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SUPPLEMENT ARTICLE

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Dietary intake and quality for young adolescents in sub-Saharan Africa: Status and influencing factors

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Abstract

Adolescents face the risk of the triple burden of malnutrition—the co-existence of micronutrient deficiencies, underweight and overweight and obesity and related noncommunicable diseases. Poor-quality diets are a modifiable risk factor for all forms of malnutrition in adolescents. However, there is limited knowledge about diet quality for African adolescents. We analyzed data from 4609 school-going adolescents aged 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania. Dietary intake was assessed using food frequency questionnaires, and diet quality computed using the Global Diet Quality Score (GDQS). Generalized estimating equations linear regression models were used to evaluate factors associated with adolescent diet quality. Mean adolescent age was 12.4 (±1.4) years and 54% of adolescents were female. Adolescents reported physical activity on 1.5 (±1.7) days/week. The mean GDQS (±SD) was 20.6 (±4.0) (maximum 40). Adolescent consumption of vegetables, fruit, nuts and seeds, eggs, fish and poultry was low, and refined grain consumption was relatively high. Boys consumed unhealthy foods less frequently but consumed fewer cruciferous vegetables and deep orange tubers. Older adolescents had higher fish and lower red meat consumption. Having an unemployed mother versus farmer (estimate −2.60, 95% confidence interval [CI]: −4.81, −0.39), and having 3–4 days of physical activity per week versus none (estimate 0.64, 95% CI: 0.11, 1.17) were associated with GDQS. We found evidence of poor-quality adolescent diets and gender and age differences in the consumption of healthy diets. Programs to address poor-quality diets should consider tailoring interventions for adolescent girls and boys of different ages and also consider the role of physical activity in these contexts.

KEYWORDS

adolescent, Burkina Faso, diet quality, Ethiopia, healthy, schools, Sudan, Tanzania

1 | INTRODUCTION

Adolescents make up 1.8 billion of the world's population, most of them residing in low- and middle-income countries (LMICs) (Christian & Smith, 2018). The period of adolescence, from the age of 10 to 19 years, is a critical period for physical growth and development. Adolescents experience biological, cognitive, psychosocial and emotional development during this period (National Academies of Sciences E. & Medicine, 2019). This period of growth, sexual maturation and brain development is marked by increasing nutrient requirements for adolescents to achieve their growth potential (Das et al., 2017). For example, iron needs increase for girls during adolescence due to menstrual blood loss and calcium and zinc requirements are higher in adolescents (Christian & Smith, 2018; Das et al., 2017). Further, energy requirements are increased in male adolescents (2500–3000 calories per day) (Christian & Smith, 2018; Das et al., 2017). Given their additional requirements, adolescents face nutritional vulnerability globally. Adolescents must therefore consume quality diets to meet these increased demands.

In LMICs, adolescents face the triple burden of malnutrition, with micronutrient deficiencies, stunting and underweight that remain prevalent, and increasing overweight and obesity which increases their risk of noncommunicable diseases (NCDs) in later life. Adolescents consuming inadequate micro- and macro-nutrients are likely to have nutritional deficiencies, impaired linear growth and development, and miss the opportunity for catch-up growth (Canavan & Fawzi, 2019). Anaemia affects 30% of all female adolescents and 20% of male adolescents in LMICs (Christian & Smith, 2018). A study among adolescents in Burkina Faso, Ethiopia, Ghana, Nigeria, Tanzania and Uganda found that underweight (thinness) affected 14.3% (Darling et al., 2020). Overweight and obesity affect up to 340 million children and adolescents globally, and has increased in prevalence from 4% in 1975 to 18% in 2016 (Di Cesare et al., 2019).

The problems of undernutrition (food insecurity, nutritional deficiencies, stunting, wasting and underweight) and overweight and obesity (and related diseases) in all age groups, including adolescents, share a common cause; and, poor-quality diets are a contributing factor (Popkin et al., 2020; Wells et al., 2021). First, poorly functioning food systems in LMICs contribute to poor diets and inadequate availability of micronutrient-rich foods including fruits, vegetables, nuts and animal-source foods, for example, dairy for adolescents. Second, with the global transition in food systems, there is increased availability of low-quality foods at cheaper prices and increased consumption of unhealthy foods, such as refined, processed, and fast foods, as well as sugar-sweetened beverages (SSBs) by adolescents (Popkin et al., 2020). Combined with lower physical activity and increasing sedentary behaviour and screen time for adolescents, these factors can increase their risk of poor health outcomes. Adolescents consuming unhealthy diets are more likely to develop overweight or obesity and NCDs such as hypertension and diabetes (Christian & Smith, 2018). Adolescent diets shape diets, behaviours and nutrition status into adulthood (Christoph et al., 2019; Simmonds et al., 2016), hence the need to support healthy adolescent diets to foster healthy habits into adulthood.

There are limited tools for assessing diet quality for adolescents in LMICs (Chiplonkar & Tupe, 2010; Trijsburg et al., 2019). Previous studies of adolescent diets in LMICs have assessed dietary diversity as a proxy for overall diet quality, given its association with micronutrient adequacy (Dalwood et al., 2020; Mohammed & Tefera, 2015; Nithya & Bhavani, 2018). There is a limitation in that dietary diversity only assesses the risk of micronutrient deficiency and misses the opportunity to evaluate the increasing consumption of unhealthy foods by adolescents. The Global Diet Quality Score (GDQS) is a novel tool that also assesses the consumption of unhealthy foods and food groups associated with a higher risk of chronic diseases such as refined grains, processed meats, fast foods and other foods that are high in saturated fats (Bromage, Batis, et al., 2021). The GDQS has been associated with higher nutrient adequacy, mid-upper arm circumference, anaemia and folate levels among adults (Bromage, Andersen, et al., 2021; Bromage, Zhang, et al., 2021).

We sought to evaluate the quality of diets of school-going adolescents aged 10–15 years using the GDQS tool in four African countries, Burkina Faso, Sudan, Ethiopia and Tanzania. We also assessed the factors influencing adolescent diets in these contexts.

Key messages

- Dietary transition is occurring globally and diets for African adolescents have not been spared.
- Poor-quality diets providing insufficient fruits, vegetables and animal source foods and increasing consumption of unhealthy foods may be exposing African adolescents to the triple burden of malnutrition.
- We found evidence of poor-quality adolescent diets, and gender and age differences in the consumption of healthy diets.
- Programs to address poor-quality diets should consider tailoring interventions for adolescent girls, boys and adolescents of different ages, and should consider the role of physical activity to promote optimal health outcomes for adolescents.

2 | METHODS

The study was a cross-sectional, school-based Adolescent Health and Nutrition Study conducted in four sub-Saharan African (SSA) countries, Burkina Faso, Ethiopia, Sudan and Tanzania that are part of the Africa Research Implementation Science and Education (ARISE) Network. Study participants were adolescents aged between 10 and 14 years in Ethiopia, Sudan and Tanzania and 11–15 years in

Burkina Faso. Data collection was conducted in Ouagadougou in Burkina Faso, Addis Ababa in Ethiopia, Khartoum in Sudan and Dar es Salaam in Tanzania from March to December 2020.

The study used a multistage cluster random sampling technique to sample schools and students in each site. First districts and administrative units were selected randomly, then 20 primary schools were selected in each district per country. There were 60 students randomly selected per school, resulting in a sample of approximately 1200 adolescents per country.

In Burkina Faso, 22 secondary schools with grades 3–6 were randomly selected from 251 schools in five arrondissements of Ouagadougou. Then, 1059 adolescents were randomly selected from the schools using proportionate representative sampling. In Ethiopia, two schools were randomly selected from each of the 10 boroughs in Addis Ababa. Then, 60 adolescent boys and girls were selected in each school. In Sudan, study participants were selected from four localities, Bahri, Omdurman, Karrari and Umbada, out of seven in Khartoum. In each locality, three public primary schools were randomly selected and 60–100 adolescent boys and girls from grades 5 to 8 randomly selected. In Tanzania, four public primary schools were randomly selected in each of the administrative districts of Dar es Salaam. A total of 20 adolescents, 4 from each district, were then selected at random.

Written parental consent and adolescent assent were obtained before data collection. Nonconsenting adolescents, those that were too ill to be interviewed, or were absent during data collection were excluded from the study. A description of the study design is provided elsewhere (Shinde et al., 2022).

A standardized survey questionnaire was developed and adopted for each country and translated into the local language, Amharic in Ethiopia, Arabic in Sudan and Swahili in Tanzania. In Burkina Faso, interviews were conducted in French. Trained study research assistants administered the standardized survey questionnaire to adolescents in face-to-face interviews. Data on sociodemographic characteristics, parental characteristics, water, sanitation, and hygiene practices, antimicrobial resistance, media use, mental health, dietary intake, physical activity and anthropometric status were collected.

Adolescent weight was assessed using a SECA scale to the nearest 100 g. Haemoglobin was assessed using a HemoCue device (HemoCue AB). Data collection for the study was completed between March and December 2020.

2.1 | Study outcomes

The main study outcome was diet quality for adolescents. Dietary intake for adolescents was assessed using a locally adapted 7-day food frequency questionnaire. Adolescents were asked to recall their frequency of consumption of foods classified in 25 food groups. The frequency of consumption of food groups was classified as never, once per week, two to four times per week, five to seven times per week or at least once per day.

2.2 | GDQS

The GDQS has been recently proposed as a novel measure of diet quality. It is an improvement on a previously utilized tool for the assessment of diet quality, the Prime Diet Quality Score (PDQS), which assesses the consumption of healthy foods, as well as unhealthy food groups that have been associated with diet-related chronic diseases (Alvarez-Alvarez et al., 2020; Bromage, Batis, et al., 2021; Fung et al., 2018, 2020) and poor pregnancy outcomes (Gicevic et al., 2018; Madzorera et al., 2020). The GDQS was developed to further refine the PDQS for use as a global tool in different contexts. The GDQS includes more food groups to incorporate the diversity of nutritionally important foods consumed across LMICs and has been validated in SSA and other contexts (Bromage, Batis, et al., 2021). It has been validated for associations with higher micronutrient adequacy and lower risk of poor nutrition outcomes including anaemia, and underweight/wasting in multiple sites including 10 African countries, China, India, Mexico and the USA (Bromage, Andersen, et al., 2021; Bromage, Zhang, et al., 2021; Castellanos-Gutiérrez et al., 2021; Fung et al., 2020; He & Li, 2020; Matsuzaki et al., 2021).

In this study, we adapted the GDQS as follows:

1. We computed GDQS using frequencies rather than amounts to account for the data collection tool used in this study. The GDQS is usually based on grams/day to facilitate more comparable assessments across countries and over time (Bromage, Batis, et al., 2021). Our study tool asked adolescents to report their frequency of consumption of key foods and did not collect data on the amounts consumed for each food. In the survey, the frequency of consumption was recorded as, (a) never, (b) once per week, (c) two–four times per week, (d) five–seven times per week and (e) once per day.
2. We scored consumption of high-fat dairy as healthy for adolescents, at all consumption levels. This was an adaptation from the original scoring which used four categories, including a 3+ times per day frequency option which is scored negatively (Bromage, Batis, et al., 2021). For this adolescent population, we determined that both low- and high-fat dairy could be classified as healthy as dairy is an important source of nutrients for adolescents.

In our current study, we classified foods consumed by adolescents into 17 healthy food groups (dark green vegetables, legumes, nuts and seeds, deep orange fruits, citrus fruits, other fruits, poultry, fish, whole grains, liquid vegetable oils, low-fat dairy, high-fat dairy, eggs, cruciferous vegetables, deep orange vegetables, deep orange tubers, other vegetables) and 8 unhealthy food groups (red meat, processed meat, refined grains and baked goods, sweets and ice cream, SSBs, juice, white roots and tubers and fried foods eaten away from home) for the GDQS. Scoring for food groups is shown in Supporting Information: Table 1. In brief, scores were allocated as follows: dark green vegetables, legumes and nuts and seeds (0–1 serving per week [0 points], 2–3 servings per week [2 points], and ≥4 servings per week [4 points]); cruciferous vegetables, deep orange vegetables, deep orange tubers and other vegetables ([0–1 serving per week (0 points), 2–3 servings per week (0.25 points) and ≥4 servings per week (0.50 points]). For the remaining healthy food groups scoring was allocated as: 0–1 serving per week (0 points), 2–3 servings per week (1 point) and ≥4 servings per week (2 points). For unhealthy food groups, scoring was assigned as 0–1 serving per week (2 points), 2–3 servings per week (1 point) and ≥4 servings per week (0 points). The scoring for red meat allocated maximum points for moderate consumption and minimum points for low and high intake.

We classified all dairy in the study as high-fat dairy. Each adolescent was assigned a low intake of low-fat dairy given its low availability in the study sites and that low-fat dairy consumption is difficult to ascertain for adolescents. Points for each food group were summed to give an overall score (range: 0–40), with a greater overall score indicating higher diet quality. Binary scores were calculated for categories of high risk of poor diet quality (GDQS < 10, binary indicator, Y/N), and low risk for poor diet quality (GDQS > 23, binary indicator, Y/N) (Intake—Center for Dietary Assessment, 2021). We calculated tertiles of GDQS intake to rank overall diet quality for adolescents.

2.2.1 | Anthropometric status

We classified adolescents as underweight, normal weight, overweight or obese based on body mass index (BMI)-for-age based on the WHO 2007 growth reference (WHO [WHO], 2019). We classified underweight as BMI for age and sex <−2 standard deviations (SDs) from the median, overweight as BMI by age and sex between 1 and 2 SD and obesity as BMI by age and sex ≥2 SD.

2.3 | Statistical analysis

Descriptive statistics used frequencies and percentages for categorical variables and means and SDs for continuous variables. We described dietary intake for adolescents and their nutrition (anthropometric) status across the four countries. We used Poisson regression models to evaluate gender and age differences in the consumption of healthy and unhealthy food groups and GEE linear regression models to assess the age and sex differences in healthy and unhealthy diet scores. We used generalized estimating equation linear models with exchangeable correlation (Liang & Zeger, 1986), controlling for clustering by the school, to evaluate the factors associated with diet quality for adolescents and Poisson regression models to assess the relative risk of consumption of high quality diets among adolescents.

We considered as potential confounders country (Burkina Faso, Ethiopia, Sudan and Tanzania), respondent sex (female/male), age, categories of physical exercise (0 day, 1–2 days per week, 3–4 days per week, 5–6 days per week), measures of food insecurity such as no food in the house (no/yes), skipped a meal in the past month (no/yes), and went without eating for a whole day in the past month (no/yes), maternal and paternal education (none or incomplete primary, primary school or incomplete secondary, secondary school, tertiary education), maternal occupation (farmer, merchant, teacher/government employee, unemployed, stay at home parent, other), paternal occupation (farmer, merchant, teacher/government employee, unemployed, NGO employee, other), and parents alive (both alive, only mother alive, only father alive). We computed a wealth index using factor analysis for each country based on asset ownership. We selected potential confounders based on associations with the outcomes in univariate regression models at levels of $p < 0.20$. We used the missing indicator method to adjust for missing confounder data in the analysis (Groenwold et al., 2012). Analysis was conducted using SAS 9.4.

2.4 | Ethical consideration

Ethical approval for the study was received from the institutional ethical review boards of the Addis Continental Institute of Public Health (ACIPH), Ethiopia; Ahfad University Ethical Committee and the University of Khartoum, Sudan; National Institute for Medical Research (NIMR), Tanzania; Ethics Committee for Research on Health of the Ministry of Health of Burkina Faso; the Ethics Committee of the Medical Faculty of the University Heidelberg and Harvard Office of Human Research Administration, USA.

3 | RESULTS

We analysed data from 1051 adolescents in Burkina Faso, 1200 in Ethiopia, 1101 in Sudan and 1257 in Tanzania. Table 1 shows the characteristics of the study population. The mean age (±SD) of adolescents in the study was 12.4 (±1.4) years, and 53.5% of the respondents were female. Maternal education was lower in Ethiopia and Tanzania where at least 67% of adolescents reported primary school or no education for their mothers/female caregivers. Across all sites, the most common occupation for fathers/male guardians was being a merchant (34.6%), and in Tanzania, 50% of all fathers had this occupation. In Sudan, the most common occupations for fathers were being teachers or government employees. For mothers/female guardians, the most common occupation was being a stay-at-home mother (33.4%), while in Tanzania most were merchants (51.0%) and in Sudan most were teachers or government employees (41.5%).

On average, adolescents exercised 1.5 (±1.7) days each week. The frequency of reported exercise among adolescents was high in Tanzania with 23.7% of adolescents reporting physical activity 5–6 days each week, while in Sudan almost all adolescents reported no physical activity at all. Food insecurity was reported infrequently by adolescents with 7.9% reporting not having food in the house, and 6.9% reporting going for an entire day without eating. The mean GDQS (±SD) for adolescents in the study was 20.6 (±4.0) out of a maximum score of 40. The highest GDQS was reported in Sudan (mean: 23.8 ± 3.2), and the lowest in Burkina Faso (mean: 19.3 ± 3.6) and Tanzania (mean: 19.3 ± 4.2). Overall, in the study, 7.3% of the adolescents were at risk of poor diet quality (GDQS < 15) and 26.8% had a low risk of poor diet quality (GDQS > 23). The risk of poor diet quality was highest in Tanzania (15.0%), and lowest in Sudan (0.5%).

Figure 1 shows the frequency of consumption of various food groups by adolescents. Vegetable consumption was low generally across all sites

TABLE 1 Sociodemographic characteristics of study adolescents aged 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania

	Overall	Burkina Faso	Ethiopia	Sudan	Tanzania
N	4609	1051	1200	1101	1257
Sociodemographic					
Age of respondent (years) (Mean, SD)	12.4 (1.4)	13.5 ± 1.2	12.6 ± 1.2	12.1 ± 1.3	11.6 ± 1.2
Sex					
Male	2143 (46.5)	451 (42.9)	543 (45.3)	548 (49.8)	601 (47.8)
Female	2466 (53.5)	600 (57.1)	657 (54.8)	553 (50.2)	656 (52.2)
Maternal education					
None	278 (8.5)	0 (0)	225 (23.1)	20 (2.3)	33 (4.5)
Primary school	1246 (38.1)	308 (44.8)	430 (44.2)	46 (5.2)	462 (63.6)
Secondary school	884 (27.0)	168 (24.5)	251 (25.8)	306 (34.6)	159 (21.9)
Tertiary education	863 (26.4)	211 (30.7)	67 (6.9)	512 (57.9)	73 (10.0)
Household					
Siblings (mean, SD)	3.0 ± 2.0	4.0 ± 2.0	2.0 ± 2.0	4.0 ± 2.0	2.0 ± 2.0
Paternal occupation					
Farmer	100 (2.9)	46 (5.5)	10 (1.3)	19 (1.9)	25 (3.0)
Merchant	1178 (34.6)	233 (27.9)	251 (32.6)	283 (28.8)	411 (49.9)
Teacher or govt employed	1075 (31.5)	160 (19.1)	227 (29.5)	586 (59.7)	102 (12.4)
Unemployed	119 (3.4)	18 (2.2)	46 (6.0)	20 (2.0)	35 (4.3)
NGO employee	115 (3.4)	115 (13.8)	0 (0)	0 (0)	0 (0)
Other	823 (24.1)	264 (31.6)	235 (30.6)	74 (7.5)	250 (30.4)
Maternal occupation					
Farmer	33 (0.8)	3 (0.3)	4 (0.4)	4 (0.3)	22 (2.0)
Merchant	1234 (29.7)	326 (35.5)	266 (24.5)	86 (8.1)	556 (51.0)
Teacher or govt employed	851 (20.5)	124 (13.5)	238 (21.9)	442 (41.5)	47 (4.3)
Unemployed	299 (7.2)	11 (1.2)	46 (4.2)	221 (20.8)	21 (1.9)
Stay at home	1388 (33.4)	331 (36.0)	390 (35.9)	302 (28.4)	365 (33.5)
Other	356 (8.6)	124 (13.5)	143 (13.2)	10 (0.9)	79 (7.3)
Improved fuel	3491 (90.6)	1020 (97.1)	899 (89.7)	1081 (99.7)	491 (68.4)
Improved water	4486 (97.3)	1015 (96.6)	1179 (98.3)	1099 (99.8)	1193 (94.9)
Improved toilet	4587 (99.5)	1049 (99.9)	1181 (98.4)	1101 (100)	1256 (99.9)
Adolescent characteristics					
Exercise (days per week) (mean, SD)	1.5 ± 1.7	2.2 ± 1.4	1.4 ± 1.5	0.0 ± 0.2	2.6 ± 2.0
Exercise: 0 days	1791 (44.5)	96 (10.5)	452 (39.8)	1087 (99.0)	156 (17.8)
1–2 days/week	1315 (32.7)	584 (63.9)	417 (36.7)	10 (0.9)	304 (34.6)
3–4 days/week	559 (13.9)	147 (16.1)	201 (17.7)	0 (0.0)	211 (24.0)
5–6 days/week	362 (9.0)	87 (9.5)	66 (5.8)	1 (0.1)	208 (23.7)
Food insecurity					
No food in house	364 (7.9)	82 (7.8)	77 (6.4)	38 (3.5)	167 (13.3)
Skipped a meal	316 (6.9)	79 (7.5)	49 (4.1)	35 (3.2)	153 (12.2)
Whole day without eating	316 (6.9)	79 (7.5)	49 (4.1)	35 (3.2)	153 (12.2)

(Continues)

TABLE 1 (Continued)

	Overall	Burkina Faso	Ethiopia	Sudan	Tanzania
Global Diet Quality Score (GDQS)					
Score (mean, SD)	20.6 ± 4.0	19.3 ± 3.6	20.1 ± 2.8	23.8 ± 3.2	19.3 ± 4.2
GDQS (<15): High risk of poor diet quality	336 (7.3)	109 (10.4)	33 (2.8)	5 (0.5)	189 (15.0)
GDQS (>23): Low risk of poor diet quality	26.8 (26.8)	161 (15.3)	177 (14.8)	653 (59.3)	242 (19.3)

Note: Data shown are *N* (%).

Abbreviation: GDQS, Global Diet Quality Score.

(Figure 1a), with most vegetables being consumed less than three times each week on average, except for the other vegetables group (all sites except Sudan). Cruciferous vegetables were some of the least frequently consumed across all sites (less than twice per week on average). Additionally, dark green vegetable consumption was low across all sites. In Ethiopia, all vegetables except other vegetables were consumed on average once each week. Consumption of fruits was low across all sites. In Ethiopia, adolescents reported intake of different types of fruits once or not at all each week on average. Figure 1b shows that consumption of nuts and seeds and deep orange roots and tubers (e.g., orange-fleshed sweet potato) were low across all sites except in Sudan. However, consumption of whole grain and liquid vegetable oils was relatively higher in Ethiopia, Sudan (whole grain) and Tanzania (vegetable oils).

Figure 1c shows that the frequency of consumption of animal-source food (ASF) products by adolescents across the four study countries was low. Adolescent consumption of ASF was relatively higher in Sudan. Dairy was an important part of adolescent diets in Sudan and fish consumption was more frequent in Burkina Faso, where adolescents had consumed fish on average 2 days a week. Finally, Figure 1d shows the consumption of unhealthy foods by adolescents. Refined grains were the most consistently consumed unhealthy food group across all sites. In Tanzania, consumption of fried foods away from home was more frequent, and juice and sweets consumption by adolescents was reported on average at least 2 days a week in Sudan and Tanzania. Adolescents in Sudan consumed SSBs and red meat for at least 2 days each week and although consumption of processed meats was low, it was consumed at a somewhat higher frequency in Sudan.

Figure 2 shows the dietary profile of girls and boys in the study sites. Diet quality for girls (GDQS: 18.7 vs. 19.9 for boys) was marginally lower in Tanzania and was the same in other sites. In Sudan, girls reported slightly higher consumption of healthy foods compared to boys, while in Tanzania, boys reported slightly higher consumption of healthy foods. In Tanzania, boys reported lower consumption of unhealthy foods (represented by higher scores for unhealthy foods).

Overall, underweight affected 13.2%, overweight affected 8.0% and obesity 2.5% of the adolescents across the study. In Supporting Information: Figure 1, we show the nutritional profile of adolescent girls and boys in the study countries. Among girls, the prevalence of being underweight was highest in Sudan (15%) and Ethiopia (14%). Comparatively the prevalence of overweight and obesity was 15% in Burkina Faso, 15% in Sudan and 14% in Tanzania, and lowest in Ethiopia at 7%. Among adolescent boys, being underweight was highest in Ethiopia (21%) and Sudan (18%). Overweight and obesity among adolescent boys was 11% in Sudan and Burkina Faso and 8% in Tanzania. The dual burden of malnutrition, that is the coexistence of under and overnutrition is therefore evident among adolescent girls (Sudan, >10% prevalence) and adolescent boys (Burkina Faso and Sudan). Overall stunting prevalence was 15% in the study. At least a quarter of all adolescent boys in Tanzania were stunted and the prevalence was higher than 15% in all sites except Sudan (results not shown). Among adolescent girls, the prevalence of stunting was highest in Tanzania (17.2%), and lowest in Sudan (9%).

Table 2 shows the associations between adolescent sex and age with the consumption of food groups derived from the GDQS. Being a male adolescent was associated with lower consumption of healthy food groups of cruciferous vegetables (relative risk [RR]: 0.83, 95% CI: 0.71, 0.97), deep orange tubers (RR: 0.82, 95% CI: 0.71, 0.95) and liquid vegetable oils (RR: 0.94, 95% CI: 0.90, 0.99) compared with girls. Adolescent boys also had a lower reported intake of refined grains (RR: 0.87, 95% CI: 0.79, 0.95) compared with adolescent girls. Additionally, adolescent boys had 0.35 units higher scores (95% CI: 0.15, 0.56) for consumption of unhealthy food groups (indicating that they were less likely to consume unhealthy foods). Being an adolescent 13 years or older was associated with a higher likelihood of consuming fish (RR: 1.23, 95% CI: 1.09, 1.39), and lower consumption of red meat (RR: 0.90, 95% CI: 0.82, 0.99).

Table 3 shows the factors associated with the quality of adolescent diets in the study countries. Overall, we found that the GDQS for adolescents residing in Burkina Faso (estimate −4.99, 95% CI: −5.72, −4.25), Ethiopia (estimate −4.25, 95% CI: −4.98,−3.52) and Tanzania (estimate −5.21, 95% CI: −6.11, −4.32), GDQS was lower compared with that of adolescents residing in Sudan. Adolescents that were physically active on 3–4 days per week tended to have higher GDQS (estimate 0.64, 95% CI: 0.11, 1.17). Adolescents whose mothers or female guardians were unemployed had low GDQS (estimate −2.60, 95% CI: −4.81, −0.39). Additionally, having the father only being alive was associated with better diet quality for adolescents (estimate 2.21, 95% CI: 0.91, 3.52).

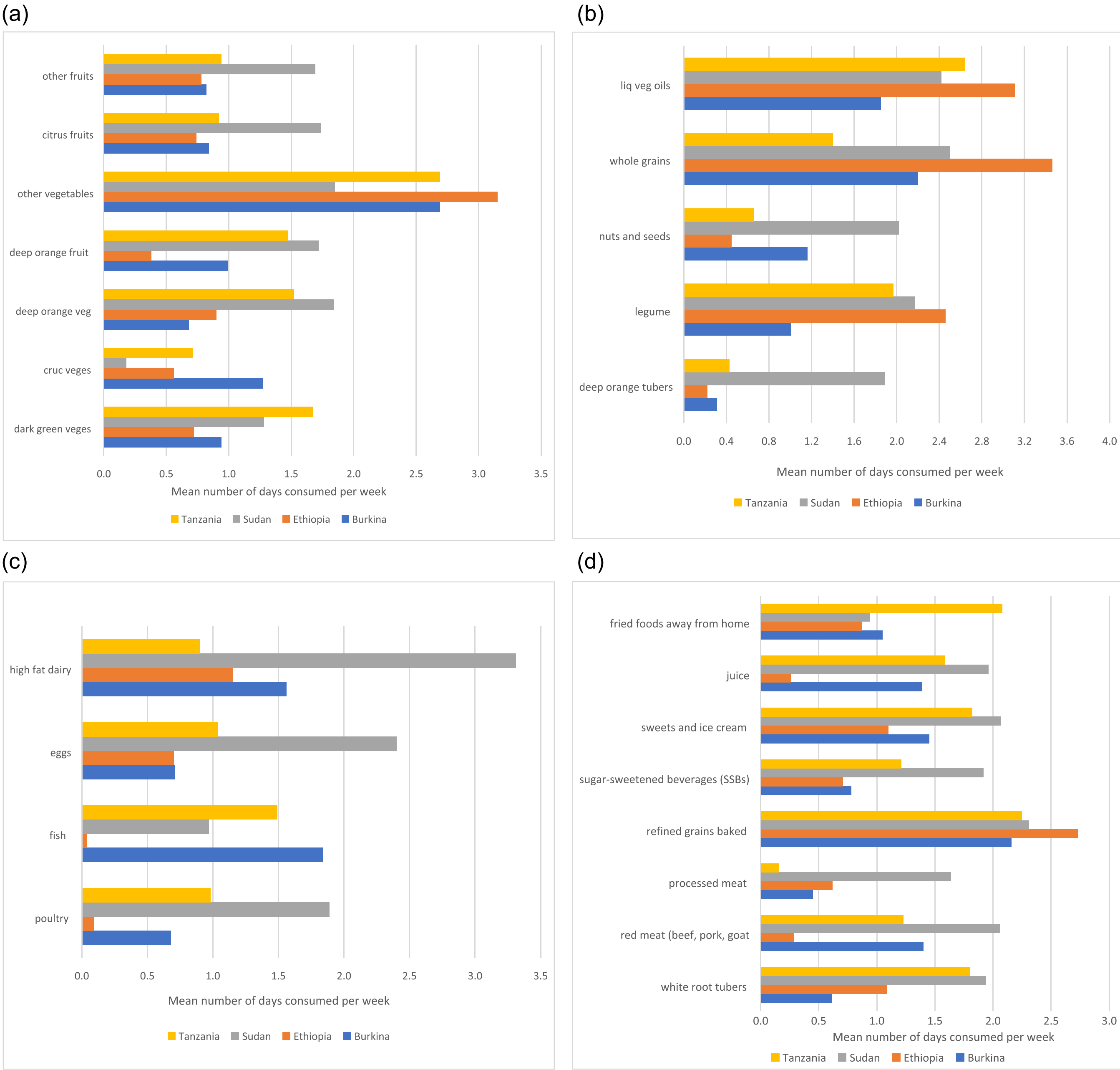

FIGURE 1 (a–d) Mean weekly frequency of consumption of (a) vegetables and fruits, (b) legumes, nuts and other healthy food groups, (c) animal source foods, and (d) unhealthy foods by adolescents 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania.

We evaluated factors associated with the consumption of high-quality diets by adolescents in the study population. Adolescents residing in Burkina Faso (estimate 0.22, 95% CI: 0.15, 0.33), Ethiopia (estimate 0.28, 95% CI: 0.22, 0.36) and Tanzania (estimate 0.28, 95% CI: 0.20, 0.40) were less likely to consume high-quality diets compared with adolescents in Sudan. Adolescents whose fathers or male guardians were unemployed (estimate 1.67, 95% CI: 1.03, 2.69) or whose employment was in the other category (estimate 1.53, 95% CI: 1.01, 2.31) were more likely to report high-quality diets compared to those who were government employees.

4 | DISCUSSION

We evaluated adolescent diets and the factors associated with diet quality for adolescents in Burkina Faso, Ethiopia, Sudan and Tanzania. We also assessed gender and age differences in consumption of healthy and unhealthy diets during adolescence. We found that adolescent diet quality was poor across all study countries and consumption of micronutrient-rich food such as vegetables, fruit, nuts and seeds, and ASF by adolescents was low. Adolescent boys were less likely to consume unhealthy foods but had lower consumption of some healthy foods. However, overall diet quality did not vary by adolescent age or

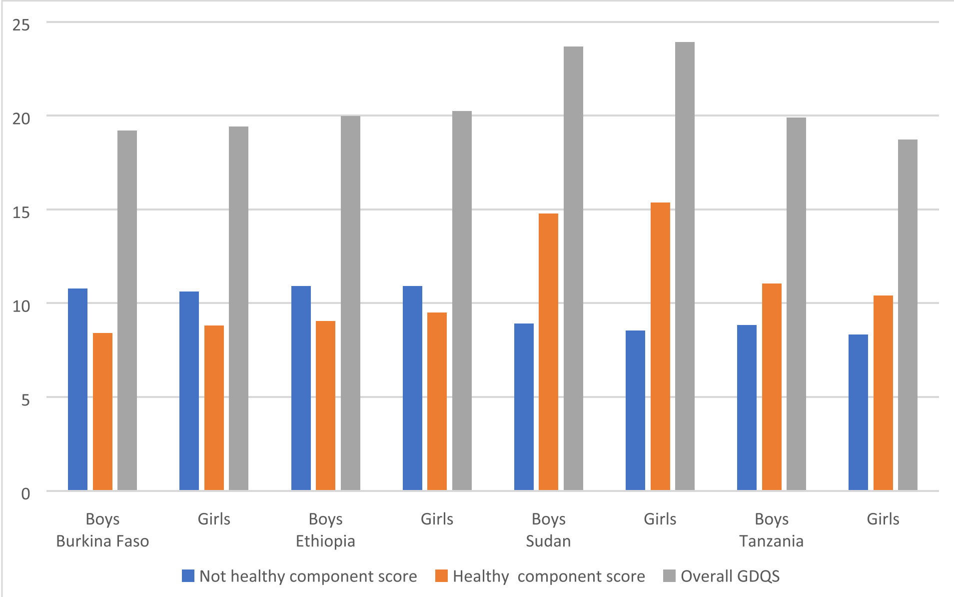

FIGURE 2 Mean global diet quality score for adolescents aged 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania by gender. GDQS score is sum of not healthy and healthy scores for each adolescent, max GDQS 40. GDQS, Global Diet Quality Score.

TABLE 2 Association of gender and age with consumption of GDQS food groups by adolescents aged 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania

	Sex[a]				Age[b]			
	Univariate RR		Multivariate RR[g]		Univariate RR		Multivariate RR[g]	
	Female	Male	Female	Male	≤12 years	≥13 years	≤12 years	≥13 years
Healthy food groups								
Dark green vegetables	ref	0.89 (0.82, 0.99)*	ref	0.87 (0.75, 1.02)	ref	0.96 (0.89, 1.03)	ref	0.99 (0.91, 1.09)
Cruciferous vegetables	ref	0.93 (0.83, 1.05)	ref	0.83 (0.71, 0.97)*	ref	1.01 (0.90, 1.13)	ref	1.01 (0.81, 1.27)
Other vegetables	ref	1.00 (0.98, 1.01)	ref	1.00 (0.96, 1.03)	ref	0.99 (0.97, 1.01)	ref	1.00 (0.96, 1.04)
Deep orange vegetables	ref	0.93 (0.87, 1.00)	ref	0.92 (0.83, 1.03)	ref	0.96 (0.89, 1.03)	ref	0.98 (0.92, 1.05)
Deep orange fruit	ref	0.96 (0.89, 1.03)	ref	0.91 (0.79, 1.05)	ref	0.97 (0.91, 1.03)	ref	1.06 (0.96, 1.15)
Deep orange tubers[f]	ref	0.88 (0.80, 0.97)*	ref	0.82 (0.71, 0.95)**	ref	0.99 (0.89, 1.09)	ref	1.06 (0.98, 1.14)
Citrus fruits	ref	1.02 (0.94, 1.11)	ref	0.95 (0.86, 1.05)	ref	0.98 (0.90, 1.06)	ref	1.00 (0.91, 1.09)
Other fruits	ref	0.91 (0.82, 1.01)	ref	0.89 (0.77, 1.03)	ref	0.90 (0.82, 0.98)*	ref	0.98 (0.89, 1.07)
Legume	ref	1.05 (1.00, 1.09)*	ref	1.03 (0.98, 1.09)	ref	1.01 (0.98, 1.04)	ref	1.00 (0.96, 1.05)
Nuts and seeds	ref	1.05 (0.98, 1.13)	ref	0.98 (0.88, 1.08)	ref	0.97 (0.91,1.03)	ref	0.99 (0.93, 1.06)
Poultry	ref	1.02 (0.93, 1.12)	ref	1.05 (0.92, 1.19)	ref	0.99 (0.89, 1.09)	ref	1.02 (0.95, 1.11)
Fish	ref	1.00 (0.93, 1.07)	ref	0.96 (0.86, 1.07)	ref	1.04 (0.98, 1.10)	ref	1.23 (1.09, 1.39)**
Whole grains	ref	0.97 (0.94, 1.00)	ref	1.03 (0.99, 1.06)	ref	0.98 (0.96, 1.01)	ref	0.99 (0.96, 1.01)
Liq veg oils	ref	1.02 (0.99, 1.05)	ref	0.94 (0.90, 0.99)*	ref	0.97 (0.94, 1.01)	ref	1.01 (0.97, 1.06)
Eggs	ref	0.98 (0.90, 1.07)	ref	0.98 (0.90, 1.08)	ref	0.95 (0.88, 1.02)	ref	0.95 (0.88, 1.02)
Low fat dairy	ref	–	ref	–	ref	–	ref	–
High fat dairy[c]	ref	1.03 (0.96, 1.10)	ref	0.96 (0.89, 1.03)	ref	0.96 (0.91, 1.01)	ref	–
Unhealthy foods and food groups								
White root tubers	ref	1.02 (0.99, 1.05)	ref	1.00 (0.98, 1.04)	ref	1.03 (1.01, 1.05)	ref	1.02 (0.99, 1.04)

TABLE 2 (Continued)

	Sex[a]				Age[b]			
	Univariate RR		Multivariate RR[g]		Univariate RR		Multivariate RR[g]	
	Female	Male	Female	Male	≤12 years	≥13 years	≤12 years	≥13 years
Red meat	ref	1.00 (0.93, 1.08)	ref	1.00 (0.90, 1.12)	ref	0.98 (0.92, 1.04)	ref	0.90 (0.82, 0.99)*
Processed meat	ref	1.00 (0.99, 1.01)	ref	0.99 (0.97, 1.01)	ref	1.00 (0.99, 1.01)	ref	0.99 (0.96, 1.01)
Refined grains baked	ref	0.92 (0.87, 0.97)**	ref	0.87 (0.80, 0.95)**	ref	1.01 (0.95, 1.07)	ref	0.99 (0.91, 1.09)
SSBs	ref	1.01 (0.99, 1.03)	ref	1.01 (0.99, 1.05)	ref	1.03 (1.01, 1.04)*	ref	1.02 (0.98, 1.06)
Sweets and ice cream	ref	1.05 (1.02, 1.08)**	ref	1.02 (0.98, 1.06)	ref	1.01 (0.98, 1.04)*	ref	0.97 (0.93, 1.02)
Juice	ref	1.00 (0.97, 1.03)	ref	1.00 (0.96, 1.04)	ref	1.01 (0.99, 1.04)	ref	0.99 (0.96, 1.02)
Fried foods away from home	ref	1.04 (1.01, 1.07)*	ref	1.01 (0.99, 1.03)	ref	1.01 (0.99, 1.03)	ref	1.01 (0.99, 1.03)
	Univariate estimate		Multivariate estimate		Univariate estimate		Multivariate estimate	
	Female	Male	Female	Male	≤12 years	≥13 years	≤12 years	≥13 years
Healthy score[d]	ref	0.06 (−0.20, 0.33)	ref	−0.24 (−0.70, 0.21)	ref	−0.24 (−0.52, 0.05)	ref	−0.09 (−0.43, 0.25)
Unhealthy score[e]	ref	0.25 (0.10, 0.41)**	ref	0.35 (0.15, 0.56)**	ref	0.17 (0.02, 0.32)	ref	0.02 (−0.16, 0.19)

Abbreviations: GDQS, Global Diet Quality Score, RR, relative risk.

[a]Models evaluate the association of adolescent sex with consumption (yes/no) of healthy GDQS food groups.

[b]Models evaluate the association of adolescent age with consumption (yes/no) of healthy GDQS food groups.

[c]Model for high fat dairy and age did not converge.

[d]Models evaluate the association of adolescent sex and age with consumption of healthy foods.

[e]Models evaluate the association of adolescent sex and age with consumption of unhealthy foods.

[f]The adjusted model for deep orange tubers only controls for country due to convergence issues.

[g]Adjusted models consider the following as potential confounders: country (Burkina Faso, Ethiopia, Sudan and Tanzania), respondent sex (female/male), age, categories of physical exercise (0 days, 1–2 days per week, 3–4 days per week, 5–6 days per week), skipped a meal in the past month (no/yes); went without eating for a whole day in the past month (no/yes); maternal and paternal education (none or incomplete primary, primary school or incomplete secondary, secondary school, tertiary education); maternal occupation (farmer, merchant, teacher/government employee, unemployed, stay at home parent, other), paternal occupation (farmer, merchant, teacher/government employee, unemployed, NGO employee, other), handwashing practices, access to improved water, and wealth index (quintiles).

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

sex. Adolescents with higher levels of physical exercise consumed better quality diets and having an unemployed mother was associated with lower quality diets. Paternal occupation was associated with the consumption of high-quality diets.

In this study, we found that overall diet quality was poor across all contexts with diets in Burkina Faso, Ethiopia and Tanzania most affected. We found low consumption of vegetables including cruciferous vegetables and dark green vegetables, fruits, nuts and seeds and deep orange roots and tubers among adolescents across all sites. On the other hand, whole grains and legume consumption was high in Ethiopia. Our study findings are consistent with previous studies that have reported poor quality dietary intake among adolescents in Senegal (Giguère-Johnson et al., 2021), South Africa (Wrottesley et al., 2020) and Brazil (Andrade et al., 2016). Studies have reported inadequate fruit and vegetable intake among adolescents across multiple sites, with less than 30% of adolescents in LMIC meeting WHO recommendations for fruit and vegetable intake (Darfour-Oduro et al., 2018; Keats et al., 2018). This is of concern as fruit and vegetable intake and consumption of higher quality diets by adolescents may be protective against inflammation (Bujtor et al., 2021) and metabolic syndrome in adolescence (Ducharme-Smith et al., 2021).

ASF consumption was low across most sites except Sudan (e.g., dairy), with low egg, fish (except in Burkina Faso) and poultry consumption evident among adolescents. Low ASF consumption by adolescents is also of concern. Adolescent girls have a high risk of iron deficiency at the onset of menstruation, especially on the African continent (Akseer et al., 2017; Kupka et al., 2020), Inadequate consumption of animal source foods is a key contributing factor. Additionally, low ASF consumption may predispose adolescents to low intake of other micronutrients including vitamin B12, zinc and calcium (Akseer et al., 2017), further affecting their health.

Studies have found that factors associated with adolescent diet quality include socioeconomic status, age, sex, urbanization, maternal education, and employment status (Marshall et al., 2014). Gender differences in consumption of healthy diets between boys and girls have been previously reported. Some studies suggest that female adolescents may have poorer diets (Blum et al., 2019; Kaur et al., 2020). Other studies have found higher fruit and vegetable consumption in girls, and higher sodium, oil, and meat and beans consumption among boys (Acar Tek et al., 2011). A study in South Africa found that factors associated with higher consumption of fast foods by adolescents included male sex (Van Zyl et al., 2010). We found no

TABLE 3 Gender and other factors influencing adolescent diet quality (GDQS), high risk of low diet quality for adolescents aged 10–15 years in Burkina Faso, Ethiopia, Sudan and Tanzania

	Overall GDQS		High diet quality[a]	
	Univariate Estimate (95% CI)	Multivariate Estimate (95% CI)	Univariate RR (95% CI)	Multivariate RR (95% CI)
N				
Sociodemographic				
Country				
Burkina Faso	−4.33 (−4.97, −3.69)	−4.99 (−5.72, −4.25)***	0.26 (0.20, 0.34)***	0.22 (0.15, 0.33)***
Ethiopia	−3.59 (−4.11, −3.07)	−4.25 (−4.98, −3.52)***	0.26 (0.21, 0.31)***	0.28 (0.22, 0.36)***
Sudan	ref	ref	ref	ref
Tanzania	−4.34 (−4.92, −3.75)	−5.21 (−6.11, −4.31)***	0.34 (0.29, 0.39)***	0.28 (0.20, 0.40)***
Sex				
Male	0.32 (0.04, 0.61)	0.22 (−0.18, 0.63)	1.03 (0.92–1.16)	1.00 (0.85, 1.21)
Female	ref	ref	ref	ref
Age of respondent (years)	−0.03 (−0.11, 0.05)	−0.00 (−0.11, 0.10)	0.99 (0.95, 1.04)	1.00 (0.95, 1.05)
Days of physical activity per week				
None	ref	ref	ref	
1–2 days	0.22 (−0.07, 0.52)	0.31 (−0.13, 0.74)	0.98 (0.84, 1.15)	
3–4 days	0.55 (0.20, 0.90)**	0.64 (0.11, 1.17)*	1.05 (0.90, 1.22)	
5–6 days	−0.01 (−0.55, 0.53)	−0.12 (−0.76, 0.53)	0.99 (0.76, 1.27)	
Food security				
No food in house	−0.65 (−1.07, −0.23)**		0.85 (0.69, 1.04)	1.04 (0.72, 1.50)
Skipped a meal	−0.69 (−1.14, −0.25)**	−0.60 (−1.42, 0.22)	0.85 (0.67, 1.08)	
Household				
Parents alive				
Both alive	ref	ref	ref	
Only mother alive	−0.41 (−0.80, −0.02)*	−0.08 (−1.32, 1.16)	0.84 (0.68, 1.04)	
Only father alive	−0.04 (−1.12, 1.19)	2.21 (0.91, 3.52)**	0.52 (0.21, 1.27)	
Maternal education				
None	−0.18 (−0.57, 0.20)	−0.28 (−0.84, 0.29)	1.06 (0.85, 1.31)	
Primary school	ref	ref	ref	
Secondary school	0.20 (−0.10, 0.51)	0.14 (−0.23, 0.50)	1.29 (1.12, 1.50)	
Tertiary education	0.10 (−0.26, 0.47)	−0.03 (−0.54, 0.48)	1.17 (0.95, 1.43)	
Maternal occupation				
Farmer	ref	ref		
Merchant	−0.87 (−2.17, 0.44)	−0.70 (−2.60, 1.20)		
Teacher or govt employed	−0.81 (−2.13, 0.52)	−1.00 (−2.94, 0.94)		
Unemployed	−2.39 (−3.99, −0.79)*	−2.60 (−4.81, −0.39)*		
Stay at home	−0.50 (−1.78, 0.77)	−0.46 (−2.37, 1.45)		
Other	−0.79 (−2.17, 0.59)	−0.48 (−2.42, 1.45)		

TABLE 3 (Continued)

	Overall GDQS		High diet quality[a]	
	Univariate Estimate (95% CI)	Multivariate Estimate (95% CI)	Univariate RR (95% CI)	Multivariate RR (95% CI)
Paternal education				
None			0.77 (0.50, 1.20)	0.66 (0.33, 1.37)
Primary school			ref	ref
Secondary school			1.15 (0.98, 1.34)	1.09 (0.87, 1.37)
Tertiary education			1.38 (1.15, 1.67)**	1.26 (0.96, 1.64)
Paternal occupation				
Farmer	ref	ref	ref	ref
Merchant	0.62 (0.08, 1.15)*	0.33 (−0.40, 1.05)	2.06 (1.17, 3.63)*	1.44 (0.92, 2.27)
Teacher or govt employee	0.87 (0.30, 1.43)**	0.50 (−0.19, 1.19)	2.36 (1.40, 3.99)**	1.34 (0.88, 2.04)
Unemployed	0.52 (−0.33, 1.38)	−0.24 (−1.29, 0.80)	2.40 (1.29, 4.45)*	1.67 (1.03, 2.69)*
Employed by NGO	0.61 (−0.35, 1.56)	0.14 (−1.11, 1.40)	2.61 (1.41, 4.84)**	1.83 (0.81, 4.17)
Other	0.56 (0.02, 1.10)*	0.41 (−0.20, 1.01)	2.11 (1.24, 3.57)*	1.52 (1.01, 2.31)*
Wealth index				
Quintile 1	−0.22 (−0.65, 0.22)	−0.05 (−0.51, 0.41)	0.90 (0.71, 1.14)	1.06 (0.87, 1.29)
Quintile 2	−0.26 (−0.62, 0.11)	−0.22 (−0.63, 0.19)	0.81 (0.67, 0.98)*	0.97 (0.82, 1.15)
Quintile 3	0.11 (−0.24, 0.46)	−0.09 (−0.56, 0.38)	0.97 (0.82, 1.14)	1.05 (0.92, 1.20)
Quintile 4	−0.24 (−0.56, 0.07)	−0.11 (−0.53, 0.31)	0.88 (0.76, 1.03)	1.03 (0.88, 1.20)
Quintile 5	ref	ref	ref	ref
Other adolescent characteristics				
Siblings (number)	−0.01 (−0.06, 0.05)		0.99 (0.96, 1.02)	1.00 (0.97, 1.03)
Commute type				
Walk	ref		ref	ref
Bike	0.15 (−0.35, 0.64)		1.04 (0.87, 1.24)	0.89 (0.56, 1.42)
Bus	−0.48 (−1.15, 0.20)		0.85 (0.60, 1.22)	1.15 (0.76, 1.72)
Ride or taxi	0.17 (−0.35, 0.69)		1.41 (1.14, 1.74)**	1.18 (0.70, 2.00)

Abbreviations: CI, confidence interval; GDQS, Global Diet Quality Score, RR, relative risk.

[a]For models of risk of high diet quality defined as GDQS > 23, binary indicator, Y/N.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

association between sex and overall diet quality, but sex-specific differences in the consumption of key food groups. Adolescent boys were less likely to consume cruciferous vegetables, deep orange tubers, liquid vegetable oils and refined grains. Further, older adolescents consumed fish more frequently and red meat infrequently. These findings contrast with one study that found that while adolescent diets did not change with age in male adolescents, they improved with age in female adolescents (Winpenny et al., 2018). However, in our study, we had younger adolescents (10–15 years).

Adolescent diets in our study may be insufficient to provide sufficient micro- and macronutrients and consumption of unhealthy foods by adolescents was evident. This is not surprising as dietary intake of adolescents in LMICs generally been reported to be suboptimal and transition of adolescent diets is increasing (Fan & Zhang, 2020; Kupka et al., 2020). Dietary transition in this age group is often characterized by increased consumption of energy-dense but micronutrient-poor diets, while levels of physical activity often decline (Kupka et al., 2020). Adolescents are vulnerable to marketing and peer pressure towards consumption of unhealthy foods (Barker et al., 2021), while the snack foods often consumed by adolescents tend to be unhealthy, with high levels of added sugar, salt and saturated fats (Kupka et al., 2020). This often leads to increased rates of overweight and obesity. Previous reports indicated that these risks may be higher among adolescents in urban settings in LMICs (Kupka et al., 2020). At the same time, adolescents may be vulnerable to skipping meals eg breakfast or dieting (Kupka et al., 2020). Therefore, understanding and intervening on adolescent diets are of critical importance.

In our study, adolescents with higher levels of physical activity consumed better-quality diets and having an unemployed mother was associated with lower quality diets. It is feasible that adolescents practicing healthful behaviours including physical activity would also practice healthy eating (Coulson et al., 1997). Alternatively, greater ability to exercise and eat healthier diets among adolescents may be related to economic status and better access to resources for physical activity and quality diets.

BMI or overweight status in adolescents may mediate associations between adolescent diets and poor health outcomes. Associations between the consumption of high-quality adolescent diets and with lower risk of cardiovascular disease (Dahm et al., 2016), blood pressure and higher total cholesterol have been noted (Çağiran Yilmaz et al., 2019). In this study, overweight and obesity prevalence was 9.9% and prevalence was higher in adolescent girls. This is consistent with other reports of higher overweight among girls, and lower than the adolescent overweight and obesity of rate 15% on the African continent (Akseer et al., 2017).

Additionally, our findings of the adolescent underweight of about 13.2% are similar to prevalences of 14% and 10% reported in Sudan and Namibia, respectively (Akseer et al., 2017) or 17% of the adolescent girls in East Africa (Raru et al., 2022). These findings suggest that the triple burden of malnutrition may exist among adolescents on the African continent. Therefore, approaches that address poor-quality diets, as well as consumption of healthy foods concurrently, should be promoted among adolescents on the continent.

A contributing factor to the findings above may be low levels of physical activity. In our study, 44.5% of all adolescents reported no physical activity at all in a week and to up 99% in Sudan and 40% in Ethiopia. A study in Nigeria found that 37% of the adolescents engaged in 60 min of moderate- to vigorous-intensity physical activity daily, with a higher prevalence among boys (Oyeyemi et al., 2016). In South Africa, a study reported that 95% of females decreased informal physical activity during adolescence compared with 93% of all males (Micklesfield et al., 2021). These findings suggest that there is variation in the levels of physical activity for adolescents across countries and sex, with girls less likely to engage in physical activity compared with boys. There may be country-specific sociocultural factors that influence physical activity. Further research must be conducted to understand these factors and how interventions can increase physical activity among adolescents and particularly among girls.

The study has several strengths and weaknesses. The study is one of the first to evaluate the quality of and factors influencing adolescent diets in several African countries. Intervening on the diets of adolescents in early life is an important strategy to impact their diet quality into adulthood, and to foster lifelong healthy eating behaviours. Second, we have included large study sample sizes. The limitations of our study include that we evaluated diet quality for adolescents using a tool validated in an adult population (Bromage, Andersen, et al., 2021; Bromage, Zhang, et al., 2021). Given limited availability of diet quality scores tailored for adolescents' unique dietary needs (Rodriguez et al., 2017), we believe this approach is acceptable. Similar approaches have been taken in previous studies using alternative measures such as the dietary approaches to stop hypertension (Winpenny et al., 2018), Healthy Eating Index-2010 and the alternate Mediterranean diet (Bekelman et al., 2021). These studies have mostly been in the USA and other regions and did not include African adolescents. The GDQS has potential for future use to assess diet quality in this study population.

We used an alternative approach of quantifying GDQS using frequencies as we did not have information on amounts consumed by adolescents. The approach of using frequency of consumption has been previously considered in the GDQS validation study (Bromage, Batis, et al., 2021). Further, the purpose of assessment of adolescent diets in this study is not for providing most accurate diet quality scores, but rather to assess overall quality of adolescent diets and allow ranking of adolescents based on their diets. The use of frequencies of consumption provides sufficient information for this. Further, this approach should not be a source of bias in this current study. We believe that measurement error in the outcome would be nondifferential with regard to the exposure. We believe that adaptations such as these are critical to allow the use of the GDQS in diverse contexts where the availability of dietary information for adolescents is limited. Additional validation studies would be informative in the future to address this issue.

Finally, our study was conducted among school-going adolescents and may have limited generalizability to the general adolescent population in the study countries. However, given that respondents were selected from capital cities of the countries involved in the study, we believe the results are representative of adolescents' dietary behaviours and patterns in urban settings in SSA.

Our findings highlight the need for a more nuanced understanding of the factors influencing adolescent diets and diet quality on the African continent. We found evidence of poor-quality adolescent diets, with limited consumption of healthy foods, including fruits, vegetables, nuts and seeds and animal source foods, and increasing consumption of unhealthy foods such as refined grains. We found differences by sex, with adolescent boys consuming unhealthy foods less frequently but also consuming fewer vegetables. Finally, consumption of key food groups varied by adolescent age. Programs to address poor-quality diets should consider how adolescent diets vary by different country contexts, and sex and age-specific differences can inform intervention design. Further, programs should also focus on increasing the consumption of nutrient-dense foods (vegetables, fruit, nuts and seeds, eggs, fish and poultry) by adolescents and tailor interventions for identified gaps for adolescent girls and boys and adolescents of different ages. Finally, it is important to consider the role of physical activity in these contexts as an important strategy to improve nutrition and health for adolescents, particularly for girls.

AUTHOR CONTRIBUTIONS

Isabel Madzorera conceived the study, conducted the data analysis and drafted the article. Wafaie W. Fawzi was a co-principal investigator for the parent study, conceived the study, contributed to study design, interpreted the data and guided revisions of the manuscript. Deepika Sharma was a co-principal investigator for the parent study, contributed to study design and guided revisions of the draft manuscript. Sabri Bromage, Mary Mwanyika-Sando, Alain Vandormael, Huda Sherfi, Amare Worku, Sachin Shinde, Ramadhani Abdallah Noor and Till Baernighausen interpreted the data and guided revisions of the manuscript. All authors contributed to the editing of the final version of the manuscript.

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DATA AVAILABILITY STATEMENT

Data described in the manuscript, code book, and analytic code will be made available upon request pending application and approval by the study team.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

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