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ORIGINAL RESEARCH ARTICLE

Effectiveness of School-Based Nutrition Education on Adolescent Dietary Diversity in Osun State, Nigeria

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Abstract

Background Adolescents in low and middle-income countries often consume monotonous, starch-based diets, which result in micronutrient deficiencies and poor health outcomes.

Methods A quasi-experimental study involving four schools (two intervention, two control) in Osun State assessed the effect of a short school-based nutrition education program on dietary knowledge and diversity among 120 students. The intervention comprised four one-hour sessions over two weeks using role plays, group discussions, and WHO-adapted materials.

Results The proportion of students with high knowledge in the intervention group increased from 12% to 23%, while high dietary diversity rose from 17% to 22%. Although improvements were observed, these changes were not statistically significant ($p > 0.05$). The short intervention duration and small sample size may have limited measurable effects. Cost and food availability remained major barriers.

Conclusion Short-term, school-based interventions can improve nutrition literacy and intentions but require longer duration and integration with school feeding and household support for measurable dietary impact.

Keywords Dietary diversity, Nutrition education, Nutrition intervention, Public health

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1 Introduction

Adolescence is a transformative stage of human development characterized by rapid physical, emotional, and cognitive changes. During this period, nutritional needs increase substantially to support accelerated growth, hormonal changes, and heightened physical activity.[1] In many low- and middle-income countries, including Nigeria, adolescents face significant dietary challenges that predispose them to malnutrition and diet-related health conditions.[2] Poor dietary patterns, limited access to nutritious foods, and inadequate knowledge about healthy eating contribute to nutritional deficiencies that can impair growth, cognitive performance, and overall well-being.[3]

Dietary diversity, defined as the number of different food groups eaten in a specified time period, is a recognized and widely accepted measure of diet quality. A varied diet is necessary to provide an adequate intake of micronutrients, such as iron, zinc and Vitamins A and C, necessary to support immune function, cognitive development and long-term health status.[4] Numerous studies have documented that most adolescents in Nigeria follow a restrictive type of diet which contains mainly starchy food products (rice, corn/maize, cassava) as their only source of calories, and very few (if any) fruits, vegetables or animal-derived food sources.[2,5] National estimates indicate that only 18% of adolescents meet the minimum dietary diversity, with even lower proportions reported in urban centers such as Lagos, where just 17.2% of adolescents consume adequately varied diets.[5] These dietary inadequacies contribute to widespread micronutrient deficiencies, including anemia, which affects over half of adolescent girls in Nigeria.[6]

The National Bureau of Statistics[7] reported that the average cost of a healthy diet in South-West Nigeria was approximately ₦750 per person per day, which remains unaffordable for many households. Consequently, adolescents from low-income families are at higher risk of poor diet quality and the dual burden of undernutrition and emerging overweight/obesity. Therefore, School-Based Nutrition Education Programs have been proposed as a strategy to improve adolescents' diet, knowledge, attitudes, and practices. Because schools are where most adolescents attend and are at a major developmental point in their lives, Schools represent a significant opportunity to implement nutrition education interventions. Studies conducted in Nigeria have provided data to support the effectiveness of school-based nutrition education programs to improve dietary behaviours. For instance, Adeoya et al.[8] found that a nutrition education intervention in Ibadan improved students' knowledge, food preferences, and related behaviors. Similarly, interventions that highlight the long-term risks of poor diet, such as obesity and related non-communicable diseases, have been shown to motivate healthier food choices among adolescents.[9]

Although these encouraging results may indicate that there is potential for success from school-based interventions, there are many obstacles that inhibit the successful implementation of these programs, including limitations related to available resources, lack of appropriate teaching materials, and socio-cultural food preferences.[5] Additionally, there is very limited evidence regarding how effective these types of programs have been relative to improving the dietary diversity of adolescents from Nigeria's government schools located in low-income communities. Closing this information gap is critical to developing scalable strategies for improving nutrition among Nigerian adolescents.

This study, therefore, evaluates the effectiveness of a structured school-based nutrition education program in improving dietary knowledge and dietary diversity among adolescents in Osun State.

2 Methods

Study Design

This study employed a quasi-experimental design with pre-test and post-test evaluation. Two groups were included: an intervention group that received a structured nutrition education program in schools, and a control group that did not participate in any nutrition education program. The pre-and post-test design enabled assessment of changes in dietary diversity and nutritional knowledge due to the intervention group's nutrition education program.

Study Location

The research was conducted in four government-owned secondary schools located in Osun State, Nigeria. The enrolled schools were Fakunle Comprehensive High School, Ataoja School of Science, Laro Grammar School, and L.A. Adenle Grammar School. Two of the four schools were randomly assigned to the Intervention arm, while the other two schools were designated as the Control group.

Study Population and Eligibility

The study population was adolescents aged 10–19 years enrolled in the selected schools. Inclusion criteria were: (i) persons within the defined age range, (ii) enrolled in one of the selected schools, and (iii) willing to participate with informed consent. Exclusion criteria were: (i) severe medical conditions that could interfere with the diet or nutritional status, and (ii) persons who refused to participate.

Sample Size and Sampling

The sample size was initially estimated using Cochran's

formula[10] for an infinite population, which produced a value of 384 participants. However, because the actual study population of eligible students across the four selected schools was approximately 180, the sample size was adjusted using the finite population correction (FPC) formula:

$$n_f = \frac{n0}{1+(n0-1)/N}$$

Where nf is the adjusted sample size, n0 is the initial sample size (384), and N is the total study population (180). Application of this formula yielded an adjusted sample size of approximately 123.[11] The final sample size of 120 was established to account for possible non-responses and to provide the sample with a balanced representation of all four schools involved in the study. From each of the four schools involved in the study, 30 adolescents, all of whom were randomly selected through systematic random sampling, were included in both the intervention and control groups.

The class registers of each selected school were used to create a sample frame, and all eligible students were eligible to be included in the sampling frame. The systematic random sampling method's sampling interval was calculated by dividing the total number of eligible students in each school by the number of needed sample members from that school. This ensured that there would be no bias regarding representation from either class or gender in each school's sample.

Data Collection Procedures

Data collection occurred in three stages: at baseline Survey (Pre-Intervention), all participants completed a structured questionnaire designed to capture socio-demographic information, nutrition knowledge, dietary practices, and barriers to dietary diversity. Dietary diversity was assessed using the Food and Agriculture Organization (FAO) 12-food group classification system (4) applied to a 24-hour recall, from which a Dietary Diversity Score (DDS) was calculated. DDSs were categorized as low (≤ 4 food groups), moderate (5–8), and high (≥ 9) based on FAO guidelines for adolescent dietary assessment. Each food group consumed contributed one point to the DDS, producing a possible range of 0-12. Inferential tests used the continuous DDS. Both scales showed adequate score variation to justify treatment as continuous variables in parametric analyses. Nutritional knowledge was assessed using a 20-item questionnaire covering five domains: food groups, nutrient functions, balanced diet, healthy food choices, and breakfast practices. Items were scored as correct (1) or incorrect / "don't know" (0). For analysis, items were aggregated into domain scores and averaged to generate a Nutrition Knowledge Index ranging from 0 to 5, with higher scores indicating better knowledge. For descriptive purposes, the index was categorized as low (< 2.5), moderate (2.5-3.9), and high (≥ 4). All inferential analyses used the continuous index.

In the intervention schools, the nutrition education program was implemented during a two-week period. During the two weeks, four interactive sessions, approximately 1 hour long per session, were conducted. In the first week, the students were introduced to healthy eating and the different food groups (session 1) and the health benefits of eating fruit, vegetables, and a balanced diet (session 2). The second week's focus was on the micronutrition of iron and vitamin A, and breakfast habits and recommendations for developing good breakfast habits (session 3), followed by practical ways for improving dietary variety and reducing the risk of poor nutrition (session 4). Teaching methods included group discussions, role plays, quizzes, and games, supported by visual aids such as posters depicting the five food groups, daily meal guides, and food hygiene practices. Nutrition pamphlets adapted from WHO's Implementing Effective Actions for Improving Adolescent Nutrition[12] were distributed to reinforce key lessons. The control schools received no intervention during this period.

At the end of the two-week program, the same questionnaire was re-administered to both groups in order to assess changes in knowledge and dietary diversity. The post-intervention assessment was conducted within one week after completion of the two-week education program, ensuring recall accuracy and minimizing external influences between exposure and outcome measurement.

Data Analysis

Data were analyzed using SPSS (version 30.0). Descriptive statistics (mean, standard deviation, frequency, percentage) summarized socio-demographic data and baseline measures. Paired samples t-tests were used to compare pre- and post-intervention continuous outcomes within groups, while independent t-tests compared between-group means. Chi-square tests were used for categorical variables. The nutritional knowledge and DDSs were categorized for descriptive presentation; all inferential analyses were conducted using the continuous scores. Paired t-tests assessed within-group changes over time, while categorical distributions are presented for interpretative clarity. Primary analyses focused on within-group changes in the intervention arm using paired t-tests to assess pre- and post-differences. Between-group comparisons were not emphasized due to the short intervention duration and limited statistical power. The nutrition knowledge index and DDS showed approximately symmetric distributions on visual inspection of histograms; given sample size and scale properties, parametric tests were considered appropriate. Significance was set at $p < 0.05$.

In compliance with the principles of the Declaration of Helsinki, ethical approval for this study was obtained

from the UNIOSUN Health Research Ethics Committee (UNIOSUNHREC) as well as from the Osun State Ministry of Education. Additional permission was granted by the respective school authorities before data collection. Parents and guardians of the participating adolescents provided written consent, while the adolescents themselves provided assent to participate. The respondents also received an assurance regarding the confidentiality of their responses and that their participation in the study was entirely voluntary. The adolescents could withdraw their consent to participate at any time during the course of the study, without fear of penalties or repercussions.

3 Results

Socio-Demographic Characteristics of Respondents

The socio-demographic profile of respondents in Table 1 shows trends that were representative of secondary school students. The majority of respondents (over half) in the control group (55%) were in the age range of 13-15 years old; a smaller percentage of respondents (38%) in the control group were between 16-18 years old; while only 7% of respondents were in the age range of 10-12 years old. The majority of respondents were male (70%) compared to female (30%). Most respondents (53%) were in their Senior Secondary School 1 (SSS1), and almost all respondents (95%) were living with one or both of their parents or guardians. For parental education, the majority (48%) of respondents reported that their parents had completed secondary school, while the next largest percentage of respondents' parents completed tertiary education (30%), and 12% of respondents reported that their parents had not completed any level of school. More than half of the households (53%) had 4-6 people living in them.

In the intervention group, older adolescents predominated, with 55% aged 16–18 years and 37% aged 13–15 years. Gender distribution was nearly balanced (52% male, 48% female). The majority were in SSS1 (38.3%) and SSS2 (33.3%). A higher proportion of parents had a tertiary education (47%), compared to 33% with secondary education. Most lived with parents or guardians (88%), and household sizes of 4–6 persons were most common (48%). There were no statistically significant differences between the control and intervention groups at baseline with respect to age, gender, parental education, living arrangement, or household size.

Table 1 Selected socio-demographic characteristics of respondents (n = 120, 60 per group)

Variable	Control (n = 60) n (%)	Intervention (n = 60)n (%)	χ^2	df	P-value
Age (years)			4.10	2	0.129
10–12	4 (7)	5 (8)			
13–15	33 (55)	22 (37)			
16–18	23 (38)	33 (55)			
Gender			3.47	1	0.062
Male	42 (70)	31 (52)			
Female	18 (30)	29 (48)			
Parental education			3.92	3	0.271
No formal education	7 (12)	7 (12)			
Primary education	6 (10)	5 (8)			
Secondary education	29 (48)	20 (33)			
Tertiary education	18 (30)	28 (47)			
Living with parents/guardians			1.75	1	0.322
Yes	57 (95)	53 (88)			
No	3 (5)	7 (12)			
Household size (persons)			0.06	3	0.996
1–3	12 (20)	12 (20)			
4–6	29 (48)	28 (47)			
7–9	10 (17)	11 (18)			
≥10	9 (15)	9 (15)			

Values are presented as a number (percentage); χ^2 = Pearson Chi-square test comparing control and intervention groups at baseline.; df = degrees of freedom; Statistical significance was set at $p < 0.05$.

Nutritional Knowledge of Respondents

At baseline, nutritional knowledge was low to moderate in both groups. In the control group, 57% scored low, 37% moderate, and 7% high. The intervention group performed slightly better, with 40% low, 48% moderate, and 12% high.

After the intervention, little change was observed in the control group, where 55% remained low and 38% moderate. In contrast, the intervention group showed visible improvement: the proportion of students with high knowledge doubled to 23%, while those with low knowledge decreased to 28%, as shown in Table 2.

Dietary Diversity among Respondents

At baseline, dietary diversity in the control group was predominantly moderate (68%), with 25% low and 7% high. In the intervention group, 60% were moderate, 23% low, and 17% high. At endline, control group scores were largely unchanged (67% moderate, 25% low, 8% high). In the intervention group, high dietary diversity rose to 22%, but low scores also increased slightly to 28%, while moderate scores dropped to 50%, as shown in Table 3.

Dietary Practices and Barriers to Food Variety

In both groups, the majority ate three meals per day (60% in the control and 72% in the intervention group). Fruit consumption was generally low: half of the control group consumed fruits only 1–2 times weekly, compared to 47% of the intervention group who consumed fruits 3–4 times weekly. Vegetable intake was similarly limited, with fewer than 20% in either group consuming them daily. Water intake was relatively high, with over 80% of both groups drinking water at least four times daily. Food prepared outside the home was consumed frequently, with 63% of the control group and 40% of the intervention group reporting intake at least once weekly. Mothers were the main food preparers in both groups, though self-preparation was more common in the intervention group (37%) compared to the control (18%). Barriers to dietary variety differed between groups. In the control group, cost was the main barrier (55%), while in the intervention group, availability (38%) and lack of interest (32%) predominated, followed by cost (30%). Importantly, willingness to eat healthier foods if taught nutrition in school was higher in the intervention group (80%) compared to the control group (55%).

Tests of Difference for Nutritional Knowledge and DDSs of the Intervention Group before and after Intervention

The nutritional knowledge score showed only a slight numerical improvement following the intervention. At baseline, the mean knowledge score in the intervention group was 4.75 ± 0.40, increasing marginally to 4.80 ± 0.35 at endline. This represented a mean difference of 0.05, which was not statistically significant on a paired samples t-test ($t(59) = 0.82$, $p = 0.41$). Although the proportion of students classified within the high-knowledge category increased, the overall change in the mean score did not reach statistical significance. Similarly, the mean DDS increased slightly from 6.22 ± 2.44 at baseline to 6.64 ± 2.07 at endline (mean difference = 0.42), but this change was not statistically significant ($t(59) = 1.12$, $p = 0.27$). While shifts in category distribution were observed, particularly an increase in high knowledge and high dietary diversity in the intervention group, these improvements did not reach statistical significance.

Table 2 Nutritional knowledge (pre- and post-intervention) (n = 120, 60 per group)

Group	Time	Low n (%)	Moderate n (%)	High n (%)	P-value (baseline/ endline, intervention group)
Control	Baseline	34 (57%)	22 (37%)	4 (7%)	-
Control	Endline	33 (55%)	23 (38%)	4 (7%)	-
Intervention	Baseline	24 (40%)	29 (48%)	7 (12%)	0.410
Intervention	Endline	17 (28%)	29 (48%)	14 (23%)	-

Values are presented as n (%). Categories are descriptive. P-values are based on paired t-tests of continuous knowledge scores comparing baseline and endline within the intervention group.

Table 3 DDSs (baseline and endline) (n = 120, 60 per group)

Group	Time	Low n (%)	Moderate n (%)	High n (%)	P- value (baseline/ endline, intervention group)
Control	Baseline	15 (25%)	41 (68%)	4 (7%)	-
Control	Endline	15 (25%)	40 (66%)	5 (8%)	-
Intervention	Baseline	14 (23%)	36 (60%)	10 (17%)	0.270
Intervention	Endline	17 (28%)	30 (50%)	13 (22%)	-

Values are presented as n (%). P-values are derived from paired t-tests comparing mean continuous DDSs (DDS) at baseline and endline within the intervention group; categorical classifications are descriptive.

4 Discussion

The results highlight both the potential and limitations of short-term school-based nutrition education programs in improving adolescent dietary knowledge and practices. While the differences in the socio-demographics of participants within the intervention and control groups were not statistically significant, the intervention group had an increased prevalence of both older adolescents and parents with post-secondary education. This could indicate that older adolescents have more autonomy over the types of foods they eat, have more exposure to outside influences when it comes to food choices, and therefore may be more likely to accept health promotion initiatives.[13] In addition, the slightly higher percentage of females in the intervention group compared to males could also account for the improved dietary behaviours seen in the intervention group. Research has shown that adolescent girls tend to adopt healthier eating habits than adolescent boys.[14]

Parental education emerged as a key determinant of adolescent nutrition. The higher proportion of tertiary-educated parents in the intervention group may have created a supportive home environment for applying nutrition messages, consistent with evidence linking parental education to adolescent dietary quality.[15] Most respondents lived with parents, reinforcing the importance of parental influence on adolescent health outcomes.[16]

At baseline, the participant distribution across the predefined knowledge categories indicated that a large number of participants fell within the low and moderate knowledge groups, reflecting gaps in adolescent health education reported in Nigeria and elsewhere.[17,18] The intervention improved knowledge, with the proportion of students demonstrating an increase in nutritional understanding doubling, even if the change was not statistically significant. Both Ghana and Nigeria have reported similar trends, where structured nutrition education programs improved adolescent knowledge, but also, the increase was not always statistically significant.[8,19] This suggests that while short-term interventions can raise awareness, sustained reinforcement may be needed to consolidate gains.

Most adolescents' diets in Sub-Saharan Africa are mainly composed of starchy foods, with minimal consumption of nutrient-dense foods, which is reflected in the moderately diverse diet reported in this study. The increased diversity reported in the intervention group indicates an improvement in dietary diversity as a tool for food supplementing micronutrient needs,[20] but the increase in low DDSs (indicating continuing financial and food barriers) demonstrates the need for increased financial resources and additional access to food, as previously outlined in the study of Shapu et al.[21] who highlighted that better education regarding nutrition does not necessarily translate into improved food practices due to the structural limitations of the food environment. The intake levels of both fruit and vegetable consumption were low in both groups relative to WHO recommendations,[22] and the amount of foods consumed by the students that were prepared outside of their homes, particularly with students reporting personal experiences of the healthiness of those foods,[23] creates additional concern regarding the dietary pattern of the students. These findings strongly emphasize that nutrition education must be integrated with the promotion and development of positive food environments.

The lack of statistically significant changes in knowledge and dietary diversity echoes findings from other contexts where brief interventions showed promise but were insufficient to drive measurable outcomes.[24, 25] Longer programs integrated into school curricula, combined with school feeding initiatives and household-level support, may be necessary for sustainable impact.

Changes in knowledge and dietary diversity due to the nutrition education provided to students through school interventions were very modest/non-significant. Possible explanations include the fact that the study's interventions were short-term; students still face structural barriers related to household food insecurity and limited access to affordable, nutrient-dense foods; and also, that while students were more willing to implement healthier eating habits, implementing these behavioral changes will require a sustained, supportive environment in which to do so. Schools can enhance long-term dietary improvements through the integration of nutrition education with the established school feeding programs that ensure fruit and vegetable availability, in addition to providing parents with take-home materials, to encourage the involvement of parents within the school community.

This study is one of the very few quasi-experimental studies conducted within Nigeria to assess the impact of school nutrition education on knowledge and dietary diversity. The use of both the control and intervention groups allowed for a stronger comparative evaluation, but the limited time frame of the intervention greatly reduced any potential influence or effectiveness of the intervention. Additionally, the absence of a formal statistical method for comparing changes between the groups removes the ability to definitively assign cause to any observed improvements solely to the intervention. Conducting the study in one urban area limits how far results could be considered generalisable, and reliance upon self-reported dietary information is likely biased toward false-positive results. Furthermore, many of the structural barriers experienced by participants as a result of low food security or limited food availability

limited the ability of participants to apply their acquired knowledge of how to eat healthfully or improve their diet and, thus, reduce any apparent effect of the nutrition education intervention.

5 Conclusion

This study assessed the socio-demographic characteristics, nutritional knowledge, dietary diversity, and practices of adolescents in Osun State, Nigeria, and evaluated the effect of a school-based nutrition education program. While baseline findings confirmed low knowledge and moderate dietary diversity, the intervention group showed encouraging improvements in knowledge and a modest rise in high dietary diversity. However, statistical tests revealed no significant changes. Dietary practices highlighted persistent barriers, including low fruit and vegetable intake, reliance on food prepared outside the home, and cost and availability as key obstacles to dietary variety. Importantly, a higher proportion of intervention group respondents expressed willingness to adopt healthier diets if taught nutrition in school, suggesting receptiveness to sustained programs. However, the effectiveness of this program to increase nutritional knowledge and interest in eating healthier diets was limited and would require long-term integration into the school curriculum, as well as a system for encouraging food assistance at home and during the school day.

Declarations

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Artificial Intelligence Disclosure
Artificial intelligence tool (Quillbot) was used only to support language editing and paraphrasing during manuscript preparation. All other activities, like conceptualisation, data analysis, interpretation, and manuscript development, were carried out by the authors. We take full responsibility for the content of this article.

Authors' Contributions
All authors contributed to the conception and design of the study, data collection, and manuscript preparation. Each author was also involved in writing and critically revising the manuscript, and all have approved the final version for submission.

Availability of Data and Materials
The datasets generated and analyzed during the current study are not publicly available due to confidentiality agreements with participants, but are available from the corresponding author on reasonable request.

Conflict of Interest
The authors reported there are no competing interests to declare.

Consent for Publication
Not applicable.

Ethical Considerations
In accordance with the Declaration of Helsinki, ethical approval was obtained from the UNIOSUN Health Research Ethics Committee and the Osun State Ministry of Education under the Code of Ethics UNIOSUNHREC/2025/HND/026. Permission was also granted by participating schools. Written parental consent and adolescent assent were obtained. Participation was voluntary, confidentiality was assured, and participants could withdraw at any time without penalty.

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References

1. Uktamovna RZ. The transformative journey of adolescence: a study of the physical, cognitive, emotional, and social changes during the teenage years. Span J Innov Integr. 2025;39:169–172.
2. Olatona FA, Ogide PI, Abikoye ET, Ilesanmi OT, Nnoaham KE. Dietary diversity and nutritional status of adolescents in Lagos, Nigeria. J Family Med Prim Care. 2023;12(3):1547–1554. doi:10.4103/jfmpc.jfmpc_1783_22
3. Roberts M, Tolar-Peterson T, Reynolds A, Wall C, Reeder N, Rico Mendez G. The effects of nutritional interventions on the cognitive development of preschool-age children: a systematic review. Nutrients. 2022;14(3):532. doi:10.3390/nu14030532
4. Food and Agriculture Organization of the United Nations. Minimum dietary diversity for women: a guide for measurement. Rome: FAO; 2021.
5. Gabriel TS, Kasim M, Oluma FA, Muka T, Llanaj E. Adolescent nutrition in Nigeria: a systematic review. J Nutr Sci. 2024;13:e38. doi:10.1017/jns.2024.34
6. United Nations International Children's Emergency Fund. 7.3 million adolescent girls and women of reproductive age in Nigeria are undernourished. Abuja: UNICEF; 2023.
7. National Bureau of Statistics. Cost of a healthy diet in Nigeria: November 2023. Abuja: NBS; 2023.
8. Adeoya AA, Akinwusi AT, Nagatomi R. Effectiveness of nutrition education in enhancing knowledge and attitude of pupils on choice of school mid-day meal in Ibadan, Nigeria. Food Sci Nutr. 2023;11(7):3758–3766. doi:10.1002/fsn3.3359

9. Arilewola AO, Omotola A, Adeyemi T, Okafor J. Effect of health educational intervention on knowledge and perceptions of health consequences of obesity among secondary school students. Int J Health Educ Behav. 2020;29:139–146. doi:10.21522/TIJPH.2013.08.02.Art014

10. Cochran WG. Sampling techniques. 3rd ed. New York: John Wiley & Sons; 1977.

11. Israel GD. Determining sample size. Gainesville (FL): University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences; 1992.

12. World Health Organization. Implementing effective actions for improving adolescent nutrition. Geneva: WHO; 2018.

13. Xu T, Tomokawa S, Gregorio ER Jr, Mannava P, Nagai M, Sobel H. School-based interventions to promote adolescent health: a systematic review in low- and middle-income countries of WHO Western Pacific Region. PLoS One. 2020;15(3):e0230046. doi:10.1371/journal.pone.0230046

14. Reicks M, Davey C, Anderson AK, Banna J, Cluskey M, Gunther C, et al. Frequency of eating alone is associated with adolescent dietary intake, perceived food-related parenting practices, and weight status: cross-sectional Family Life, Activity, Sun, Health, and Eating (FLASHE) study results. Public Health Nutr. 2019;22(8):1555–1566. doi:10.1017/S1368980019000107

15. Egg S, Wakolbinger M, Reisser A, Schätzer M, Wild B, Rust P. Relationship between nutrition knowledge, education and other determinants of food intake and lifestyle habits among adolescents from urban and rural secondary schools in Tyrol, Western Austria. Public Health Nutr. 2020;23(17):3136–3147. doi:10.1017/S1368980020000488

16. Runo WS, Kiara K, Mandela R. Influence of nutrition knowledge on healthy food choices among pupils in Nyeri County, Kenya. Int J Res Sci Innov. 2020;7:1–9.

17. Olumakaiye MF, Nzeagwu OC, Otitoola OC, Ariyo O, Abe J, Popoola BR, et al. Regional and socio-demographic predictors of dietary proficiency of adolescent girls in Nigeria. North Afr J Food Nutr Res. 2024;8:195–206. doi:10.51745/najfnr.8.18.195-206

18. Antwi J, Ohemeng A, Boateng L, Quaidoo E, Bannerman B. Primary school-based nutrition education intervention on nutrition knowledge, attitude, and practices among school-age children in Ghana. Glob Health Promot. 2020;27(1):114–122. doi:10.1177/1757975920945241

19. Abizari AR, Ali Z. Dietary patterns and associated factors of schooling Ghanaian adolescents. J Health Popul Nutr. 2019;38:5. doi:10.1186/s41043-019-0162-8

20. Wiafe MA, Apprey C, Annan RA. Dietary diversity and nutritional status of adolescents in rural Ghana. Nutr Metab Insights. 2023;16:11786388231158487. doi:10.1177/11786388231158487

21. Shapu RC, Ismail S, Lim PY, Ahmad N, Garba H, Njodi IA. Effectiveness of triple benefit health education intervention on knowledge, attitude, and food security towards malnutrition among adolescent girls in Borno State, Nigeria. Foods. 2022;11(1):130. doi:10.3390/foods11010130

22. Kalmpourtzidou A, Eilander A, Talsma EF. Global vegetable intake and supply compared to recommendations: a systematic review. Nutrients. 2020;12(6):1558. doi:10.3390/nu12061558

23. Daba DB, Shaweno T, Belete KT, Workicho A. Magnitude of undernutrition and associated factors among adolescent street children in Jimma Town, South West Ethiopia. Nutr Diet Suppl. 2020;12:31–39. doi:10.2147/NDS.S233393

24. Adom T, De Villiers A, Puoane T, Kengne AP. School-based interventions targeting nutrition and physical activity, and body weight status of African children: a systematic review. Nutrients. 2019;12(1):95. doi:10.3390/nu12010095

25. Wrottesley SV, Pedro TM, Fall CH, Norris SA. A review of adolescent nutrition in South Africa: transforming adolescent lives through nutrition initiative. S Afr J Clin Nutr. 2019;33(3):94–132. doi:10.1080/16070658.2019.1607481