Accepted manuscript

VEGETABLE CONSUMPTION AND PROMOTION AMONG SCHOOL-AGE CHILDREN AND ADOLESCENTS IN WEST AFRICA: A SYSTEMATIC REVIEW AND NARRATIVE SYNTHESIS

Kosisochukwu C. Igbokwe[1], Shirley I. Ejoh[1], Gideon O. Iheme[2,3]

[1]Department of Human Nutrition and Dietetics, University of Ibadan, Ibadan Nigeria.

[2]Department of Food Studies, Nutrition and Dietetics, Uppsala University, 753 10 Uppsala, Sweden

[3]Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike Nigeria.

Corresponding author: Shirley Isibhakhomen Ejoh shirleyejoh@gmail.com; +2348056014140

Running Title: Children's vegetable intake in West-Africa

This peer-reviewed article has been accepted for publication but not yet copyedited or typeset, and so may be subject to change during the production process. The article is considered published and may be cited using its DOI

10.1017/S0007114524003301

The British Journal of Nutrition is published by Cambridge University Press on behalf of The Nutrition Society

Abstract

Low vegetable consumption among school-age children and adolescents put them at risk of micronutrient malnutrition and non-communicable diseases. There is a dearth of synthesized literature on vegetable intake and interventions to promote increased consumption among this age-group in West-Africa. This study pooled evidence on vegetable consumption and interventions to promote vegetable consumption among school- age children and adolescents (6-19 years) in West-Africa. Quantitative and qualitative studies from year 2002 to 2023 were electronically searched in PubMed, African Journals Online (AJOL), and Google Scholar databases. PRISMA system was adhered to in reporting this review **(**PROSPERO ID: CRD42023444444). Joanna Briggs Institute (JBI) critical evaluation tool was used to appraise quality of studies. Forty (40) studies met the search criteria out of N= 5,080 non-duplicated records. Meta-analysis was not possible due to high heterogeneity. Low vegetable consumption expressed in frequency or amounts was recorded among the school-age children and adolescents in the reviewed studies.

Intervention studies were mostly among adolescents; the most common type of intervention was the use of nutrition education. Insufficient evidence and high heterogeneity of studies reflect the need for more high-quality interventions using globally identified standards but applied contextually. School-age children appear to be an under-served population in West-Africa with regards to nutrition interventions to promote vegetable consumption.

There is a need for multi-component intervention studies that encourage vegetable consumption as a food group. Gardening, parental involvement, gamification and goal setting are promising components that could improve availability, accessibility and consumption of vegetables.

Keywords: Vegetable intake, nutrition interventions, malnutrition, micronutrient, food systems**.**

List of Abbreviations

CVDs	Cardiovascular Diseases; FVFruits and Vegetables
FAO	Food and Agriculture Organization
FFQ	Food Frequency Questionnaire
GSHS	The Global School-based Student Health Survey
JBI	Joanna Briggs Institute
LMICs	Low- and middle-income countries
NCDs	Non-Communicable Diseases
NHANES	National Health and Nutrition Examination
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
RDA	Recommended Daily Allowance
SAC	School-age Children
UNICEF	The United Nations Children's Fund
UNSCN	United Nations Systems Standing Committee on Nutrition
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

2.0 Introduction

School-age represents an important developmental stage of life and the second window of opportunity to consolidate the health and nutrition gains made after early childhood for growth, psychosocial development, and establishing lifelong dietary and lifestyle habits and preparation for pubertal life (adolescence) [1]. Good nutrition during this phase is essential to ensuring their optimal growth and development as well as improving short and long-term health outcomes. Children's nutrition is particularly important, not only because many eating habits that are formed in childhood will persist into adulthood but also because nutrition plays a role in preventing chronic diseases [2]. In order to maximize long-term health outcomes, it is also crucial to support children in developing good eating habits, as this is pivotal to support the adoption of healthy eating behaviors at this stage [3]. There is an increasing awareness that children's eating behaviours are influenced by environmental factors: home environment and parental influence, as well as the school environment are recognized as major contributors to the eating habits of children [4,5].

Due to the dynamic nature of their growth and development, school-age children and adolescents have an increased need for nutrients [6]. This should include nutrients needed to support physical and cognitive growth and development; offer sufficient energy reserves for illnesses and pregnancy and avoid the adult onset of nutrition-related diseases [7].

Several population groups particularly school-age children and adolescents appear to be excluded in most global and regional data related to nutrition, with only under-5 children, women of reproductive and adults prominently captured [8]. This gap results in limited insights into the food consumption habits of these overlooked age groups, despite the existence of various national interventions aimed at addressing their nutritional needs [9].

Low fruit and vegetable (FV) consumption increase the risk of micronutrient deficiencies and non-communicable illnesses, which are known to be major causes of death globally [10, 11]. For example, childhood overweight and obesity are associated with low consumption of certain nutrient-rich foods and excessive consumption of nutrient-poor, high-calorie foods [12]. The number of children and adolescents who are overweight or obese has more than doubled over the past 50 years [13, 14]. Thus, school-age children and adolescents' diets low in FVs may deprive

them of micronutrients essential for growth, development, and bodily functions, which increase their risk of developing non-communicable diseases (NCDs) later in life [15]. Hence promoting increased consumption of FV among school-age children and adolescents is of public health importance.

Western Africa is one of the youngest populations in the world with more than a tenth of its population estimated to be below 15 years of age [16]. In this region like other low-and middle-income countries (LMICs), many school-age children do not meet dietary recommendations for FV [17-20]. Sub-Saharan Africa has been found to be the region with one of the highest levels of micronutrient deficiencies in under-five children and women comparable only to South Asia [21]. Although, intake levels of fruit and vegetables for all age groups in Africa except North Africa are well below the recommended standards [22], Western Sub-Saharan Africa has the highest age-standardized prevalence rates of dietary iron deficiency than other regions in Africa, which fruits and vegetables are the primary plant-based sources [21]. These global and regional evidence are also supported by studies within different location in the Western African region where insufficient amounts of fruits and vegetables were reported [17, 23, 24]. It is probable that most of the poor/ low intake may be more for vegetables, as studies have shown that children's preferences for vegetables in particular are consistently lower than for fruits [25].

The period of school-age and adolescence are critical stages where attitudes, knowledge and skills acquired can influence their behavior in adulthood [26]. This then offers a window of opportunity for interventions to build their capacity to acquire healthy eating habits, and improve their vegetable intake, to prevent micronutrient malnutrition and the onset of diet-related chronic diseases in later life, associated with poor and unhealthy dietary patterns and practices earlier life. Hence there is need to take a critical look at the vegetable intake of the target population and also intervention studies to promote their consumption. However, when compared to other lifecycle stages, limited research and intervention studies have focused on the health and nutrition of school-age children [27]. For adolescents, there is a lot of focus on their reproductive health. There are very few interventions to address the poor intake of vegetables and fruits among school-age children-age and adolescents. To the best of the authors' knowledge, a comprehensive review of the literature specifically studying the vegetable intake and interventions to promote health-related behavior to improve vegetable intake among school-age

children and adolescents to support these assumptions in the West Africa sub-region where regional evidence suggests priority attention is needed, has not been undertaken.

Therefore, the purpose of this study was to perform a comprehensive systematic review and provide an up-to-date summary to answer the following questions: (1) What is the vegetable intake and consumption pattern of school-age children and adolescents in West Africa, including the methodologies/assessment tools employed? (2) What are the common interventions that have been used to promote health-related behaviour to improve vegetable intake among school-age children and adolescents in West Africa? (3) What are the barriers and facilitators to vegetable consumption and promotion among school-age children and adolescents in West Africa? It is hoped that the results from this review may be used to guide future research and inform intervention studies for promoting increased vegetable consumption among school-age children and adolescents.

3.0 Methods

A systematic review of literature of qualitative and quantitative studies was conducted according to a pre-specified protocol that was registered with the International Prospective Register of Systematic Reviews (PROSPERO record with the ID CRD42023444444). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) system was adhered to in the reporting of this review.

Search Strategy

The search took place between 16th December, 2022 and 28th March, 2023. For primary research publications published between the years of 2002 and 2022, three databases were used: PubMed, African Journals Online (AJOL), and Google Scholar. We did not conduct a search of the grey literature since we preferred to include only works that had been peer-reviewed, published and available online. The following keyword combinations were used in each of the various databases advanced search features: (Vegetable OR micronutrient) AND (Intake OR consumption OR diet OR dietary OR eating OR nutrition) AND (Primary school children OR Adolescent OR school-age children OR secondary school student OR teen OR pupil) AND (Nigeria OR Benin OR Burkina Faso OR Cabo Verde OR Cote d'Ivoire (Ivory Coast) OR

Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Liberia OR Mali OR Mauritania OR Niger OR Senegal OR Sierra Leone OR Togo).

Inclusion and Exclusion Criteria

Studies were considered eligible for inclusion if they met the following criteria:

Population: School-age children and adolescents in the West African region between the ages of 6 and 19 years were included. Studies published in English were included.

Outcomes: Studies were included if they reported vegetable consumption, promotion of vegetables, or the role of micronutrients from vegetables.

Study design: Experimental (Intervention studies) and observational (cross-sectional, cohort, and case control) were eligible.

Systematic reviews, unpublished theses, case studies, conference abstracts, special population studies (participants characterized with an illness or a problem), population studies involving children under 6 and those involving adults aged 19 and older, and studies with low risk of bias or written in another language other than English were all excluded. Studies whose conclusions did not take into account vegetable intake, promotion of vegetables, or the role of micronutrients were excluded.

Study Selection

The article titles were screened to find publications that were pertinent. The paper's alignment with the necessary inclusion and exclusion criteria was then verified by reading the abstract of pertinent articles by two of the researchers. The articles whose abstracts either satisfied these requirements or fell short of effectively describing the specifics were then downloaded and reviewed in their entirety.

Data Collection/Extraction

Utilizing tables, the data were individually retrieved, and recorded using Microsoft Excel by two of the researchers. Missing information was noted as unavailable. The following information was included in the data that was extracted: title, author(s), country, city or location, sample population, methodology (sample size, study design, sampling techniques, variables, and study

instruments), data analysis, important findings, and conclusion. All discrepancies were discussed and resolved by all three researchers.

Quality Assessment/Appraisal

The risk of bias assessment for the included studies were independently conducted by two of the researchers. The Joanna Briggs Institute (JBI) critical evaluation tools that were appropriate for this review's eligible study designs were applied to each included document to help determine whether to include, exclude, or request more information on a particular study [28]. The JBI checklist, which consists of 8 questions, was used to assess the methodological quality of research by identifying the amount of potential biases in the design, conduct, analysis, and write-up based on the range of our eligible designs. The eight questions focus on: *(1) study based on random/pseudo random sample, (2) clear definition of study inclusion criteria, (3) description of study subjects and settings, (4) outcomes/exposures measured in a valid and reliable way, (5) identification of co-founding factors and strategies, (6) sufficient descriptions for comparison groups, (7) follow-up done for a sufficient time period, and (8) appropriate statistical analysis* [28]. There are four possible responses to each question: "yes," "no," "unclear," and "NA" (non-applicable). Owing to the varying design of the studies reviewed, the researchers focused on identifying criteria common across all of them. These studies were rated positive for inclusion when at least 50% of each of the five common criteria - 1, 2, 3, 4, and 8 were met, however, fulfilling all the criteria would result in a total score of 8 (1 point per criterion). The risk of bias was categorized into three levels; low quality (0–2), medium quality (3-5), and high quality (6–8).

Similar to the screening, the methodological quality of the eligible studies was evaluated, all disagreements were resolved by consensus of the researchers or consultation of a third reviewer.

Data Analysis and Synthesis

Data were deductively grouped and analysed according to the relevant research questions: i) vegetable intake and consumption pattern of school-age children and adolescents in West Africa (outcome variables, measurement tools, study outcome/frequency of vegetable consumption), ii) Interventions that have been used to promote vegetable intake among school-age children and adolescents iii) Barriers and facilitators of vegetable consumption.

4.0 Results

A total of 11,380 possibly relevant articles were found in three (3) databases after the literature search (**Figure 1**). 5080 articles remained after duplicate records were removed. 4970 records were eliminated after those articles' eligibility was checked for the title and abstract. The remaining 110 documents were evaluated and scrutinized in their entirety. Full text screening resulted in the exclusion of seventy articles. Thus, 40 articles in all were finally included in this review.

Description of Study Characteristics

In total, 24,391 SAC and adolescents recruited mostly from schools from 5 different countries were included in this review. Most of the studies were mainly reported from the population of Nigeria (n = 26). Sample size ranged from 18 to 2786 participants with more than 75% (30 out of 40) of the included studies recruiting between 101-1000 participants. Outcomes of each study varied, but the majority primarily focused on the frequency of vegetable consumption. An overview of the included studies is presented in **Table 1,** while the summary of study characteristics is presented in **Table 2**.

Quality Assessment of Included Studies

The quality assessment/appraisal using JBI critical appraisal check list for descriptive/case studies as presented in **Figure 2** showed that 80% of the reviewed studies were based on random/pseudo random sample and had clear definition of study inclusion criteria respectively. All studies had a clear description of the study subjects and setting, 90% had their outcomes measured in a valid and reliable way while 12.5% identified other confounding factors and strategies. For the reviewed qualitative studies, 10% gave sufficient description for comparison of groups while follow-up done for a sufficient time period was 7.5%. Almost all (95%) of the studies were analysed appropriately. In general, six (15%) were assessed as high quality, thirty-four records (85%) as medium quality and none for low quality, indicative of reliable evidence and low risk of bias. Detailed quality appraisal of each study is reported in supplementary material **Table 1.**

Dietary Assessment Methodologies

Assessment tools in the included studies primarily consisted of food frequency questionnaire (n=14). The number of items in the FFQs included 4 item FFQ [37], 54 item FFQ [34, 43], 12 item FFQ [45], 11 item FFQ [49], 81 item FFQ [57], 6 item FFQ [61], 100 item FFQ [64]. In addition, a 24-hr dietary recall was used in twelve of the studies. In six studies, fruit and vegetable consumption data were merged together [42, 47, 48, 56, 61, 66]. Three of the studies used the Global School-based Student Health Survey (GSHS) questionnaire [58, 61-62] and eight used validated and acceptable questionnaire/tool for national surveys [38, 41, 45, 48, 51, 55-56, 67]. One of these studies [45] used an online questionnaire (KoBo Collect) to collect data. Questionnaire piloting was reported in nineteen of the studies. In comparison, six studies did not report the type of dietary assessment measured (quantity, frequency, etc.). The WHO recommended five servings of fruits and vegetables was used as the adequacy cutoff point in two of the studies [42, 43] reporting the percentage of SAC and adolescents meeting recommendation. Nonetheless, other cutoff points were used in few studies. One of the studies [54] defined inadequacy as intake of <1 slice of fruit or <1 portion of raw or cooked vegetable per day. Another study [36] established their cutoff mark as two servings of FV, while another [55] used the WHO recommendation of 25g of fibre.

Dietary Outcome (Vegetable Consumption Pattern)

Vegetable consumption data was presented in means, percentage of students consuming regularly or irregularly and those meeting the recommendations, and frequencies. Mean consumption was recorded among four countries. A study by Giguère-Johnson *et al.,* [55] conducted in Senegal reported mean vegetable consumption as 32 $\pm$ 44g/day while a study conducted in Benin [56] reported a mean consumption of 97g/day. In Burkina-Faso [62] vegetable consumption was reported to be 2.3 times/week and 1.68 servings/week as observed by Owusu *et al.,* [57] in Ghana.

Interventions that Promote Vegetable Intake

Five of the reviewed studies [40, 45, 52, 65, 68] evaluated interventions that promote vegetable intake among school-age children and adolescents as shown in **Table 3**. These include school garden and complementary education, nutrition education, gamification, school-based fruit stall, health education. Two of the reviewed studies [29, 50] found an increase in vegetable consumption and dietary habits among the respondents due to their parents owning a home garden.

Barriers/Facilitators of Vegetable Consumption

Three of the reviewed studies implemented in a school environment assessed the barriers/facilitators influencing vegetable consumption while one study looked at the behavioural determinants of healthy food consumption (fruit and vegetable). Three studies reported on facilitators only and two of them were studies from Nigeria [32, 41], and the third one from Burkina-Faso [62]. One study from Nigeria [42], reported both facilitators and barriers. The general observation from the reviewed studies was that vegetable consumption was facilitated by availability and accessibility at home and in school, consumption by parents, siblings and peers and its health benefits. Specific comments captured were: "*it being served at home, siblings like vegetable, like the taste of vegetables, and like for home-made stew"*.

"her mum loves taking fruits and she joins her; that's how she developed the habit of taking fruits and vegetables". Barriers to vegetable consumption reported were: preparation time, lack of taste and attractiveness as well not making one feel full after consuming it.

5.0 Discussion

In this review, studies on vegetable promotion and consumption among school-age children and adolescents in West Africa were comprehensively examined. The review included 40 studies in total, and these publications included information on the frequency of vegetables consumed by country as well as interventions that support increasing vegetable consumption among different age groups. Due to high heterogeneity of the reported studies consulted, a meta-analysis was not possible. The results of this systematic review reveal that most studies lumped intake of fruits and vegetables together; and within the vegetable group, the types were not disaggregated either. This has implications on providing accurate results on the adequacy or lack thereof of vegetable consumption among the age-group studied.

Vegetable intake/ consumption pattern of school-age children and adolescents

The observed disparities in data assessment tools and techniques for vegetable consumption in different studies has been previously mentioned by several authors and expert groups [69, 70, 71]. These reports posited that unavailability of harmonized dietary assessment indicators pose a critical gap for comparability of findings and pooling of evidence to compensate for this missing global evidence for the target population in question. The varied FFQ items ranging from 4 to

100 further strengthens the case for more standardization/harmonization of fruit and vegetable dietary indicators. However, this is more challenging as other studies have affirmed that reproducibility of FFQ varies between the FFQ items and age groups, and lower reproducibility is often found among children and adolescents than adults and elderly [72].

The low consumption of vegetables (at least one portion/day), which ranged from 0.04% - 26.8% is not surprising, as it corroborates with evidence that Western Africa is far from meeting their recommended five portions (400g) of fruits and vegetables per day [20, 73]. Similarly, another study also reported that adolescents in 49 low-income countries did not consume as much fruits and vegetables as recommended [74]. The inadequacy of vegetable consumption suggests that West African countries are at a higher risk of non-communicable diseases, and increased prevalence of micronutrient malnutrition.

Interventions that Promote Vegetable Intake

Nutrition and health education interventions delivered in various forms particularly with visual aids were the dominant vegetable intake interventions given to the school-age children and adolescents. Interventions that had additional hands-on/ practical components like gardening and gamification were less prominent. This corroborates the report from a systematic review on school-based health and nutrition interventions addressing double burden of malnutrition and educational outcomes of adolescents in low- and middle-income countries [75]. The study reported a higher prevalence of nutrition education alone compared to having nutrition education along with other hands-on/ practical intervention components that will actually facilitate positive dietary outcomes.

Although traditional nutrition education methods reportedly show good promise in these studies, there are still concerns regarding the extent to which this method achieves impactful outcome among the age group in question if not combined with other practical components/ activities [76]. Authors suggest that the design of nutrition and health education for young people should incorporate hands-on practical components within the environment [77]. School feeding is the largest social safety net for young people, with increasing institutional and political commitment in west Africa targeted for young people, while home gardening on the other hand is being advocated as a sustainable approach to improve food security in low income settings [8]. Thus, integrating additional components like practical gardening sessions will not only promote

behavioural change but also increase availability, accessibility and offer some additional fresh fruit and vegetables for consumption in a sustainable way.

Virtually all nutrition focused game interventions in literature were directed to children and adolescents, as they are important stakeholders of the game industry [25, 78]. Integrating nutrition and health education into this youth dominated industry is an innovation that will likely garner the interest of the consumers [79]. Several nutrition incentive-based behaviour change interventions in literature were structured as a reward for positive behaviours [80, 81]. It will be interesting to see how much evidence evolves to support the translation of points in nutrition education games into values usable in real life to influence behaviour changes as reported in our studies.

Barriers and Facilitators of Vegetable Consumption

Family (parental intake) and home environment (accessibility and availability) were the dominant factors influencing vegetable consumption among school-age children and adolescents. This corresponds with reports from a systematic review on determinants of fruit and vegetable consumption among children and adolescents [82, 83]. Another study reported that parental participation, when combined with digital interventions, improved teenagers' dietary and physical activity behaviors [84]. Evaluation of the factors that affect children and adolescents' intake of fruits and vegetables in various parts of the world has shown that parental intake and home accessibility and availability were consistently positively associated with intake [85, 86]. A study among Tehrani teenagers revealed that motivation was significantly influenced by verbal encouragement, supervision, and instructions from parents, family, relatives, and friends [87].

Limitation of the Study

There are limitations to this systematic review. First, it is difficult to compare results since different research employed different methods to measure vegetable consumption (e.g., some used a 24-hour dietary recall, while others used an FFQ). Selection of appropriate risk of bias tool was challenging as studies on vegetable consumption employed distinct research design. Furthermore, the reference period and response categories varied even among articles that used the same technique. Second, data heterogeneity was noted, which made comparing research challenging. Furthermore, the consumption indicators used in the various papers differed (some studies gave means, others percentages, and yet others frequencies). In cases where fruits and

vegetables were lumped together, it was difficult to ascertain the consumption of vegetables and also in those studies that assessed vegetable consumption, most of them grouped the various types of vegetable together while few studies disaggregated them. Finally, not all countries in the West African sub-region had published record for studies on vegetable consumption among these age-groups. Hence our review is limited to the results of the studies from the countries where we found published studies.

Conclusion

This review indicates an inadequate intake of vegetables among school-age children and adolescents in countries located in West Africa. Inadequate vegetable intake may contribute to poor health outcomes especially micronutrient inadequacies, and other nutritional problems associated with low intake of vegetables. Therefore, it is crucial to discover the most effective programmes that can early on influence children and adolescents' healthy eating habits and in particular their vegetable intake. The interventions found in the articles reviewed include the use of nutrition education, gamification, school-based fruit stall and school gardens and complementary nutrition education. These interventions seemed to influence vegetable consumption and nutrition knowledge of the school-age children and adolescents. More empirical multi-component and innovative studies to improve vegetable consumption as a food group are urgently needed in the West Africa sub-region. Such studies should include food system factors that will make vegetables more available, accessible and desirable for children and adolescents. For example, parental participation (related to home food environment), vegetable gardening (production at home and/or school), food demonstrations (cooking/recipe development) and school meals, all linked to interactive nutrition education lessons among others are important factors to consider in such studies. Gamification of nutrition education as a means to promote better dietary habits among this age-group seems to also be a promising strategy to explore as well.

It is also important that the types of vegetables studied should be disaggregated; furthermore, to identify the types of vegetables (leafy and non-leafy) that is commonly and less commonly consumed among the target group. Studies that focus on quantification of different types of vegetables consumed are also needed. In countries where studies have been carried out, it is encouraged that they are published so that the progress made in regions/countries are updated.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Declaration of interests: The authors have no conflict of interest to declare. This study was conducted according to a pre-specified protocol that was registered with the International Prospective Register of Systematic Reviews (PROSPERO record with the ID CRD42023444444)

Availability of data and material: The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Author's Contribution: K.C.I, S.I.E and G.O.I were responsible for the formulation of research concept and design. K.C.I performed the literature searches; K.C.I and G.O.I performed the selection of studies, data extraction and risk of bias assessment. K.C.I drafted the manuscript while S.I.E and G.O.I critically reviewed the manuscript. S.I.E performed final corrections, proofreading and editing of the manuscript. All authors reviewed and approved the final manuscript.

References

1. United Nations Systems Standing Committee on Nutrition (UNSCN, 2017). Schools as a System to Improve Nutrition A new statement for school-based food and nutrition interventions. Discussion Paper, September, 2017. https://www.unscn.org/uploads/web/news/document/School-Paper-EN-WEB.pdf (Accessed October, 2024)
2. Schwarzenberg SJ & Georgieff MK (2018) Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health. *Pediatrics*, **141**: e20173716.
3. Berti C &Agostoni C (2017) Programming long-term health: Establishing healthy eating patterns in early infancy. Early Nutrition and Long-Term Health, 427 – 470. Woodhead Publishing ISBN 9780081001684.

4. Scaglioni S, De Cosmi V, Ciappolino V *et al.* (2018) Factors influencing children's eating behaviours. *Nutrients*, **10**(6), 706.
5. Ishdorj A, Jensen H & Crepinsek M (2013) Children's consumption of fruits and vegetable: Do School Environment and Policies Affect Choice at School and Away from School? *Applied Economic Perspective and Policy*, **35** (2): 341 – 359.
6. Ochola S & Masibo PK (2014) Dietary intake of school children and adolescents in developing countries. *Annals of Nutrition and Metabolism*, **64** (Suppl. 2): 24–40.
7. Erkan TÃ (2011) Adolescent nutrition. *Turkish Pediatrics Archive/Turk PediatriArsivi*, ***46***(June), 49–53.
8. Iheme GO (2021). The Under-nutrition Situation of School Age Children In Nigeria; A Systematic Review. Current Nutrition and Food Science 17 (8): 826-832. http://dx.doi.org/10.2174/1573401317666210216114311
9. World Food Programme (2022). State of School Feeding Worldwide 2022. Rome, World Food Programme
10. Yip C, Chan W & Fielding R(2019) The associations of fruit and vegetable intakes with burden of diseases: a systematic review of meta-analyses. *Journal of the Academy of Nutrition and Dietetics*, **119**(3): 464–481
11. Afshin A, Sur PJ, Fay KA *et al*.(2019) Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*, **393**(10184): 1958–1972.
12. Harika R, Faber M, Samuel F *et al*. (2017) Are low intakes and deficiencies in iron, vitamin A, zinc, and iodine of public health concern in Ethiopian, Kenyan, Nigerian, and South African children and adolescents? *Food and Nutrition Bulletin*, ***38***(3): 405-427.
13. World Health Organization (2020). "Obesity and Overweight." WHO. 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
14. Micha R, Venkatesh M, Ashkan A *et al*.(2020) "2020 Global Nutrition Report: Action on Equity to End Malnutrition."
15. Lopes PH, Donne KA, George KK *et al*. (2018) "Fruit and Vegetable, Sugar-Sweetened Beverage Consumption among Kindergartners in Accra Metropolitan Area, Ghana: A Cross-Sectional Study." *European Journal of Preventive Medicine*, **6**(4): 53–57.

16. World Bank (2024). Western & Central Africa. World Bank. https://www.worldbank.org/en/region/afr/western-and-central-africa
17. Hall J, Moore S, Harper S *et al*. (2009) Global variability in fruit and vegetable consumption. *American Journal of Medicine,* **36**(5): 402–409.
18. World Health Organization (2005). "Fruit and Vegetables for Health: Report of a Joint FAO/WHO Workshop, 1–3 September 2004, Kobe, Japan."
19. Spence AC, Karen JC, Sandrine L*et al*. (2018) "Early Childhood Vegetable, Fruit, and Discretionary Food Intakes Do Not Meet Dietary Guidelines, but Do Show Socioeconomic Differences and Tracking over Time." *Journal of the Academy of Nutrition and Dietetics*, **118**(9):1634-1643.
20. Padget A & Briley ME (2005) "Dietary Intakes at Child-Care Centers in Central Texas Fail to Meet Food Guide Pyramid Recommendations." *Journal of the American Dietetic Association,* **105**(5): 790–93.
21. Han X, Ding S, Lu J.*et al*. (2022) Global, regional, and national burdens of common micronutrient deficiencies from 1990 to 2019: A secondary trend analysis based on the Global Burden of Disease 2019 study. E Clinical Medicine, 44, 101299. https://doi.org/10.1016/j.eclinm.2022.101299
22. Dijkxhoorn Y, De B, Piters S.*et al*. (2021) Enhancing fruit and vegetable consumption in low-and middle income countries through a food systems approach. https://edepot.wur.nl/555408
23. Micha R, Khatibzadeh S, Shi P *et al*. (2015) Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE), Global, regional and national consumption of major food groups in 1990 and 2010: a systematic analysis including 266 country-specific nutrition surveys worldwide BMJ Open, **5**(9):e008705
24. Miller V, Yusuf S, Chow CK *et al*.(2016). Availability, affordability, and consumption of fruits and vegetables in 18 countries across income levels: findings from the Prospective Urban Rural Epidemiology (PURE) study. The Lancet Global Health **4** (10), e695–e703.
25. Hoelscher DM, Evans A, Parcel G*et al*. (2002) Designing Effective Nutrition Interventions for Adolescents. *Journal of the American Dietetic Association,* 102(3), S52–S63. https://doi.org/10.1016/s0002-8223(02)90422-0

26. Jacob CM, Hardy-Johnson PL, Inskip HM, *et al.* (2021) A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10 to 19 years. *International Journal of Behavioural Nutrition and Physical Activity*.**18**: 1–22. https://doi.org/10.1186/S12966-020-01065-9/FIGURES/3.

27. Saavedra, JM, Prentice, AM. (2022). Nutrition in school-age children: a rationale for revisiting priorities. *Nutrition Reviews,* **81**(7). https://doi.org/10.1093/nutrit/nuac089

28. Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, Currie M, Qureshi R, Mattis P, Lisy K, Mu P-F. Chapter 7: Systematic reviews of etiology and risk. In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017.

29. Ilo JG, Onabanjo OO, Badejo CO *et al*. (2022) The Dietary Pattern and Hemoglobin Status of School-Age Children in Odeda Local Government Area of Ogun State in Nigeria. *International Journal on Food, Agriculture, and Natural Resource,* **03**(01):8-13.
30. Anyiam PN, Nwuke CP, Adimuko GC *et al.*(2022). Dietary Intakeand Nutritional Status of School-Children in Umudike, South-East Nigeria during Covid-19 Context. *International Journal of Nutrition Sciences*, **7**(2):81-89.
31. Amu EO, Olatona FA &Deji SA (2017) A comparative study of food consumption pattern among publicand private primary school children in Ojodu Local Government Area, Lagos State, Nigeria. *Njfp,* **8**(2).
32. Fadeiye EO & Adekanmbi ET(2020) Fruit and vegetable consumption among primary school pupils of Egbeda Local Government Area, Oyo State, Nigeria. *Ife Journal of Agriculture,* 9.
33. Adeomi AA, Aliyu SM & Sabageh AO (2020) Eating Pattern, Dietary Diversity and Nutritional Status of Children and Adolescents Residing in Orphanages in Southwestern Nigeria. *Journal of Community Medicine and Primary Health Care,***32**(1):59-69
34. Agugo UA, Asinobi CO & Afam-Anene O (2019). Impact of Food Consumption Pattern on the Body Mass Index (BMI) of School Children (5-12 Years) in Selected Motherless and Orphanage Homes in Imo State. *Journal of Nutrition Science Research,* **4**: 135.

35. John-Akinola YO, Akano OO & Akinwale O (2021) Supporting a Participatory Process for Evidence on Healthy Eating to Promote Healthy Diet among Children: An Illustration from Nigeria. *Health Behaviour and Policy Review*, **8**(3):269-276
36. Adeniyi OF, Fagbenro GT & Olatona FA (2019) Overweight and Obesity Among School-aged Children and Maternal Preventive Practices against Childhood Obesity in Select Local Government Areas of Lagos, Southwest, Nigeria. *International Journal of MCH and AIDS*, **8**(1): 70-79.
37. Akinola IJ, Odugbemi B, Bakare OQ *et al*. (2022) Dietary Habits, Physical Activity and Sleep Pattern among In-School Adolescents in Lagos, Nigeria. *Annals of Health Research*, **8**(1):63-73
38. Olumakaiye MF (2013) Dietary diversity as a correlate of undernutrition among school-age children in southwestern Nigeria. *J Child Nutr Manag*, **1**: 37:1–32.
39. Ayogu R (2019) Energy and nutrient intakes of rural Nigerian schoolchildren: Relationship with dietary diversity. *Food Nutr. Bull*, **40**:241–253.
40. Ibeanu VN, Edeh GC &Ani PN (2020). Evidence-Based Strategy for Prevention of Hidden Hunger among Adolescents in a Suburb of Nigeria. *BMC Public Health*, 20.
41. Menakaya NC & Menakaya IN (2022) Qualitative study exploring perceptions, attitudes and practices of adolescent university students in Lagos, Nigeria, towards a healthy lifestyle. *African Journal of Primary Health Care and Family Medicine*, **14**(1):1-12.
42. Silva OO, Olayinka OA & Tinuola OO (2017) "Knowledge and Consumption of Fruits and Vegetables among Secondary School Students of Obele Community Junior High School, Surulere, Lagos State, Nigeria." *Journal of Clinical Sciences*, **14**(2): 68–73.
43. Olatona FA, Ogide PI, Abikoye ET *et al*. (2020) Dietary Patterns, Nutritional Knowledge and Status of Adolescents in Lagos, Nigeria. Research Square.
44. Anaemene D & Ogunkunle M (2020) Overweight Status and Dietary Habit of Children Attending Private Schools in Ado Odo Ota, South Western Nigeria. *African Journal of Food Agriculture and Nutrition Dev*, **20**:22.
45. Shapu CR, Ismail S, Poh-Ying L*et al*. (2022) Impact of Health Education Intervention on Dietary Practice among Adolescent Girls in Government Secondary Schools Maiduguri: A Cluster Randomized Control Trial: A Cluster Randomized Control Trial on Health Education Intervention on Dietary Practice. *The Nigerian Health Journal*, **22**(4):417–427

46. Ogunkunle MO & Oludele AS (2013) Food intake and meal pattern of adolescents in school in Ila-Orangun, South-West Nigeria. *South African Journal of Clinical Nutrition*, **26**:188–193.
47. Wordu GO & Wachukwu-Chikodi HI (2019) Dietary intake and prevalence of adolescent hypertensive in Port Harcourt, Nigeria. *International Journal of Research Granthaalayah*, **7**:22-9
48. Uba DS, Islam MR, Haque MI *et al*. (2020) Nutritional status of adolescent girls in a selected secondary school of north-eastern part of Nigeria. Deakin University. Journal contribution
49. Wordu GO & Orisa CA (2021) Diet, Physical Activity and Food Consumption Pattern of Adolescent Girls in Port Harcourt, Rivers State, Nigeria. *European Journal of Nutrition and Food Safety*, **13**(8):38-47
50. Nnebue CC, Ilika AL, Uwakwe KA *et al.* (2016) Feeding Practices and Determinant of the Nutritional Status of Pupils in a public primary School in Aladinma Owerri, Nigeria. *International Journal of Clinical Nutrition*, **4**(1): 12 – 18.
51. Sanusi RA, Yusuf FK & Ejoh SI (2015) Assessment of dietary diversity of in-school adolescents in Ibadan, Oyo State, Nigeria. *West Afr. J. Food Nutr*, **12**:69–77.
52. Ezezika O, Oh J, Edeagu N *et al*. (2018) Gamification of nutrition: A preliminary study on the impact of gamification on nutrition knowledge, attitude, and behaviour of adolescents in Nigeria. *Nutr Health*, **24**(3):137-144.
53. Seidu AA, Aboagye RG, Frimpong JB *et al*. (2021) Determinants of Fruits and Vegetables Consumption among In-School Adolescents in Ghana. *Adolescents*,**1**(2):199-211.
54. Yaméogo T, Sombié I, Kyelem C *et al.* (2018) Determinants of Fruit and Vegetables Intake among Secondary School Pupils in the City of Bobo-Dioulasso (Burkina Faso): A Cross-Sectional Study. *Open Journal of Internal Medicine*, **8**:1-9.
55. Giguère-Johnson M, Ward S & Ndéné Ndiaye A s(2021) Dietary intake and food behaviours of Senegalese adolescent girls. *BMC Nutrition*, **7**: 41.
56. Nago ES, Lachat CK & Huybregts L (2010) Food, energy, and macronutrient contribution of out-of-home foods in school-going adolescents in Cotonou, Benin. *British Journal of Nutrition*, **103** (2):281-288.

57. Owusu A, Murdock PO & Weatherby NL (2007) Measuring nutritional intake of adolescents in Ghana, West Africa. *International Electronic Journal of Health Education*, **10**:104–113.
58. Sagbo H, Kpodji P, Bakai TA *et al*. (2022) Socio-economic determinants of healthy behaviours among primary schoolchildren and adolescents in Lokossa district of southern Benin. *International Health*, **15**(3):265-273.
59. Doku D, Koivusilta L & Raisamo S (2013). Socio-economic differences in adolescents' breakfast eating, fruit and vegetable consumption, and physical activity in Ghana. *Public Health Nutrition*, **16**:864-872.
60. Abizari AR, Azupogo F, Nagasu M *et al*. (2017) Seasonality affects dietary diversity of school-age children in northern Ghana. *PLOS ONE*, **12**(8): e0183206.
61. Hormenu T (2022) Dietary intake and its associated factors among in-school adolescents in Ghana. *PLoS ONE*, **17**(5): e0268319.
62. Dabone C, Delisle H & Receveur O (2013). Predisposing, facilitating and reinforcing factors of healthy and unhealthy food consumption in schoolchildren: a study in Ouagadougou, Burkina Faso. *Global Health Promotion*, **20**:68-77.
63. Fiorentino M, Landais E, Bastard G *et al*. (2016) Nutrient intake is insufficient among Senegalese Urban School children and adolescents: results from two 24 h recalls in state primary schools in Dakar. *Nutrients*, **8**(10):650
64. Alangea OD, Aryeetey RN& Gray HL (2018) Dietary patterns and associated risk factors among school-age children in urban Ghana. *BMC Nutrition*, **4**: 22.
65. Nago E & Chabi SM (2019) A Pilot School-based Intervention to Increase Fruit Intake in Adolescents in Urban Benin. *Food and Public Health*, **9**(4): 111-118
66. Otuneye AT, Ahmed PA, Abdulkarim AA *et al*. (2017) Relationship between dietary habits and nutritional status among adolescents in Abuja municipal area council of Nigeria. *Nigerian Journal of Paediatrics*, **44**:128–135
67. Uzosike TCJ, Okeafor I & Mezie-Okoye M (2020) Dietary Diversity, Nutritional status and Academic performance of pupils in public primary schools in Port Harcourt Metropolis. *Journal of Community Medicine and Primary Healthcare*, **32**(2): 42-56

68. Schreinemachers MS, Ouedraogo S, Diagbouga A *et al.*(2019) Impact of school gardens and complementary nutrition education in Burkina Faso. *Journal of Development Effectiveness*, **11**(2):132-145
69. FAO (2018). Dietary Assessment: A resource guide to method selection and application in low resource settings. Rome.
70. Micha R, Coates J, Leclercq C *et al*. (2018) Global Dietary Surveillance: Data Gaps and Challenges. Food and Nutrition Bulletin, 39(2), 175–205. https://doi.org/10.1177/0379572117752986.
71. Gurugubelli VS, Fang H, Shikany JM *et al*. (2022) A review of harmonization methods for studying dietary patterns. Smart Health, 23, 100263. https://doi.org/10.1016/j.smhl.2021.100263.
72. Cui Q, Xia Y, Wu Q *et al* (2021) A meta-analysis of the reproducibility of food frequency questionnaires in nutritional epidemiological studies. *International Journal of Behavioral Nutrition and Physical Activity*, **18**, (12). https://doi.org/10.1186/s12966-020-01078-4.
73. World Health Organization (2020). Healthy Diet. https://www.who.int/news-room/fact-sheets/detail/healthy-diet
74. Darfour-Oduro SA, Buchner DM, Andrade JE *et al*. (2018) A comparative study of fruits and vegetables consumption and physical activity among adolescents in 49 Low-and-Middle-Income Countries. *Sci Rep*,**8**(1):1623.
75. Shinde S, Wang D, Moulton GE *et al*. (2023) School-based health and nutrition interventions addressing double burden of malnutrition and educational outcomes of adolescents in low- and middle-income countries: A systematic review. *Maternal and Child Nutrition*. https://doi.org/10.1111/mcn.1343
76. Miguel-Berges ML, Santaliestra-Pasias AM, Mouratidou T *et al*. (2017) Associations between food and beverage consumption and different types of sedentary behaviours in European preschoolers: The ToyBox-study. *European Journal of Nutrition*, 56:1939–1951. doi: 10.1007/s00394-016-1236-7
77. Azevedo J, Padrão P, Gregório MJ *et al*. (2019) A Web-Based Gamification Program to Improve Nutrition Literacy in Families of 3- to 5-Year-Old Children: The Nutriscience Project. *Journal of Nutrition Education and Behavior*, 51(3):326–334. https://doi.org/10.1016/j.jneb.2018.10.008

78. Rosati R, Regini L, Pauls A *et al.* (2024) Gamification in nutrition education: the impact and the acceptance of digital game-based intervention for improving nutritional habits. *Journal of Computers in Education.* https://doi.org/10.1007/s40692-024-00314-1
79. Edwards EA, Lumsden J, Rivas C*et al*. (2016) Gamification for health promotion: Systematic review of behaviour change techniques in smartphone apps. *BMJ Open*, e012447. doi: 10.1136/bmjopen-2016-012447
80. Spring B, Schneider K, Mcfadden HG*et al*. (2012) Multiple behavior changes in diet and activity: a randomized controlled trial using mobile technology. Arch Intern Med, 172(10):789–796. doi: 10.1001/archinternmed.2012.1044.
81. Mantzari E, Vogt F, Shemilt I *et al.* (2015) Personal financial incentives for changing habitual health-related behaviors: a systematic review and meta-analysis. Prev Med. 2015;75:75–85. doi: 10.1016/j.ypmed.2015.03.001
82. Mette R, Rikke K, Knut-Inge K *et al*. (2006) *International Journal of Behavioural Nutrition and Physical Activity.* 3, 22
83. Fadeiye EO, Popoola BR, Emuoke DK *et al*. (2019) Factors influencing fruit consumption among undergraduates in Obafemi Awolowo University, Ile-Ife, Osun state, Nigeria. *Ife Journal of Agriculture,* **31**(2):80-89
84. Rose T, Mary B, Chandni M J *et al.* (2017) "A Systematic Review of Digital Interventions for Improving the Diet and Physical Activity Behaviors of Adolescents." *Journal of Adolescent Health*, **61**(6): 669–77.
85. Rasmussen M, Krølner R, Klepp KI *et al*. (2006) Determinants of fruit and vegetable consumption among children and adolescents: A review of the literature. Part I: Quantitative studies. *International Journal Behavioural Nutrition and Physical Activity*, 3:22.
86. Sumonja S & Novakovic B (2012) Determinants of fruit, vegetable, and dairy consumption in a sample of school children, Northern Serbia. *Preventing Chronic Disease*, 31:10:E178.
87. Rakhshanderou S, Ramezankhani A, Mehrabi Y *et al.* (2014). Determinants of fruit and vegetable consumption among Tehranian adolescents: A qualitative research. *Journal of Research in Medical Sciences*, **19**:482-9.

Table 1: Overview of the Included Studies

Authors, year, and location	Sample Size	Region/ Area	Study Population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Ilo*et al.,* 2022 Nigeria [29]	227	Rural	School-age children (6-12 years)	Cross-sectional	Food frequency pattern of the children	FFQ	Green leafy vegetable consumption – 61.0%
Anyiam*et al.,* 2022 Nigeria [30]	384	Urban	School-age children (6-12 years)	Community based cross-sectional	Food intake/frequency of consumption from each food group	FFQ (on selected food groups) and 24hr dietary recall	Vegetable consumption is consumed Occasionally – 0.52% <3x/week – 25.52% 4-6x/week – 44.5% Daily – 29.4%
Amu *et al*., 2017 Nigeria [31]	206	Urban	School-age children (8-10-year-old)	Community based comparative cross-sectional	24- hour dietary pattern	24hr dietary recall	**Public school:** 2x/week – 24.3% Once/week – 28.2% Occasionally – 47.6% **Private school:** 2x/week – 21.3% Once/week – 23.3% Occasionally – 55.3%
Fadeiye and Adekanmbi, 2020 Nigeria [32]	260	Sub-urban	School-age children and adolescents (6-16-year-old)	Cross-sectional	Fruits and vegetables consumed and their rate of consumption on a weekly basis.	FFQ	Result showed that tomatoes (96.5%), onions (94.2%), carrot (92.7%), okro (88.1%), and bitter leaf (80.4%) were mostly consumed.

Table 1: Overview of the Included Studies (cont'd)

Author year,and location	Sample Size	Region/ Area	Study Population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Adeomi*et al*., 2020 Nigeria [33]	260	Urban	School-age children and adolescents (5-19-year-old)	Cross-sectional study	Frequency of food consumption	24hr dietary recall	In the week preceding the week of study, vegetable consumption was ≤3x/week - 20.0% >3x/week – 80.0%
Agugo*et al*., 2019 Nigeria [34]	115	Urban	School-age children (5-13-year-old)	Cross-sectional	Feeding pattern in each home from the caregivers	54-item FFQ	2-3x/week - 71.4%
John-Akinola*et al*., 2021Nigeria [35]	728	Urban	School-age children and adolescents (6-15-year-old)	Cross-sectional	Food contents in lunch boxes were observed using a checklist.	24hr dietary recall	21%
Adeniyi*et al*., 2019 Nigeria [36]	440	Urban	School-age children (6-13-year-old)	Community based cross-sectional Cross-sectional	Food consumption pattern	Not stated	0.04%

Akinola*et al.*, 2022 Nigeria [37]	1120	Urban	Adolescents (10-19-year-old)	Dietary habits	4 – item FFQ	Never – 11.8% 1 portion/day – 33.2% 2-3 portions/day – 55.0%

Table 1: Overview of the Included Studies (cont'd)

Authors,year,and location	**Sample Size**	**Region/ Area**	**Study Population**	**Study design**	**Outcome variables**	**Measurement tools**	**Study outcome (frequency of vegetable consumption)**
Olumakaiye, 2013 Nigeria [38]	600	Urban	School-age children (6-11-year-old)	Cross-sectional	Dietary diversity measures.	24hr dietary recall and dietary diversity questionnaire composed of sixteen food groups	**Private school:** Vitamin A rich veggie/tuber – 32.3% Dark GLV – 50.3% Other vegetables – 100.0% **Public school:** Vitamin A rich veggie/tuber – 7.7% Dark GLV – 48.7% Other vegetables– 100.0%
Ayogu, 2019 Nigeria [39]	90	Rural	School-age children and	Cross-sectional	Dietary diversity, nutrient intake	24hr dietary recall and dietary diversity	32.1%

			adolescents (6-15-year-old)			questionnaire	
Ibeanu et al., 2020 Nigeria [40]	869	Sub-urban	Adolescents (13-17-year-old)	Quasi-experimental study design with one intervention group	Consumption pattern of micronutrient-rich foods		The study revealed percentage increase in the proportion of respondents who consumed carrot (336.34%) and leafy vegetables (85.56%) daily after the intervention.

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	**Sample Size**	**Region/ Area**	**Study population**	**Study design**	**Outcome variables**	**Measurement tools**	**Study outcome (frequency of vegetable consumption)**
Menakaya and Menakaya, 2022 Nigeria [41]	18	Urban	Adolescents (18-19-year-old)	Qualitative study	Dietary pattern	Interview guide/in-depth interview	Study participants described their attitudes and practices towards a healthy lifestyle in terms of personal conviction and disposition, regular physical activity and consumption of fruits and vegetables

Silva *et al*., 2017 Nigeria [42]	220	Urban	Adolescents (10-16-year-old)	Cross-sectional	Consumption, facilitators, and barriers to consumption of FV	Not indicated	Consumption of fruits and vegetables was appropriate in only 5.48% of the respondents, having five portions of fruits and vegetables daily.
Anaemene and Ogunkunle, 2020 Nigeria [43]	478	Urban	School-age children (8-11-year-old)	Cross-sectional Cross-sectional	Dietary habits	24hr dietary recall	School 1 – 86.2% School 2 – 72.1% School 3 – 72.9% School 4 – 64.6%
Olatona*et al.*, 2020 Nigeria [44]	682	Urban	Adolescents (10-19 year)		Dietary habits, nutrient intake	15-item FFQ and 24hr dietary recall	11.4% consumed vegetables while only 9.7% of the adolescents consumed adequate fruits and vegetables (400g or 5 servings) daily.

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	Sample Size	Region/ Area	Study population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Shapu *et al*., 2022 Nigeria [45]	417	Urban	Adolescents (10-19-year-old) - female only	Cluster randomized control trial	Dietary practice of respondents	12-item FFQ	There was a statistically significant difference at three and six months post-intervention for dietary practice; p = 0.003 and p = 0.011 between the intervention and control groups.
Ogunkunle and Oludele, 2013 Nigeria [46]	302	Semi-urban	Adolescents (10-19-year-old)	Cross-sectional	Food intake and meal patterns	FFQ (seven food groups) and 24hr dietary recall	Daily – 26.4% 4-6x/week – 2.8% <3x/week – 27.5% Occasionally – 43.3%
Wordu and Wachukwu- Chikodi, 2019 Nigeria [47]	150	Urban	Adolescents (10-19-year-old)	Cross-sectional	Eating pattern, lifestyle characteristics	Not indicated	**Fruits and vegetables:** Once/week – 16.7% 2-3x/week – 16.7% 4-5x/week – 13.3% Daily – 23.3% More/week – 30.0%
Uba*et al*., 2020 Nigeria [48]	250	Rural	Adolescents (13-19-year-old) - female only	Cross-sectional	Dietary habits	Not indicated	≤2x/week – 44.8% >2x/week – 55.2%

Table 1: Overview of the Included Studies (cont'd)

Authors year,and location	Sample Size	Region/ Area	Study population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Wordu and Orisa, 2021 Nigeria [49]	236	Urban	Adolescents (10-16-year-old)	Cross-sectional	Food consumption pattern	11-item FFQ	Never – 2.97% 1-2x/week – 38.14% 3-4x/week – 13.14% >5x/week – 16.10% Daily – 29.66%
Nnebue*et al*., 2016 Nigeria [50]	300	Urban	School-age children (5-12-year-old)	Cross sectional	Feeding practices of the children	24hr dietary recall	The 24hour nutritional dietary intake recall showed that 279(93.0%) took more of carbohydrate. Only 179(59.0%) had farms in their homes
Sanusi*et al*., 2015 Nigeria [51]	393	Urban	Adolescents (10-19-year-old)	Cross-sectional	Food and food groups consumed	24hr dietary recall and dietary diversity questionnaire	Total (fruits and green leafy vegetable) – 67.4% males – 64.4% Females – 69.9%
Ezerika *et al*., 2018 Nigeria [52]	31	Urban	Adolescents (13-17-year-	Qualitative study	Knowledge about nutrition		Participants reported that the intervention shifted their

			old)				perception and preferences, leading them to alter their behaviour by incorporating more nutritious foods (such as FV) into their diet.

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	Sample Size	Region/ Area	Study Population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Seidu*et al*., 2021 Ghana [53]	2786	Urban	Adolescents (10-19-year-old)	Cross-sectional analysis of data from GSHS.	Fruit consumption, vegetable consumption and adequate fruits and vegetable consumption	FFQ	26.8%
Yaméogo*et al*., 2018 Burkina Faso [54]	1993	Urban	Adolescents (10-19-year-old)	Cross-sectional	Vegetable intake,	24hr dietary recall and FFQ	10.0%

Giguère-Johnson *et al*., 2021 Senegal [55]	13	Urban	Adolescents (14-16-year-old) - female only	Cross-sectional	Food intake and eating behaviours	24hr dietary recall (14 food group)	4% (WHO recommendations of 25g for fiber was used)
Nago*et al*., 2010 Benin [56]	656	Urban	Adolescents (13-19-year-old)	Cross-sectional	Food composition pattern	24hr dietary recall (10 food group)	Total (fruits and vegetable) – 6% Daily – 26% (out of home foods) Daily – 74% (in-home prepared foods)
Owusu *et al*., 2007 Ghana [57]	140	Selected schools from urban and rural area	Adolescents in boarding school (14-18-year-old)	Cross-sectional	Eating pattern	81-item FFQ	2 servings of vegetables/week

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	Sample Size	Region/ Area	Study Population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Sagbo *et al*., 2022 Benin [58]	612	Rural and urban area of Lokossa	School-age children and adolescents (8-17-year-old)	Cross-sectional	Family and school context and frequency of healthy and unhealthy food consumption	FFQ	>5x/week – 32.0% <5x/week – 68.0%
Doku *et al*., 2011 Ghana [59]	1566	Rural and urban	Adolescents (12-18-year-old)	Cross-sectional	Food habits	FFQ	Never – 13.0% 1-3x/week – 34.0% 4-6x/week – 14.0% Daily – 38.0%
Abizari *et al*., 2017 Ghana [60]	228	Rural area of Tolon district	School-age children (6-12-year-old)	Cross-sectional study conducted in different seasons – dry season (Oct 2010) and rainy season (May 2011)	Dietary diversity score	24hr dietary recall based on 13 food groups	**Dry season:** Vitamin A rich dark GLV – 23.3% Vitamin A rich deep orange, yellow and red vegetable – 73.7% Vitamin C richvegetable – 96.5% All other fruits and vegetables – 93.4%

							Rainy season: Vitamin A rich dark GLV – 52.6% Vitamin A rich deep orange, yellow and red vegetable – 36.4% Vitamin C richvegetable – 100.0% All other fruits and vegetables – 90.8%

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	**Sample Size**	**Region/ Area**	**Study Population**	**Study design**	**Outcome variables**	**Measurement tools**	**Study outcome (frequency of vegetable consumption)**
Hormenu, 2022 Ghana [61]	1311	Rural	Adolescents (10-15-year-old)	Cross-sectional	Dietary practices	6-item FFQ	Fruits and vegetables – 49.9%
Daboneet *al*., 2013 Burkina Faso [62]	769	Urban and Peri-urban	School-age children (6-12-year-old)	Cross-sectional	Consumption frequency of 'healthy' foods	FFQ	Never – 17.0% 1-2x/week – 42.9% 3-4x/week – 27.7% 5-6x/week – 8.3% Daily – 4.0%

Fiorentino *et al*., 2016 Senegal [63]	545	Urban	School-age children and adolescents (5-17-year-old)	Cross-sectional	Dietary intake	24hr dietary recall	For all micronutrients, at least half of the children had insufficient intake, suggesting a diet poor in fruit and vegetables, with a special concern for zinc, vitamin A, folic acid and calcium
Alangea*et al*., 2018 Ghana [64]	487	Urban	School-age children and adolescents (9-15-year-old)	Cross-sectional	Dietary behaviour and food consumption patterns	100-items FFQ	Starchy root with vegetable dietary pattern was negatively associated with overweight/obese status, private school attendance and higher SES after controlling for age at bivariate level

Table 1: Overview of the Included Studies (cont'd)

Authors, year, and location	Sample Size	Region/ Area	Study Population	Study design	Outcome variables	Measurement tools	Study outcome (frequency of vegetable consumption)
Nago and Chabi, 2019 Benin [65]	229	Urban	Adolescents (13-19-year-old)	Pilot intervention using a pre-post without control	Dietary intake	24hr dietary recall	The contribution of fruit consumption at school to consumers' daily fruit intake rose from 3% at baseline to 78%.
Otuneye *et al*., 2017 Nigeria [66]	1550	Urban and Rural	Adolescents (10-19-year-old)	Cross-sectional	Dietary habits, knowledge of nutrition	FFQ	Urban school setting – 70.3% Rural school setting – 64.9%
Uzosike *et al*., 2020 Nigeria [67]	847	Urban	School-age children (6-11-year-old)	Cross-sectional	Dietary diversity and dietary pattern	24hr dietary recall	Dark GLV – 41.0% Vitamin A rich fruits and vegetables – 17.1% Other fruits and vegetables – 7.7%
Schreinemachers *et al*., 2019 Burkina Faso [68]	1760	Rural	School-age children and adolescents (8-14-year-old)	Repeated cluster randomized controlled trial	Fruit and vegetable preference	24hr dietary recall	There was no significant increase in other outcome indicators including FV consumption

Table 2: Summary of characteristics of studies

Characteristics	Total	References
Publication year		
2002 – 2012	3 (7.5%)	[56-57, 59]
2013 – 2022	37 (92.5%)	[29-55, 58, 60-68]
Country		
Benin	3 (7.5%)	[56, 58, 65]
Burkina Faso	3 (7.5%)	[54, 62, 68]
Ghana	6 (15.0%)	[53, 57, 59-61, 64]
Nigeria	26 (65.0%)	[29-52, 66-67]
Senegal	2 (5.0%)	[55, 63]
Number of participants		
Less than 100	3 (7.5%)	[39, 41, 52]
101 – 1000	30 (75.0%)	[29-36, 38, 40, 42-51, 55-58, 60-65, 67]
1001 and above	7 (17.5%)	[37, 53-54, 59, 61, 66, 68]
Sex		
Studies with males and females	37 (92.5%)	[29-44, 46-47, 49-54, 56-68]
Females – only study	3 (7.5%)	[45, 48, 55]
Assessment Tools		
Food frequency questionnaire (FFQ)	14 (35.0%)	[29, 32, 34, 37, 45, 49, 53, 57-59, 61-62, 64, 66]
24-hrs dietary recall	12 (30.0%)	[31, 33, 35, 43, 50, 55-56, 60, 63, 65, 67-68]
Food frequency questionnaire + 24-hr dietary recall	4 (10.0%)	[30, 44, 46, 54]
In-depth interview	1 (2.5%)	[41]
24-hrs dietary recall + Dietary diversity	3 (7.5%)	[38-39, 51]
Not stated	6 (15.0%)	[36, 40 42, 47-48, 52]

Table 3: Interventions that promote vegetable intake among SAC and Adolescents

Study and country	Study population/ Sample size	Study design	Duration of the study	Intervention	Components of the intervention	Outcome of the study
Ibeanu*et al*., 2020 Nigeria [40]	Adolescents/869 (Pre-test) and 776 (Post-test)	Quasi-experimental study with one intervention group	3 weeks intervention and 6 months post-intervention	Nutrition education	Nutrition education aids developed with nutrition facts, pictures of micronutrients-rich foods and computer graphics compiled into a 14-page booklet and includes: Definition of food nutrients, classes and amount required, food sources of micronutrients of interest, functions of the micronutrients, signs and symptoms of the micronutrient deficiencies, inhibitors of the micronutrient absorption.	Increase in nutrition knowledge and consumption of some micronutrients-rich food sources including leafy and non-leafy (carrot) vegetables among the adolescents
Shapu*et al*.,	Adolescents/403	Cluster	three months	Health	How to prevent malnutrition	The health education

2022 Nigeria [45]	randomized control trial	intervention and education post-intervention at three and six months	through information on macronutrients, micronutrients, dietary diversity and healthy eating, motivation on the prevention of malnutrition among adolescent girls and lessons learnt, and behavioural skills on practical cooking demonstration and identification of food groups.	intervention greatly impacted dietary practice among adolescent girls in Maiduguri Metropolitan Council (MMC).	

Table 3: Interventions that promote vegetable intake among SAC and Adolescents (cont'd)

Study and country	**Study population/ Sample size**	**Study design**	**Duration of the study**	**Intervention**	**Components of the intervention**	**Outcome of the study**
Nago and Chabi, 2019 Benin [65]	Adolescents/ 249	Pre-post design without control	2 months	School-based fruit stall	A single leaflet about the general health benefits of fruits and vegetables was distributed to the students and teachers and sent home for the parents.	The intervention is promising and could be an efficient and sustainable means to promote fruit consumption and healthy diet in adolescents in urban Benin

Schreinemachers *et al*., 2019 Burkina Faso [68]	School-age children and adolescents/ 1760	Repeated cluster randomized controlled trial	six months	School gardens and complementary nutrition education	A school garden for the cultivation of locally accepted vegetables. Seed of a range of vegetables was provided together with gardening tools and other equipment as needed. The second component involved complementary education about agriculture, nutrition and WASH. Topics covered were food groups, the health benefits of vegetables, food and body hygiene, and school and environmental sanitation. The third component was the involvement of parents, local farmers and other community members in the school garden.	Significant increases in children's knowledge about sustainable agriculture and about food and nutrition, but did not lead to significant improvements in children's fruit and vegetable intake

Table 3: Interventions that promote vegetable intake among SAC and Adolescents (cont'd)

Study and country	**Study population/ Sample size**	**Study design**	**Duration of the study**	**Intervention**	**Components of the intervention**	**Outcome of the study**

Ezerika*et al*., 2018 Nigeria [52]	Adolescents/ 31	Semi-structured Focus group discussion	4-12 weeks	Gamification	The core strategy of the game is to buy healthy food cards in order to get as many points as possible. Points gained in the game translate into vouchers through a voucher system integrated in the game that enables players to buy real food (fruits and non-leafy vegetables) from partnering tuck shops.	The results from the focus groups suggest that gamification of nutrition can lead to improvements in dietary behaviour among adolescents over the short-term.

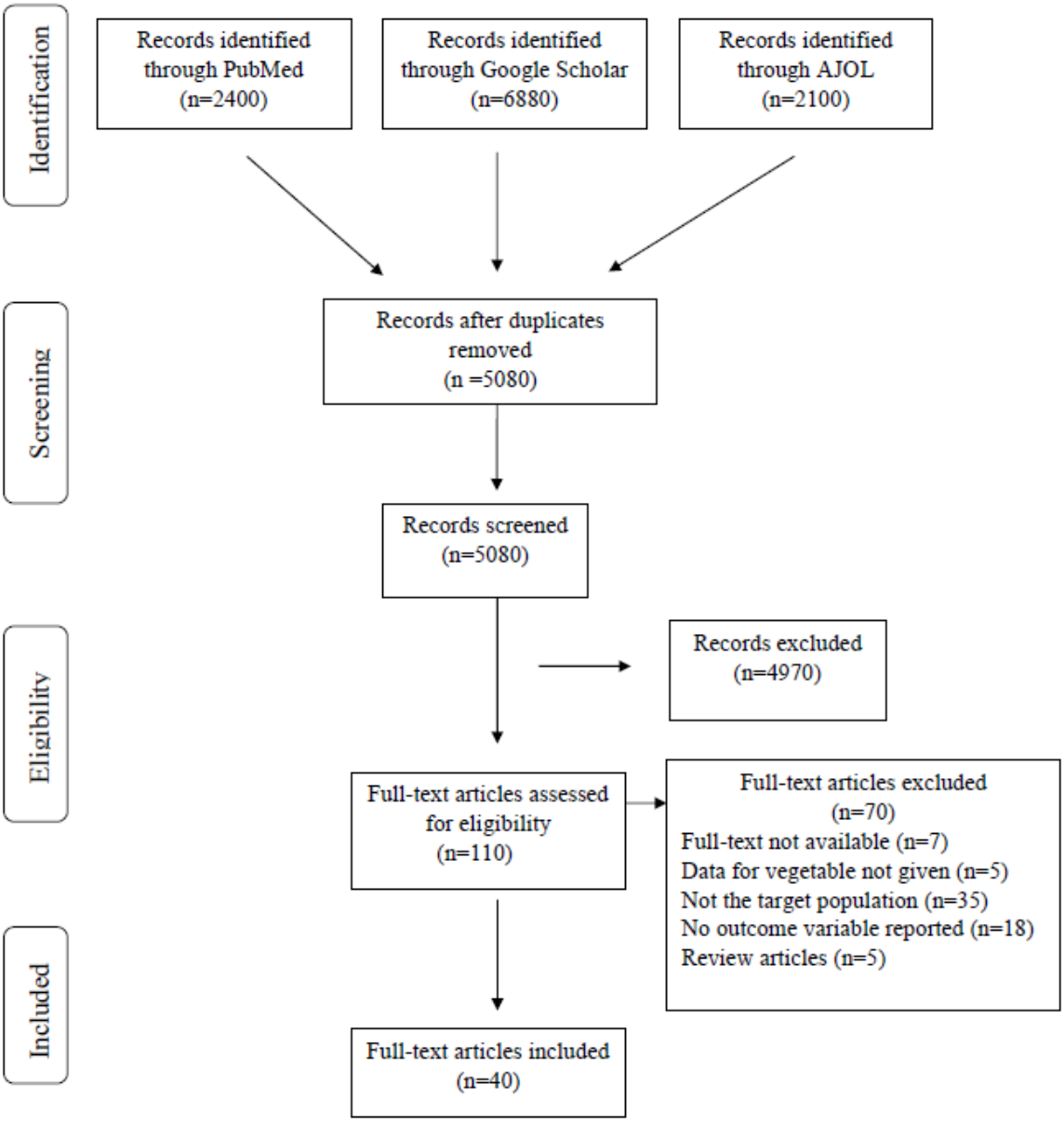

Figure 1: Flow chart of article selection based on PRISMA

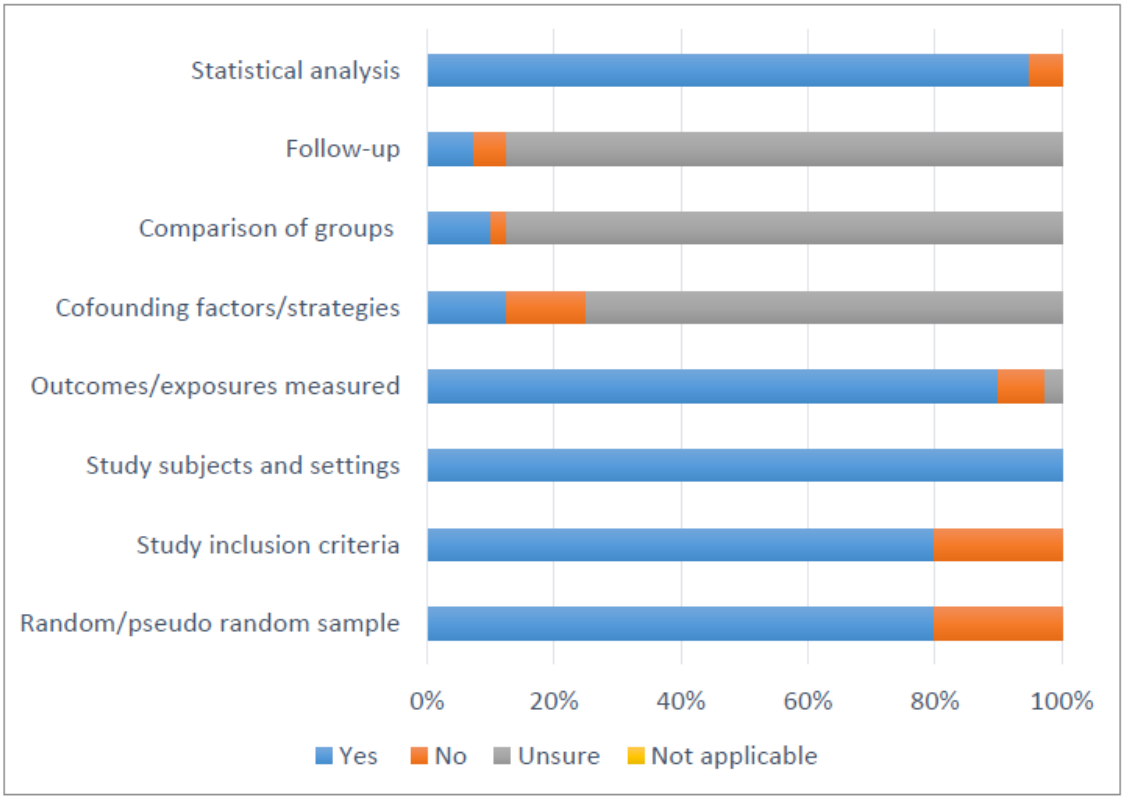

Figure 2: Quality assessment of included studies using the JBI checklist