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Home-School-Based Nutrition Intervention Program to Increase Fruit and Vegetable Consumption in Children and Adolescent: A Systematic Review

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ABSTRACT

Fruit and vegetable campaigns have been widely conducted in countries with school-based intervention programs as a promising strategy to improve eating habits, but no reviews have assessed the effectiveness of multicomponent home-school-based programs on daily fruit and vegetable intake. Through a systematic review of the literature, this study aims to determine the effectiveness of a home-school-based nutrition intervention program on children's and teenagers' consumption of fruits and vegetables. This research identified randomized controlled trials based in primary, middle, and high schools designed to increase daily fruit and vegetable intake. PubMed, Google Scholar, and Crossref were searched from 2013 to 2024. The six studies met all inclusion criteria. Three of the six studies' findings indicate that home-school-based nutrition intervention programs significantly increase fruit and vegetable intake among children and adolescents. The amount of FV consumed by teenagers at follow-up was significantly correlated with the level of parental participation in the Boost intervention. Adolescents' consumption of fruits and vegetables increased significantly during the BALANCE program intervention. The three-year school-based multicomponent intervention group's children's daily intake of fruits and vegetables increased significantly. However 3 other literature studies did not increase fruit and vegetable consumption. This study references the best approaches and strategies to prevent non-communicable diseases. Multicomponent interventions with specific duration and sustainability in the future may have the potential to be effectively implemented.

Keyword: Adolescent; Children, Consumption; Home-School-Based Intervention; Fruit; Vegetable

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Introduction

Fruit and vegetables contribute significantly to human nutrition since they are good providers of phytochemicals, dietary fiber, and other nutrients. There were studies of the links between fruit and vegetable consumption and the likelihood of a number of chronic illnesses that show that eating a lot of these foods each day is good for health (Boeing H., 2012). Evidence-based research has been done on how eating more fruits and vegetables affects direct health outcomes like the incidence of non-communicable diseases like type 2 diabetes, coronary

heart disease, and some types of cancer (Gomes F., 2020). Fruits and Vegetables (FV) are rich in micronutrients and low in energy density. All dietary recommendations recommend consuming FV. Over the previous ten years, the population's FV intake has consistently been below the recommended level (Woodside J. V., 2023). The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) released global guidelines in the early 2000s that called for 400 g of fruits and vegetables daily, excluding starchy tubers (Gomes F., 2020).

Opportunities to increase FV intake are complicated. In order to improve consumption, we will probably need multi-level, consistent, and long-lasting structural interventions and policies throughout the entire food system/supply chain. If this is accomplished, reaching the FV 5-a-day objective could have positive effects on environmental and public health (Woodside J. V., 2023). Children and adolescents are one of the groups that are vulnerable to nutritional problems. Efforts to increase awareness of fruit and vegetable consumption are carried out through nutrition promotion through communication, information, and education (Wijayanti W., 2022). Lack of vegetable consumption in children and adolescents is partly due to low knowledge and attitudes of ignoring the importance of eating vegetables (Sartika M. D., 2022).

Prevention of nutritional problems in children and adolescents needs to be done to keep them healthy, achieve at school, and become agents of behavioral change for families and communities by approaching schools and those closest to them, namely parents and teachers (Wiradnyani L. A. A., 2019). Parents and teachers often face challenges in getting children into the habit of consuming fruits and vegetables that are rich in micronutrients (Rachmi C. N., 2019).

FV campaigns have been widely conducted in countries with school-based intervention programs as a promising strategy to improve children's eating habits. Several primary studies have shown effective results in increasing FV consumption through school gardening and cooking class programs. School gardening conducted in elementary school children is an important component of nutrition education to increase knowledge and change FV consumption behavior in children. School gardening experiences in students can increase vegetable consumption, including recognition, liking, and willingness to try various vegetables (Dampang D. P., 2018). Fruit intake is significantly increased by school-based interventions, whereas vegetable intake is barely affected. These efforts, however, don't seem to increase schoolchildren's consumption of vegetables. More work is required to create strategies that increase children' consumption of vegetables and reduce obstacles to constructive behavior change (Evans C. E. L., 2012). Furthermore, the successful implementation of a family-based intervention resulted in notable increases in the consumption of fruits and vegetables by parents and adolescents. It seems that family-based newsletter treatments that encourage teenagers to eat more fruits and vegetables are both feasible and effective (Pearson N., 2010).

Previous research on interventions to increase fruit and vegetable consumption has primarily focused on either school-based or home-based strategies. School-based interventions, including gardening, nutrition education, and cooking programs, have successfully improved knowledge and fruit intake but often fall short in significantly increasing vegetable consumption (Evans C. E. L., 2012). Meanwhile, home-based interventions involving parental role modeling and meal planning have consistently improved fruit and vegetable intake among children (Pearson N., 2010). However, studies combining home and school settings are still limited, especially in low- and middle-income countries. Integrating these two domains is essential

because children's dietary behaviors are shaped both at school and within the home environment. This study is highly relevant given the persistent low fruit and vegetable consumption levels globally, particularly among children and adolescents.

There have been numerous systematic literature review studies in the form of school-based studies that have existed. However, there is still not much information on combining multiple components with home-based studies. Capturing on the previously provided background information, the author's goal is to provide a summary of the efficacy of nutritional interventions targeted at increasing the consumption of fruits and vegetables. The value of this research is based on its ability to offer data and references for the best approaches toward preventing non-communicable diseases. This study aims to see the effect of home-school-based nutrition intervention (collaboration between the roles of parents, teachers, and students) on fruit and vegetable consumption in children and adolescents.

Research Methods

The reporting guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were adhered to in this systematic literature review. There is no protocol registry where this review is listed.

A systematic literature search was performed using the following databases: PubMed, Google Scholar, and Crossref. We searched Google Scholar and Crossref by using the software Publish or Perish. One search was conducted in July–September 2024 to capture studies published within the last 10 years (2013–2024). Language restrictions were applied; studies were included if published in English. Additionally, all papers were open access. Search terms included: 1) home-school based interventions, home-based interventions, school-based interventions, 2) children and adolescents, 3) consumption FV / FV intake, all keywords combined with "AND", also used "OR" to maximize retrieval of the most relevant articles. The article search considered the eligibility criteria defined using the PICO model. The keywords for searching for articles/papers are as follows: Home-School Based Intervention OR Home-Based Intervention OR School-Based Intervention AND Consumption Fruit Vegetable OR intake fruit vegetable AND Children OR Adolescent.

The PICOS framework (Population, Intervention, Comparison group, Outcome, and Study Design) was used while determining the inclusion criteria. The following criteria were used to select studies: 1) Participants were children and adolescent aged between 5–18 years old; 2) Interventions could address education/cooking/gardening at school to children and education to parents at home interventions (multicomponent); 3) Comparison groups could non-nutritional intervention program; 4) Outcomes assessed included assessment of child fruit and vegetable intake (g/day or portion/day or kilocalories per day); 5) Randomized controlled trial studies, including cluster designs.

Duplicate search results were eliminated before being entered into Mendeley. After being vetted by scholars, titles, abstracts, and full texts were arranged in an Excel table. Full texts were checked for eligibility by researchers. A third reviewer was accessible for evaluation in the event that two reviewers were inconsistent. Two team members worked independently to extract the data. A third team member with training and experience in data extraction verified all of the extracted data. The length and duration of the intervention program, data collection techniques, and analysis techniques were used to extract the data. The following criteria were

used to summarize all of the studies: title. author, year of publication, location and population, type of intervention, length/duration of intervention, and outcomes. Reviewers assessed articles for inclusion, studied their quality, and extracted data. To avoid selection bias, reviews were conducted based on clear criteria for selected articles. Data were then summarized narratively.

Results and Discussion

There were 2024 papers identified in the first searches conducted in July–September 2024, then we removed duplicate records, e-books, and erroneous links. As a result of screening abstracts and titles, 1.143 articles were found that would fit all of the requirements. No new papers were found after evaluating the entire text. Consequently, six papers in all were included into the final evaluation. Many articles were excluded because the intervention was not multicomponent, the study design was not a controlled trial, and the outcomes were not the daily weight of FV intake. Papers were identified for this study using the Preferred Reporting Items for Systematic Reviews Flow Diagram (PRISMA 2020). Figure 1 shows specifics of the PRISMA 2020 Flow Diagram for updates systematic reviews.

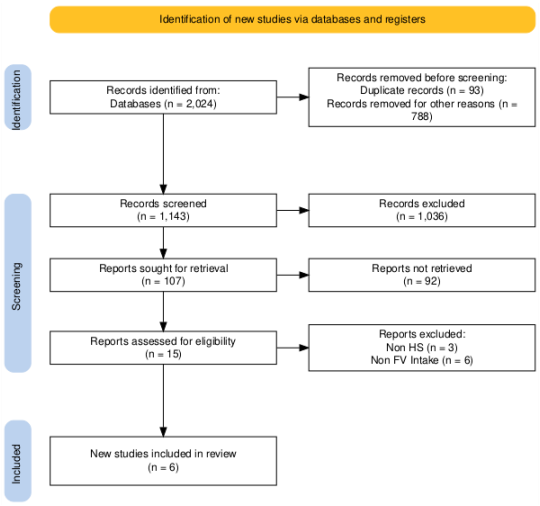

Figure 1. Details of the applied search and selection procedure were provided in the PRISMA 2020 diagram.

Table 1. Characteristics of the research that was reviewed on home-school-based strategies for increasing daily consumption of fruits and vegetables

Title, Author, Year	Characteristics			
	Population & Location	Design	Intervention & Duration	Outcome
"Parental involvement and association with adolescents' fruit and vegetable intake at follow-up: Process evaluation results from the multi-component school-based Boost intervention"	• 347 Danish 7th graders (13 13-year-olds) in the school year 2010/2011 • Denmark	Cluster-Randomized Trial	• The study included a **school component:** free FV in class and curricular activities; a local community component: fact sheets for sports and youth clubs; and a **parental component**: six parent newsletters, three supervised student-parent curricular events, a	Students with a medium and high level of parental involvement ate 47.5 (SE: 33.7) and 95.2 (SE: 34.3) grams more FV daily compared to students with low/no level of parental involvement ($p = 0.02$).

Title, Author, Year	Characteristics			
	Population & Location	Design	Intervention & Duration	Outcome
(Jørgensen et al., 2016)			student-parent Boost event, and a presentation of Boost at a parent-school meeting. • 6 months	
"A group randomized controlled trial integrating obesity prevention and control for postpartum adolescents in a home visiting program" (Haire-Joshu et al., 2015)	• 325 adolescents (mean age = 17.8 years), 694 intervention and 490 control. • 30 states across the country. USA	Randomized Controlled Trial	• During the academic school year, the PAT Teen Program, BALANCE, was offered in three parts: online activities, classroom-based meetings at the school, and home visits. • For over a year, Phase I contained baseline and posttest data. Phase II comprised a 24-month follow-up from baseline.	• "BALANCE adolescents" significantly increased their intake of fruits and vegetables as compared to the control group (p =.03). • Total daily consumption of fruits and vegetables (in kcal), control 57.1 (103.3) and intervention mean (SD) 62.3 (170).
"A comprehensive multicomponent school-based educational intervention did not affect fruit and vegetable intake at the 14-year follow-up" (Øvrebø et al., 2019)	• There were 922 subjects from seventh graders (ages 11–12) and 1028 subjects from sixth graders (10–11 years old). • Norway	Cluster Randomized Trial	• The multicomponent educational program included both a classroom-based academic program and a parental component. Over the course of seven months, home economics teachers taught the curriculum once a month, with a foundation in social cognitive theory. At school meetings, the intervention was presented to parents together with health and FV information. Parents were given six newsletters (each with a theme) throughout the intervention. During the intervention period, students in the Hedmark intervention schools (n = 9) were given a carrot or one piece of free fruit at lunch. • 14 years follow-up	• The two groups who received free fruit, with and without the instructional session, did not significantly differ in their fruit intake at either follow-up, according to the analysis. Average daily fruit consumption by educational program 1.2 (1.0-1.4) and control 1.3 (1.1-1.6) portions. • The groups who received free fruit, with and without the educational program, did not differ significantly in their consumption of vegetables at any point in time. The average daily intake of vegetables by

Title, Author, Year	Characteristics			
	Population & Location	Design	Intervention & Duration	Outcome
				educational program was 1.6 (1.3-1.8) while the control group was 1.7 (1.5-1.9).
"Increasing Fruit and Vegetable Intake of Primary School Children in a Quasi-Randomized Trial: Evaluation of the Three-Year School-Based Multicomponent Intervention" (Ili´c et al., 2022)	• 681 children (Age 7.7 ± 0.4 years) from 14 primary schools (n = 300 in the control group and n = 381 in the intervention group). • City of Zagreb, Croatia	Quasi-Randomized Trial	• The intervention made up 23 activities, including interactive 45-minute classroom workshops, 10 cross-curricular activities, 13 homework challenges, classroom visual engagement with educational posters, online parent education, and the addition of new dishes to the school food system and the modification of existing ones. • 3 years	The total daily intake of fruits and vegetables was significantly higher ($p < 0.001$) for children in the intervention group (before: 332.1 ± 164.9 g; after: 430.1 ± 186.7 g) than for the control group (before: 350.2 ± 187.5; after: 382.6 ± 196.8).
"Active for Life Year 5: a cluster randomised controlled trial of a primary school-based intervention to increase levels of physical activity, decrease sedentary behaviour and improve diet" (Lawlor et al., 2016)	• Children in the fourth grade (years 8–9) at the time of recruitment, the fifth grade (ages 9–10) during the intervention and immediate follow-up, and the sixth grade (ages 10–11) during the one-year follow-up. 60 schools and 2221 students. • Bristol City and North Somerset Administrative areas, UK	Cluster-Randomized Controlled Trial	• Lesson plans, 16-lesson materials, parent-interactive homework, teacher training, and written materials for parents and school newsletters were all part of Active for Life Year 5 (AFLY5). • 1 year	AFLY5 cannot enhance the consumption of fruits and vegetables. The intervention group ate 1.99 (1.77) servings of fruit and vegetables daily, compared to 1.81 (1.55) servings for the control group.
"A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: a cluster randomized controlled trial" (Ochoa-Avilés et al., 2017)	• 1430 adolescents (12–14 years old) at a middle school. • Cuenca, Ecuador.	Cluster-Randomized Controlled Trial	The **ACTIVITAL** intervention packages: • Phase one (17 months) The curriculum-based element Classes every two weeks and an interactive educational tools Environment-based elements include making a nutritious breakfast, staff and parental workshops, and school food stalls. • Phase two (11 months) Curriculum-based element: Classes every two weeks and an	Fruit and vegetable consumption (g/d) at the conclusion of the intervention (28 months) was 23.88 (95% CI 7.36; 40.40).

Title, Author, Year	Characteristics			
	Population & Location	Design	Intervention & Duration	Outcome
			interactive instructional toolbox are provided. component based on the environment: Food stalls at schools, employees, and Workshops for parents	

Table 1 provides an overview of the general research features. All of the papers, including Cluster-RCT, were randomized controlled trials (k = 4) (Ili´c et al., 2022; Lawlor et al., 2016; Ochoa-Avilés et al., 2017; Øvrebø et al., 2019), RCT (k = 1) (Haire-Joshu D. L., 2015), and quasi-RT (k = 1) (Ili´c A., 2022). The intervention's duration, including follow-up, varied from six months (Jørgensen et al., 2016) to 12 months and more (Haire-Joshu D. L., 2015; Ili´c et al., 2022; Lawlor et al., 2016; Ochoa-Avilés et al., 2017), even 14 14-year follow-up (Øvrebø et al., 2019). Participants' ages ranged from 7 to 18, with 9 to 14 being the most common age range (k = 5) (Jørgensen et al., 2016; Lawlor et al., 2016; Ochoa-Avilés et al., 2017; Øvrebø et al., 2019).

The studies took place in the United States (k=1) (Haire-Joshu D. L., 2015), in Denmark (k=1) (Jørgensen et al., 2016), in Norway (k=1) (Øvrebø et al., 2019), in Croatia (k= 1) (Ili´c et al., 2022), in the United Kingdom (k= 1) (Jørgensen et al., 2016; Lawlor et al., 2016), and in Ecuador (k=1) (Ochoa-Avilés et al., 2017). All studies were clearly described to take place in a primary school (Ili´c et al., 2022; Jørgensen S. E., 2016; Lawlor et al., 2016; Øvrebø et al., 2019), middle school (Ochoa-Avilés et al., 2017), and high school (Haire-Joshu D. L., 2015).

All studies included a school component and a parental component intervention (Haire-Joshu D. L., 2015; Ili´c et al., 2022; Lawlor et al., 2016; Ochoa-Avilés et al., 2017; Øvrebø et al., 2019), but one study includes a local community component too, such as fact sheets for sports and youth clubs (Ili´c et al., 2022; Jørgensen S. E., 2016; Lawlor et al., 2016). Those examples of school-based program activities were free FV in class and curricular activities (Ili´c et al., 2022; Jørgensen S. E., 2016; Øvrebø et al., 2019), a variety of ‘virtual’ interactive lessons delivered via web-based (Haire-Joshu D. L., 2015) interactive classroom workshops (Ili´c et al., 2022) (Ochoa-Avilés et al., 2017). Fruit and vegetable consumption were the outcome and effectiveness characteristics of every study (k = 6). Tools for measuring FV intake include 24-hour dietary recall techniques (Jørgensen S. E., 2016; Ochoa-Avilés et al., 2017; Øvrebø et al., 2019). Snack and Beverage Food Frequency Questionnaire (Haire-Joshu D. L., 2015), semi-quantitative food frequency questionnaire (Ili´c et al., 2022)Day in the Life Questionnaire (Lawlor et al., 2016).

Numerous studies have shown that eating enough fruits and vegetables is essential to achieving good health at any age. Optimal intake can protect against non-communicable diseases. Schools can monitor the diet of the students. Educating parents about the risks of frequently eating unhealthy foods is also important. Parents ought to contribute equally to ensuring their children's diets. Through parent-teacher meetings, the child's nutrition should be pointed out (Rajani N., 2021).

The purpose of this systematic review was to investigate how well home-school-based nutrition interventions affected the outcomes of children and adolescents: fruit and vegetable consumption. Based on the review of 6 articles, information was obtained that all of them involved multicomponent interventions, including the involvement of students, teachers, and parents to increase vegetable and fruit consumption. A school component, such as free FV in class and extracurricular activities, and a parental component, such as a boost presentation at a parent-school meeting, six parent newsletters, three supervised student-parent curricular events, and a student-parent boost event, were both included in the first study. Parental intervention involvement may improve adolescents' FV intake if implementation challenges can be overcome (Jørgensen S. E., 2016). At the same time, the second study used a program called Balance Adolescent Lifestyle Activities and Nutrition Choices for Energy (BALANCE). In order to avoid obesity, this home, school, and online intervention education campaign greatly increased consumption of fruits and vegetables (Haire-Joshu D. L., 2015).

Likewise, a fourth article showed that children in "the Three-Year School-Based Multicomponent Intervention" group significantly increased FV consumption. Interactive classroom workshops, cross-curricular activities, homework assignments, classroom visual engagement with educational posters, parent education through the website, and the addition of new and modified meals to the school food system were all part of the intervention (Ili´c et al., 2022). The intervention program in the sixth study was called ACTIVITAL. This intervention package includes two stages. Stage one, for about 17 months, was a curriculum- and environment-based component, which included parental workshops. Stage two for about 11 months. Dietary risk variables for NCDs, such as consumption of fruits and vegetables, were positively impacted by this intervention. The intervention's overall impact is positive and promising, even though it is still below the dietary guidelines. To achieve a wider impact, academics and policymakers must work together to implement the program strategies at the national level (Ochoa-Avilés A., 2017).

According to the third article, a multicomponent educational program had both a classroom-based academic curriculum and a parental component. The intervention, which included health and FV information, was presented to parents during school sessions. Students received one piece of complimentary fruit and vegetables for lunch during the intervention, and parents received six newsletters, each with a different theme. The analysis found no 14-year effects of the teaching program on fruit and vegetable consumption, despite the trial being done over a long period of time. Additionally, there was no evidence of a synergistic impact between the free fruit and the educational program. Future research could benefit from a longer intervention time, more home availability, and a greater emphasis on more thorough parental involvement. However, additional long-term research is required to assess how home-school-based programs affect adults (Øvrebø et al., 2019).

The fifth article refers to the intervention program as Active for Life Year 5 (AFLY5). Lesson plans, resources for 16 lessons, parent-interactive homework, teacher training, and written content for parents and school newsletters were all provided. However, AFLY5 does not work to increase consumption of fruits and vegetables (Lawlor et al., 2016).

The study's findings highlight how home-school-based interventions may enhance specific outcomes (such as FV consumption). Further study is required to examine the possible effects of home-school-based nutrition interventions on children and adolescents, as the data

also reveal a lack of systematic evaluation of the effects of such programs (Abderbwih E., 2022). Only randomized controlled trials, which are regarded as the gold standard for research on the efficacy of health interventions, were accepted into this review (Hariton E., 2018). The limitation of identified this study is that the researcher did not measure the quality assessment of studies to see the risk of bias based on specific criteria.

Conslusion

Three of the six studies' findings indicate that home-school-based nutrition intervention programs significantly boost the consumption of fruits and vegetables by children and adolescents. However, 3 other literature sources did not increase fruit and vegetable consumption. This study references the best approaches and strategies to prevent non-communicable diseases. Multicomponent interventions, such as home-school-based (collaboration between the roles of parents, teachers, and students) with long duration and sustainability in the future, may have the potential to be effectively implemented on a large scale if supported by policymakers.

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