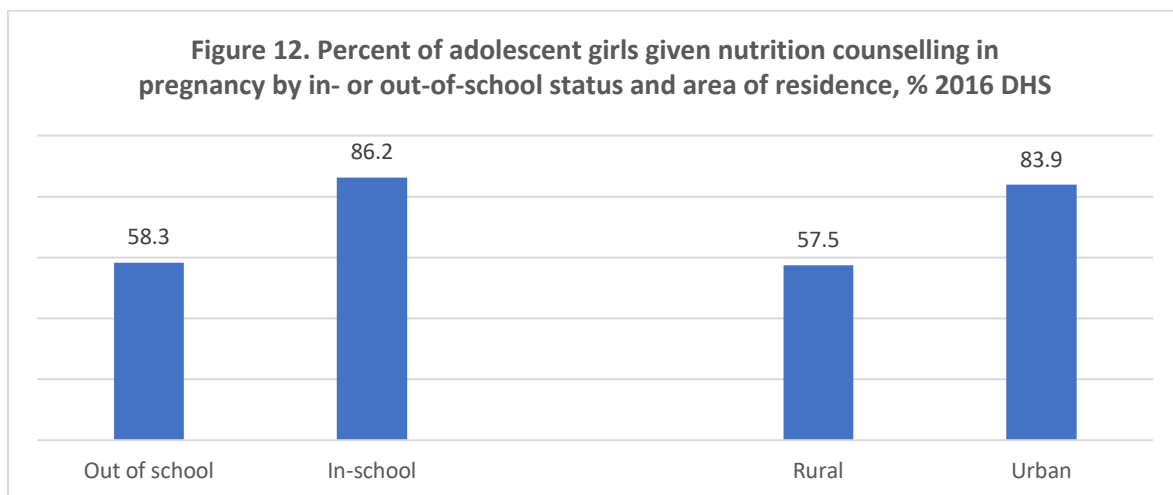
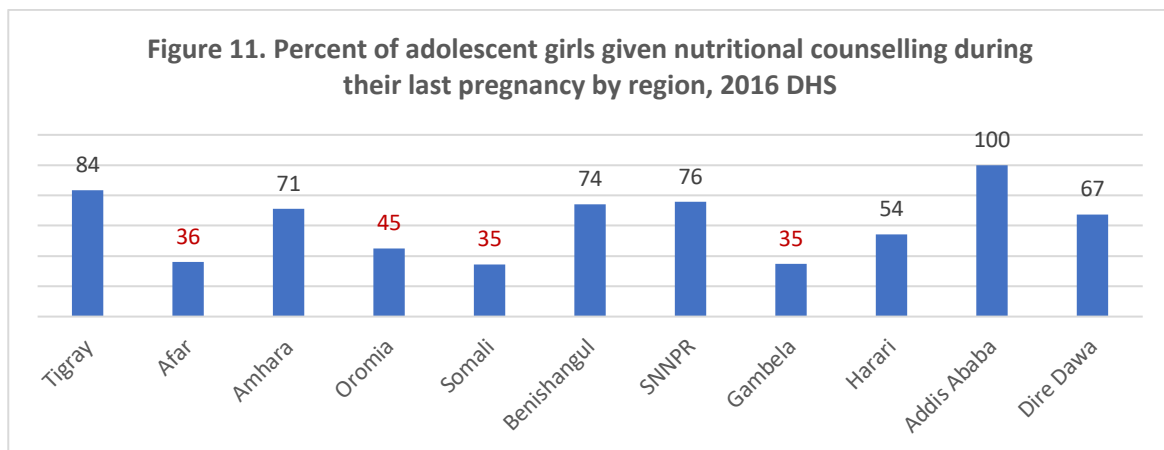
Long school days and no provision for water and sanitation facilities combined with long walking distances to school may explain in part the slightly higher proportion of underweight in-school girls as compared with out-of-school girls found in the 2016 DHS. A study in SNNP and Somali regions documented a low number of meals and snacks during the day; this improved significantly after a behavior change intervention conducted through schools with a focus on interactive activities for adolescent girls and their parents (93). In the global literature, autonomy or freedom of choice is highlighted among social factors; adolescents who reportedly had autonomy or free choice over their food selection still gave more emphasis to family and community priorities than their own individual considerations (6). In some settings, unhealthy foods continued to be consumed to identify with peer groups and generate social contacts. The influence of family members and peers was noted by adolescents who described trying to eat better (e.g., more fruit and vegetables, fewer sweets, less fried fast food) but said that they faced temptation when people around them ate less healthy foods. There are a few studies on this critical aspect of adolescent girls' food choices from Ethiopia.

Adolescent girls reported that gender differences affect nutritional outcomes through excess workload: 'High burden of energy-demanding workload is expected in families to be shouldered by adolescent girls...We should be equally treated at home in terms of workload; when I make injera or prepare food, my brother should help me in bringing water and wood... In addition, we have to get equal time to study without discrimination' (90). More studies are needed on specific social issues such as gender and age bias that may be relevant for urban and rural adolescent girls' nutrition. In a study in urban high school adolescent girls in Addis Ababa, the fear of obesity and 'worry about shape' (adjusted odds ratio = 5.0) were among factors statistically associated with low dietary diversity scores (103). A study in Bahir Dar city showed that 'high peer pressure on eating and body concern' (AOR = 1.853, 95% CI: 1.201-2.857) were factors significantly associated with overall micronutrient intake inadequacy (66).

For preventing underweight and overweight, both the intake of energy dense foods and energy expenditure (e.g., physical workload of household chores and distance walking to school and back) need to be balanced. Interventions can be targeted to specific biases (e.g., gender, adolescent age group) once they are identified (104). In a qualitative study in rural Tigray, it was noted that the government's attention to nutrition improvement is more skewed to pregnant and lactating women and children and that there is

no special training in relation to nutrition improvement for adolescent girls (90). A qualitative study of 10-17-year-old adolescents and their parents in low-income areas of Jimma noted that social and cultural factors were perceived to be the main drivers of adolescent diet and physical activity. Parents, who in turn were influenced by food affordability and accessibility and social norms, played an important role in adolescent diet (105). Older adolescents, particularly boys, had opportunities to make independent food choices outside the home, which were driven by taste and appearance. Adolescent physical activity was gendered where girls' activities included domestic work and family responsibilities, and boys had more free time to participate in outdoor games. Girls' safety was reported to be a concern to caregivers, who were fearful of permitting their daughters to share overcrowded outdoor spaces with strangers.

Current coverage of health services including nutrition counseling given to adolescent girls is inadequate and varies substantially across regions, urban/rural and by in-school and out-of-school girls. See **Figures 11 and 12**. Areas with lowest levels are indicated in red font and include Afar, Oromia, Somali, and Gambela, where coverage is less than half the population of pregnant adolescent girls.



Note: Differences are statistically significant

5. STRATEGIES FOR IMPROVEMENT

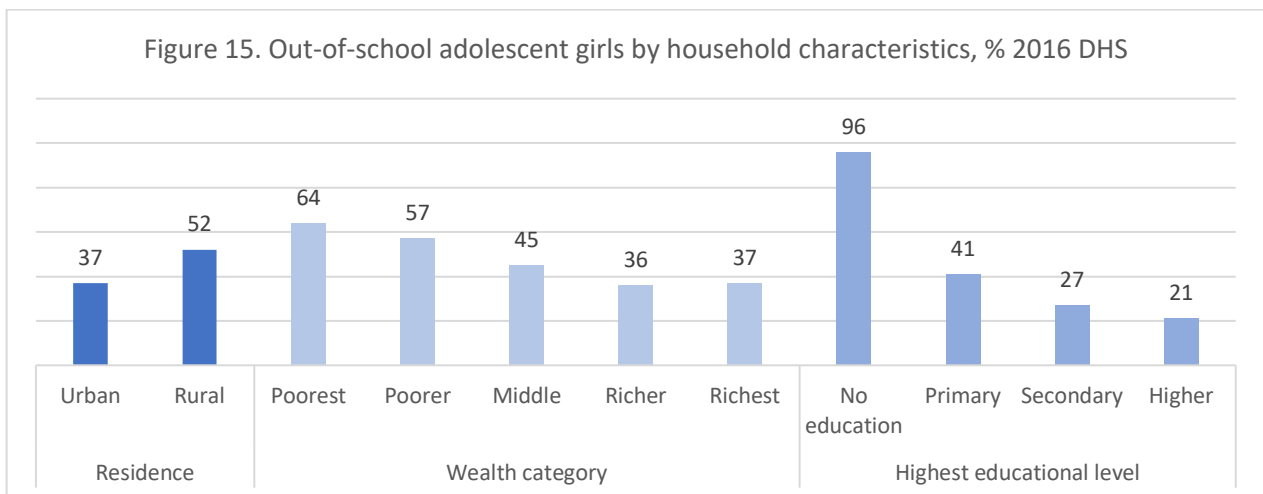
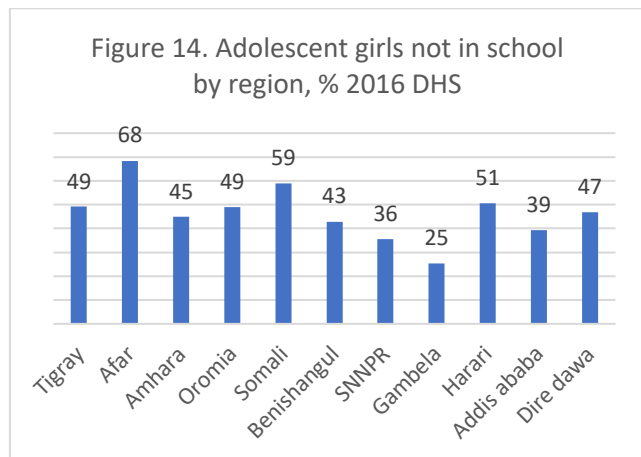
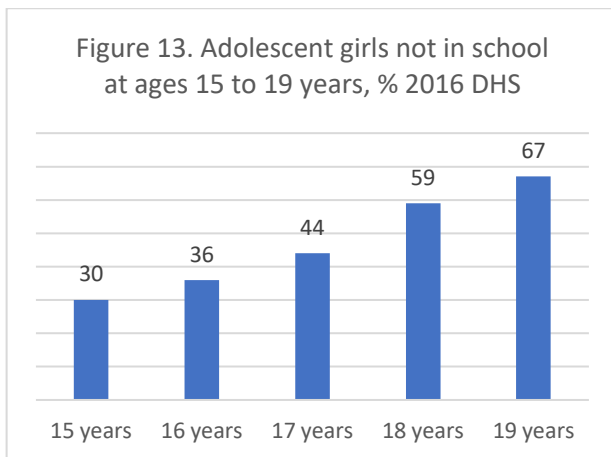
Based on the available evidence, improvements in a few program areas appear to be feasible in the near term due to the existence of policies and field experience in multiple locations in Ethiopia. These include nutrition education through schools (106), salt iodization (107), and micronutrient supplementation (108). A more comprehensive understanding of adolescent girls' nutrition environment is needed to scope out a sustainable strategy for addressing multiple underlying factors for sustained impacts. To plan relevant operational strategies targeted to critical needs and for setting program targets and planning, the readiness of systems to deliver interventions needs to be elaborated through rapid assessments. In addition, the high-risk sub-group of adolescent girls who are out of school needs to be better understood and suitable strategies designed and tested.

Recommended next steps

1. Developing further clarity on key factors and barriers to national scale-up of effective, well-tested interventions for improved adolescent nutrition in Ethiopia (nutrition education through schools [A&T model], salt iodization [USI], weekly micronutrient supplementation [WHO and UNICEF guidelines])
2. Designing, testing, and rolling out approaches for high-risk adolescent girls, such as those who live in hard-to-reach areas, are out-of-school, and belong to displaced (such as through the Ethiopia Productive Safety Net Program [PSNP]) populations; addressing water and sanitation needs in high-risk communities
3. Obtaining deeper understanding of and addressing health care utilization, including provision of high-quality reproductive health services to meet the needs of adolescent girls.
4. Instituting enabling policies to protect adolescent girls' nutrition, for example:
 - Nutrition education and weekly IFA mandated in schools with provision of follow up support and accountability.
 - Iodized salt legislation strengthened and enforced with stakeholder participation.
 - Unhealthy foods not permitted in the vicinity of schools; marketing and promotion of unhealthy foods, sweet beverages, and energy drinks not permitted; and labeling requirements strengthened. For example, in February 2023 Poland introduced legislation with the support of the medical community to ban energy drinks for <18s due to dangerous rise in proven harmful ingredients in these products.
 - Eligibility criteria expanded to include adolescent girls 10-19 years of age, and improved focus of social protection programs to cover healthy food access and nutrition literacy combined with food and cash transfers. Consideration of community group activities for peer support and development of livelihood-generating skills and soft life skills among 15- to 19-year-old adolescent girls, particularly out-of-school adolescent girls.
 - Routine monitoring of adolescent girls' BMI accompanied by trained nutrition counselors/guides available through health or education system within reach of most communities for adolescent girls' self-assessment to reassure healthy growth and prevent unjustified concerns about body image.
 - Prioritizing adolescent girls' reproductive health services delivered in a respectful, competent, and supportive way.

Out-of-school adolescent girls

While a high proportion of adolescents attend school at ages 10 to 14 years, the proportion of those out-of-school rises starting at 15 years of age, and over half drop out after 17 years of age (**Figure 13**). Afar and Somali have very high numbers, but even in Addis Ababa 4 of every 10 adolescent girls 15 years and older are not in school (**Figure 14**). Residence in a rural area is a risk factor and more than half of all rural adolescent girls in this age group are not in school. Per **Figure 15**, most adolescent girls belonging to the poorest households (57 to 64%) are not in school and almost all (96%) have no education at all.



Adolescent girls who are not in school are vulnerable to nutrition problems and are subject to more barriers in utilizing health and nutrition services than in-school girls as shown in Figure 15. According to the 2016 DHS, 26% of out-of-school adolescents (15 to 19 years) suffered from anemia as compared with 18% of adolescent girls in school. Underweight was slightly higher among in-school girls (33%) as compared with out-of-school girls (25%), possibly due to lack of meals/snacks during the school day and long walking distances to schools. Studies in Ethiopia have shown that low meal frequency including snacks are associated with stunting (22, 31) and underweight (28, 32, 33). Secondary analysis of data on adolescent girls aged 15-19 years from 10 East African countries including Ethiopia showed that walking more than 30 minutes to a water source (AOR = 1.10; 95% CI: 1.01-1.20), was a significant determinant of undernutrition among this age group of adolescent girls (18).

6. FINAL THOUGHTS

Discussion

This desk review provides an update on priority nutrition problems of adolescent girls in Ethiopia and their determinants to inform the prioritization of interventions and programs. In addition to compiling the published literature, we conducted a secondary analysis of available indicators for 15- to 19-year-old adolescent girls in the 2016 and 2019 DHS surveys. The results show that stunting prevalence is 20.7%, underweight prevalence is 27.5%, anemia prevalence is 23%, and the iodine deficiency prevalence ranges from 31% to 49%. All forms of undernutrition are particularly high in rural areas and among poor households. There are large variations across regions. There is a recent rise in overweight and obesity among adolescent girls with a current prevalence of 11.30%; this is concentrated in urban areas and wealthy households. While much is known about effective interventions for undernutrition, the same is not true for overnutrition in adolescent girls.

Studies show that the main drivers of adolescent malnutrition are access to healthy and nutrient-dense foods, knowledge of healthy dietary practices, self-efficacy, and social support. Parents have a large influence on the dietary practices of adolescent girls. Multiple factors at individual, household, community, and institutional levels shape adolescent girls' food choices. Results of studies in Ethiopia and other low- and middle-income countries (LMICs) suggest that policy interventions are needed to address structural barriers such as access to healthy food and nutrition knowledge. For existing policies, a better understanding is needed on barriers to sustained implementation and coverage at scale, such as for salt iodization and relevant high quality health services for adolescent girls. For achieving results on a national scale, integration of nutrition education or literacy and supplementation (e.g., weekly micronutrients and school meals) into existing large-scale platforms such as schools and health facilities and extend coverage to hard-to-reach areas and out-of-school adolescent girls, such as through social protection programs. To unite these efforts and generate demand for and utilization of services and information, carefully tailored public awareness and social behavior change interventions are required. However, while existing studies show us what to prioritize and the general direction of programming, deeper insights are needed on the operational needs of key interventions.

The available literature is clear that adolescent girls' own initiative is critical for success but provides limited evidence on adolescent girls' community and household environments in the Ethiopian context, their own perspectives on difficulties, and the support they need to improve nutrition. There is only one rigorously evaluated implementation research study on scalable program approaches specifically for adolescents; this addresses the critical issue of raising nutrition literacy through schools with proven impacts on dietary practices. Weekly iron-containing supplements and salt iodization accompanied by social behavior change interventions are potential candidates for rapid scale-up as well. However, for comprehensive and sustained impacts on under- and overnutrition through tailored region-specific strategies, deeper insights are needed through targeted research and rapid assessments. We need to document the readiness of different sectoral platforms across regions and system requirements for delivering key interventions to adolescent girls in Ethiopia at scale, effectively, equitably, and sustainably.

Conclusions

Successive periods of drought combined with displacement generated by prolonged conflicts and supply shortages have led to spiraling malnutrition in all age groups in Ethiopia. However, due to the pivotal role that the adolescent life-stage plays in lifelong and multi-generational risk, protecting adolescent girls' nutritional status requires urgent response. Three to four out of every ten adolescent girls in Ethiopia are experiencing undernutrition (e.g., stunting, underweight) and/or micronutrient deficiencies (e.g., iron-deficiency anemia, IDD). While macro and micronutrient deficiencies have persisted, there is a detectable

rapid rise of overweight and obesity among wealthier segments in urban areas. This requires another set of responses to address high intakes of energy-dense, highly processed junk foods with excessive salt, sugar, and fat content but low in essential micronutrients and quality protein, which result in NCDs such as hypertension, diabetes, coronary heart disease, and others. Health, education, and food system-based interventions can help to prevent severe adverse impacts on adolescent girls' growth and development.

Variability across Ethiopia's regions, rural urban differences, and adolescent girls' unique age-related associated factors call for carefully tailored evidence-based portfolios of policy and program initiatives to achieve results. Much remains unknown about supportive and limiting nutrition factors among the 10-to-14-year age group, how and where to reach the out-of-school adolescent girls in both the younger and older age groups, how to provide adolescent-friendly health services, how to tailor adolescent-sensitive social protection programs, and how best to leverage communication channels to fill large nutrition literacy gaps, beyond relying solely on the education system to inform and educate.

The role that population-based interventions such as food fortification (e.g., salt iodization), food and agriculture subsidies, and public awareness campaigns should play, and how to approach 'hot spots' such as urban private schools where adolescent girls are at greatest risk of overweight and obesity, are concerns that also need to be addressed. Experiences and lessons learned from Ethiopia and other LMICs provide some insights but there is a large gap in implementation research to provide adequate direction for future investments. Meanwhile, Ethiopia has the experience and understanding of how to scale up three effective initiatives: nutrition education through schools, salt iodization, and weekly micronutrient supplements through education and health platforms. PSNP is a vital platform for compromised households but requires greater focus on nutrition education in addition to cash and food transfers and inclusion of adolescent girls as primary beneficiaries. Public awareness and regulations to limit access of adolescent girls and other population groups to unhealthy foods, accompanied by nutrition literacy, can improve future food choices.

Limitations

The published studies in the available literature are not consistent and comprehensive, and several gaps were identified such as, nationally or regionally representative studies on 10- to 14-year-old adolescent girls, limited attention to meal frequency among dietary practices, insufficient understanding of the role of physical activity and workload, and the programmable elements of adolescent girls' environment related to food, health, education, communication, community, and social support. Also missing is data on coverage of existing or potential sectoral programs for adolescent girls in the food, health, education, communication, and social protection. The available literature is heavily reliant on quantitative studies and insights are limited from qualitative research into adolescent girls' perspective and underlying barriers and facilitators in the adolescent girls' nutrition environment. The review draws upon findings from other geographies particularly for interventions and programs and the relevance and comparability of study approaches and content of interventions is variable across studies. Even at the global level, the lack of implementation research on what effectively improves adolescent nutrition is striking. Many results in this review rely on smaller, location-specific studies, frequently using cross-sectional designs and institution-based sampling with varied exposure and outcome variables. Sample sizes differed substantially between studies. Fortunately, DHS surveys include 15- to 19-year-old adolescents and provide representative estimates at national and regional levels. IFA supplementation indicators are based on self-reporting, sometimes over long recall periods. Dietary intake data is usually from 24-hour recall or food frequency methods but may not capture nutrient intakes accurately due to self-reported recall, difficulties of portion size measurement, and inaccuracies in food composition tables. However, globally recognized indicators of dietary diversity, meal frequency, and consumption of unhealthy foods help with comparability across studies.

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ANNEX

Table 1. STUDIES ON FACTORS ASSOCIATED WITH ADOLESCENT UNDER- AND OVER-NUTRITION IN ETHIOPIA

Factors	Author, Region		Design	Key findings
Urban/ Rural location	Abate, B., et al. (2020)	All regions	Cross-sectional 2016 DHS n= 2733	Rural areas (AOR = 2.29, 95% confidence interval (CI): 1.10, 4.75) had higher odds of stunting compared to urban areas
	Abera, M., et al. (2023)	All regions	Systematic search; 76 articles and two national surveys; 2000-2022	Pooled prevalence of stunting, thinness, and overweight/obesity was 22.4% (95% CI: 18.9, 25.9), 17.7% (95% CI: 14.6, 20.8) and 10.6% (7.9, 13.3), respectively; anemia ranged from 9% to 33%. Approximately 40%-52% of adolescents have iodine deficiency.
	Arage, G., et al. (2019)	Amhara	Cross-sectional study, n=362	Rural residence increased odds of stunting (AOR = 1.34; 95% CI: 1.24, 2.33); and low underweight (AOR = 2.40; 95% CI: 1.13, 5.08)
	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Rural residence significant associated factor for adolescent stunting (AOR 2.19; CI 1.59,3.02)
	Tariku, A., et al. (2019)	All regions	Surveillance data n=1556	Odds of stunting were found to be higher in rural areas (AOR = 1.45; 95% CI: 1.01, 2.10)
Type of school	Gali, N., et al. (2017)	Oromia	Cross sectional, n= 546	Overweight/obesity was significantly associated with attending private schools (AOR=7.53 [2.51-22.3])
	Gebrie, A., et al. (2018)	All regions	Systematic review and meta-analysis, 18 studies	Attending private school: 3.22 (95% CI 2.36,4.40), associated with overweight and obesity
Family size	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Family size ≥ 5 significant associated factor for adolescent stunting AOR 2.25 (CI 1.6,3.13) and underweight [AOR 2.95 (1.76, 4.93)]
	Hailegebriel, T. (2020)	All regions	Systematic review and meta-analysis n =24, 716	The risk of stunting was increased with family size ≥ 5 (OR = 1.88, 95% CI: 1.40-2.35)
Parent's education	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Mothers' educational status (with no formal education) was a significant associated factor for adolescent underweight AOR 1.95 (1.31,2.92)
	Birru, S., et al. (2018)	Amhara	Cross-sectional study n=812	Low level of mothers' education (AOR = 2.84, 95% CI: 1.07, 7.94) increased risk of undernutrition
	Gagebo, D., et al. (2020)	SNNP	Cross-sectional study n=729	Mothers' education (secondary level AOR = 0.53, 95% CI = 0.28, 0.98) significantly reduced stunting risk Mothers' education (primary level) (AOR = 0.56, 95% CI = 0.37, 0.87), reduced risk of underweight Fathers' education primary ((AOR = 0.48, 95% CI = 0.31, 0.77) and secondary (AOR = 0.45, 95% CI = 0.26, 0.78)) associated with less underweight
	Gali, N., et al. (2017)	Oromia	Cross sectional, n= 546	Lack of fathers' education (AOR=5.57 [95% CI:1.53-20.26]) associated with overweight/obesity Wealthy households (AOR=3 [95% CI:1.09-8.26])
	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Low educational status of the father [AOR 2.45(1.02-5.86)] was associated with poor nutritional status
HH food security, income	Abate, B., et al. (2020)	All regions	Cross-sectional 2016 DHS n= 2733	Lowest wealth quintile (AOR = 2.38, 95% CI: 1.56, 9.67) had higher odds of stunting compared to the highest wealth quintile
	Alemu, T., et al. (2021)	Amhara	Cross-sectional, n=792	Lower wealth class [AOR:2.58 (95% CI: 1.310, 5.091)], and middle wealth class [AOR: 2.37 (95% CI: 1.230, 4.554)] increased odds of stunting

	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Food-insecure household significant associated factor for adolescent stunting AOR 2.04 (1.67,2.49) and underweight AOR 2.38 (1.54,3.69)
	Gagebo, D., et al. (2020)	SNNP	Cross-sectional study n=729	Household wealth index poor) (AOR = 1.94, 95% CI = 1.29, 2.92) were significantly associated with stunting
	Gali, N., et al. (2017)	Oromia	Cross sectional, n= 546	Belonging to a wealthy household (AOR=3 [95% CI:1.09-8.26]) increased the risk of overweight/obesity
	Hadush, G., et al. (2021)	Afar	Cross-sectional study n=736	Household food insecurity was a predictor of stunting (AOR = 2.88, 95% CI 1.15-7.21)
	Gebrie, A., et al. (2018)	All regions	Systematic review and meta-analysis, 18 studies	Overweight/obesity associated with high family socioeconomic status: 3.16 (95% CI 1.87,5.34)
	Hailegebriel, T. (2020)	All regions	Systematic review and meta-analysis n =24, 716	The risk of wasting/thinness was increased with low family income (OR = 2.16, 95% CI: 1.30-3.01)
	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Low monthly income [AOR (95% CI) = 2.54 (1.66-3.87)], use of food for the family only from the market [AOR (95% CI) = 5.14(2.1-12.8)] associated with underweight
	Mersha, J., et al. (2021)	Amhara	Cross-sectional study n=706	Food-insecure households (AOR: 2.62, 95% CI:1.33-5.16), significantly associated with underweight
	Tamrat, A., et al. (2020)	Amhara	Cross-sectional study n=662	Food-insecure households had a 2.52 times higher chance of being stunted [95% CI: 1.70-3.73]
	Tariku, A., et al. (2019)	All regions	Surveillance data n=1556	Odds of stunting were found to be higher if households are food insecure (AOR = 1.33; 95%CI: 1.02, 1.73)
Water and sanitation	Abate, B., et al. (2020)	All regions	Cross-sectional survey 2016 DHS n= 2733	Having no access to safe water supply (AOR = 3.17, 95% CI: 1.21-8.37) and having no access to hygienic toilet (AOR = 1.44, 95% CI: 1.17, 1.95) associated with higher stunting
	Alemu, T., et al. (2021)	Amhara	Cross-sectional, n=792	No latrine [AOR: 1.95 (95% CI: 1.11, 3.43)] associated with undernutrition
	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Households with an unprotected water source for drinking significant for adolescent stunting AOR 3.39 (2.34,4.91); lack of latrine significant associated factor for adolescent underweight
	Hadush, G., et al. (2021)	Afar	Cross-sectional study n=736	Non-availability of home latrine was predictor of stunting (AOR = 3.26, 95% CI 1.15-4.42)
	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Not washing hands with soap before eating and after using the toilet [AOR (95% CI) = 2.25(1.079-4.675)] were predictors of stunting
Age	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Younger adolescent age (10-14 years) was a significant associated factor for adolescent underweight AOR 2.45 (1.46,4.1)
	Birru, S., et al. (2018)	Amhara	Cross-sectional study n=812	Less undernutrition in younger age of adolescence (AOR = 0.22, 95% CI: 0.15, 0.34)
	Engidaw, M. and A. Gebremariam (2019)	Somali	Cross-sectional study n=415	Older adolescent girls were more likely to develop stunting as compared to younger adolescents (AOR: 2.10, 95% CI: 1.12, 3.93)
	Gagebo, D., et al. (2020)	SNNP	Cross-sectional study n=729	Older adolescent was significantly associated with stunting (AOR = 2.06, 95% CI = 1.08, 3.92)
	Hadush, G., et al. (2021)	Afar	Cross-sectional study n=736	Younger adolescents (AOR = 2.89, 95% CI 1.23-6.81) for thinness and for stunting (AOR = 1.96, 95% CI 1.02-3.74)

	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Older age [AOR (95% CI) = 2.91 (2.03-4.173)] associated with undernutrition
	Kahssay, M., et al. (2020)	Afar	Cross-sectional study n=348	Younger age (14-15 years) [AOR = 1.4, 95% CI (1.04-4.28)] associated with thinness
	Tafasa, S., et al. (2022)	Oromia	Cross-sectional study n=587	Younger age groups of 10-14 years [AOR = 2.08, 95% CI (1.07, 4.04)] were significantly associated with stunting. Age [AOR = 3.77, 95% CI (1.06, 13.37)] was significantly associated with thinness
	Tariku, A., et al. (2019)	All regions	Surveillance data n=1556	Younger ages e.g., the early (AOR = 0.027, 95%CI: 0.08, 0.09) and middle age groups (AOR = 0.21, 95% CI: 0.06, 0.71) less likely to be stunted
Gender	Gali, N., et al. (2017)	Oromia	Cross sectional, n= 546	Prevalence of overweight or obesity was 13.3%. Being a female (AOR=3.57 [95% CI:1.28-9.9]), increased risk of overweight/obesity
	Gebrie, A., et al. (2018)	All regions	Systematic review, meta-analysis	Female children: 3.23 (95% CI 2.03,5.13) more at risk of overweight/obesity
Child-bearing status	Abate, B., et al. (2020)	All regions	Cross-sectional survey 2016 DHS n= 2733	Having one child (AOR = 3.33, 95% CI: 5.78, 15.31), and two children (AOR = 4.01, 95% CI: 1.39, 7.73) had higher odds of being stunted compared to having no children
Dietary intake	Arage, G., et al. (2019)	Amhara	Cross-sectional study, n=362	Adolescents who did not have snack (AOR = 11.39; 95% CI: 1.47, 17.8) were positively associated with stunting
	Berhe, K., et al. (2019)	All regions	Systematic review and meta-analysis n=17,854	Diet diversity score <4 was a significant associated factor for adolescent underweight AOR 2.38 (1.54,3.69)
	Gagebo, D., et al. (2020)	SNNP	Cross-sectional study n=729	Meal frequency (<2/day) (AOR = 1.87, 95% CI = 1.12, 3.13) was significantly associated with thinness
	Gebrie, A., et al. (2018)	All regions	Systematic review and meta-analysis, 18 studies	Preference for sweet foods: 2.78 (95% CI 1.97, 3.93), and less use of fruits/vegetables: 1.39 (95% CI 1.10, 1.75) associated with overweight/obesity
	Hailegebriel, T. (2020)	All regions	Systematic review and meta-analysis n =24, 716	Risk of stunting increased with meal frequency ≤3 times a day (odds ratio [OR] = 3.02, 95% CI: 1.90-4.14
	Kahssay, M., et al. (2020)	Afar	Cross-sectional study n=348	Dietary diversity score of <4 food groups [AOR = 2.2, 95% CI (1.4-4.54)] was a predictor of stunting. Dietary diversity score of <4 food groups [AOR = 1.8, 95% CI (1.14-4.38)] predictor of thinness Low quantity food consumption [AOR = 3, 95% CI (1.15-7.90)] predictor of thinness
	Mersha, J., et al. (2021)	Amhara	Cross-sectional study n=706	Low dietary diversity score (AOR:2.46,95%CI:1.45-4.20), significantly associated with thinness Low dietary diversity score (AOR: 8.07, 95% CI; 4.02-16.20) associated with adolescent stunting
	Tafasa, S., et al. (2022)	Oromia	Cross-sectional study n=587	Poor dietary diversity score [AOR = 4.05, 95% CI (1.43, 11.46)], fewer than three meals per day [AOR = 3.62, 95% CI (2.16, 6.05)] were significantly associated with thinness
	Tamrat, A., et al. (2020)	Amhara	Cross-sectional study n=662	Meal frequency of less than three times per day were 2.37 times more likely to be stunted than those who had a meal frequency of three or more per day [95% CI: 1.60-3.50]
Illness	Mersha, J., et al. (2021)	Amhara	Cross-sectional study n=706	Febrile illness (AOR: 3.12,95% CI: 1.94-5.03) and diarrheal disease (AOR: 3.61, 95% CI: 2.08-6.28), significantly associated with thinness Febrile illness (AOR; 2.49, 95% CI: 1.48-4.18) associated with stunting

Physical activity/ sedentary	Gali, N., et al. (2017)	Oromia	Cross sectional, n= 546	Low physical inactivity (AOR=3.7 [95% CI: 1.06-13.02]) sedentary lifestyles (AOR=3.64 [95% CI: 1.39-9.5]) increased risk of overweight/obesity
	Gebrie, A., et al. (2018)	All regions	Systematic review and meta-analysis, 18 studies	Physical inactivity: 3.36 (95% CI 1.68, 6.72) associated with overweight/obesity
Media, mobile phone use	Alemu, T., et al. (2021)	Amhara	Cross-sectional, n=792	Lowest media exposure [AOR: 5.14 (95% CI: 1.16, 22.74)] is associated with undernutrition
	Birru, S., et al. (2018)	Amhara	Cross-sectional study n=812	Low media exposure (AOR = 1.69, 95% CI: 1.01, 2.84) associated with undernutrition
Hand-washing practices	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Not washing hands with soap before eating and after using the toilet [AOR (95% CI) = 2.25 (1.079-4.675)] were associated with poor nutritional status
Intestinal parasites, not taking deworm medicine	Berhe, K., et al. (2022)	Tigray	Cross-sectional n=398	Presence of intestinal parasite (AOR = 3.51) increased risk of anemia
	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	History of intestinal parasitic infection [AOR=2.7; 95% CI (1.19-6.21)] increased risk of anemia
	Handiso, Y., et al. (2021)	SNNP	Cross-sectional study n=843	Not taking deworming tablets [AOR = 1.56 (1.11-21)] increased risk of undernutrition

Table 2. STUDIES ON FACTORS ASSOCIATED WITH ADOLESCENT ANEMIA IN ETHIOPIA

Factors	Author	Location	Design	Key findings
Urban/ rural	Ethiopian Public Health Institute (2016)	All regions	Cross-sectional survey n=1507	Urban residence associated with lower prevalence (14.9%) than rural residence (19.3%) nationally
	Etsay, A., et al. (2022)	Afar	Cross-sectional study, n=437	Rural residence [adjusted odds ratio (AOR) = 3.42, 95% CI (1.97, 5.94)]
	Regasa, R. and J. Haidar (2019)	Oromia	Cross-sectional survey, n=448	Rural areas compared to their urban counterparts (AOR = 3.4 95% CI = 1.9 to7)
	Habtegiorgis, S., et al. (2022)	Five regions	Meta analysis n=5547	Rural residence (OR: 2.05; 95% CI: 1.66 to 2.54) was associated with anemia
HH family size	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	Large family size [AOR=3.2, 95% CI (1.29-7.89)]
	Endale, F., et al. (2022)	National	Systematic review	HH size >5 (odds ratio: 1.65; 95% CI: 1.14, 2.38)
Mother's education	Tura M.R., et al. (2020)	Oromia	Cross-sectional survey, n=523	Low mothers' educational status linked to anemia in adolescents
	Fentie, K., et al. (2020)	Oromia	Cross-sectional study, n=528	Mothers' education of at least a secondary level AOR = 0.43, 95% CI (0.18, 0.97) low anemia
	Endale, F., et al. (2022)	National	Systematic review	Illiterate mothers (odds ratio: 1.45; 95% CI: 1.13, 1.86)
HH food security or family income	Gonete, K., et al. (2018)	Amhara	Cross-sectional survey, n=462	Low household food security ((AOR = 4.1(95%CI; 1.3, 13.2))
	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	Average household monthly income <500 ETB [AOR=10; 95%CI (2.49-41.26)], 501-1000 ETB [AOR=6, 95%CI (2.54-14.33)]
	Fentie, K., et al. (2020)	Oromia	Cross-sectional study, n= 528	Low economic status (AOR = 2.16, 95% CI (1.17, 4.33))
	Endale, F., et al. (2022)	National	Systematic review	Food-insecure households (odds ratio: 1.48; 95% CI: 1.21, 1.82)
Parental presence	Gonete, K., et al. (2018)	Amhara	Cross-sectional survey, n=462	Not living with both parents ((AOR = 2;(95%CI;1.14,3.6)) or with guardians ((AOR = 2.4;(95% CI;1.02,5.6))

	Fentie, K., et al. (2020)	Oromia	Cross-sectional study, n= 528	Living separately from their family (AOR = 4.430, 95% CI (2.20, 8.90))
Age group	Tura M.R., et al. (2020)	Oromia	Cross-sectional survey, n=523	Higher among female adolescents in the age group of 15-19 years
	Engidaw, M., et al. (2018)	Somali region (refugees)	Cross-sectional study, n=532	Older age group was 2 times more likely to have anemia
	Regasa, R. and J. Haidar (2019)	Oromia	Cross-sectional survey, n=448	Anemia was almost 4 times more likely among older adolescents
	Habtegiorgis, S., et al. (2022)	5 regions	Meta analysis n=5547	Older age, 15-19 (OR: 2.13; 95% CI: 1.52 to 2.96)
Under-weight, wasting	Berhe, K., et al. (2022)	All regions	Systematic review, meta-analysis, n=9,669	Low body mass index (AOR = 2.49)
	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	Low BMI for age [AOR-3.2; 95% CI (1.43-7.05)]
	Tura M.R., et al. (2020)	Oromia	Cross-sectional survey, n=523	Wasting in female adolescents
Dietary intake	Etsay, A., et al. (2022)	Afar	Cross-sectional study, n=437	Dietary diversity score less than 4 [AOR = 3.4, 95% CI (2.1, 5.42)]
	Endale, F., et al. (2022)	National	Systematic review	The overall pooled prevalence = 23.03%; low dietary diversity (odds ratio: 1.56; 95% CI 1.05, 2.32)
	Gonete, K., et al. (2018)	Amhara	Cross-sectional survey, n=462	Dietary diversity score (AOR =4.2(95% CI;1.7, 10.5)
	Berhe, K., et al. (2022)	All regions	Meta-analysis, n=17,854	Low diet diversity score (AOR = 2.81)
	Gonete, K., et al. (2018)	Amhara	Cross-sectional survey, n=462	Low dietary diversity score ((AOR =4.2(95% CI;1.7, 10.5))
	Etsay, A., et al. (2022)	Afar	Cross-sectional study, n=437	A minimum dietary diversity score less than 4 [AOR = 3.4, 95% CI (2.1, 5.42)]
	Fentie, K., et al. (2020)	Oromia	Cross-sectional study, n=528	Low dietary diversity score (AOR = 3.57, 95% CI (1.88, 6.75))
	Tura M.R., et al. (2020)	Oromia	Cross-sectional survey, n=523	Tea/coffee consumption within 30 minutes after meal
	Engidaw, M., et al. (2018)	Somali (refugee camp)	Cross-sectional study, n=532	Heme containing foods < 1 per month compared to more than twice within a week (AOR: 11.42, 95% CI (3.42, 38.18))
	Seyoum, et al. (2019)	Oromia	Cross-sectional study, n=257	Diets were low in animal source foods, fruits, dark-green leafy vegetables; but anemia and clinical ID were low (8.7%). Iron stores were poor, 41%
Habtegiorgis, S., et al. (2022)	5 regions	Meta analysis n=5,547	Low dietary diversity (OR: 1.35; 95% CI: 1.00 to 2.34), was associated with anemia	
Knowledge of anemia	Ahmed, A. and A. Mohammed (2022)	Somali	Cross-sectional study, n=372	Lack of anemia knowledge was an independent predictor
Intestinal parasite	Berhe, K., et al. (2022)	all regions	Meta-analysis, n=17,854	Presence of intestinal parasite (AOR = 3.51)
	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	History of intestinal parasitic infection [AOR=2.7; 95% CI (1.19-6.21)]
Menstrual status	Etsay, A., et al. (2022)	Afar	Cross-sectional study, n=437	Girls with menstrual duration 5 or more days [AOR = 2.34, 95% CI (1.36, 4.01)]
	Berhe, K., et al. (2022)	All regions	Meta-analysis, n=17,854	≥ 5 days of menses (AOR = 6.21)
	Etsay, A., et al. (2022)	Afar	Cross-sectional study, n=437	Menstrual duration 5 or more days [AOR = 2.34, 95% CI (1.36, 4.01)]

	Endale, F., et al. (2022)	National	Systematic review	Pooled prevalence of anemia among adolescent girls in Ethiopia was 23.03%; menstrual blood flow > 5 days (odds ratio: 6.21; 95% CI: 1.67, 23.12)
	Mengistu, G., et al. (2019)	Amhara	Cross-sectional survey, n=443	Duration of menstruation [AOR=2.4; 95%CI (1.08- 5.44)]
	Tura M.R., et al. (2020)	Oromia	Cross-sectional survey, n=523	Menses status of female adolescents,
	Regasa, R. and J. Haidar (2019)	Oromia	Cross-sectional survey, n=448	Adolescents who attained menarche (AOR = 2.3 95%CI = 1.34 to 4.2)