

Impact of Nutrition Education Program on Children's Eating Patterns

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Abstract The Dietary Guidelines for Americans recommend that half of one's plate be filled with fruits and vegetables to reduce the risk of chronic diseases. However, adherence to these guidelines remains low among children in the U.S. This pilot study explores the feasibility and potential impact of a multi-component nutrition education program on children's dietary habits using a pre-post intervention design. The program was implemented at an elementary school in Baltimore, targeting 3rd to 5th graders, and included educational sessions, cooking, gardening, and grocery shopping activities. Two cohorts participated: 17 students in the Fall and 16 in the Spring semester. Pre- and post-intervention assessments were conducted using a validated 25-question survey to measure changes in knowledge, attitudes, and dietary behaviors. Data was analyzed using the Wilcoxon Signed Ranks test to examine paired differences and the chi-square test for categorical variables. Preliminary results indicated significant increases in the consumption of whole grains, dairy, vegetables, fruits, and healthy proteins (e.g., fish, nuts, and eggs). Additionally, participants demonstrated improved attitudes toward drinking low-fat milk and choosing low-sugar beverages. These findings suggest that the program may have positively influenced children's dietary habits and attitudes toward healthier food choices. This pilot study provides promising evidence that a well-structured, hands-on nutrition education program can enhance children's dietary behaviors, potentially contributing to long-term health improvements and chronic disease prevention.

Keywords: Nutrition education, children, dietary habits, intervention, school-based programs, healthy eating, food desert

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1. Introduction

The concept of a sustainable diet was first defined in 2010, integrating two distinct perspectives: a nutrition-centered approach focused on individual health and a broader sustainability framework encompassing environmental, economic, and societal factors [1]. Extensive research highlights the significant benefits of consuming whole foods, particularly fruits and vegetables not only for human health but also for environmental sustainability, global food security, and animal welfare. Fruits and vegetables are rich in fiber, essential nutrients, and bioactive phytochemicals, which play a crucial role in reducing the risk of chronic diseases such as obesity, cancer, cardiovascular disease, diabetes, pulmonary disorders, and Alzheimer's disease [2].

However, the U.S. food production system is highly resource-intensive, utilizing approximately 50% of the country's irrigated land designated for food production, 80% of its available freshwater, and 17% of its fossil energy supply [3]. This level of dependence on finite resources raises concerns about the long-term sustainability of

current dietary patterns. Research indicates that a meat-based diet demands significantly more land, water, and energy compared to a plant-based diet [4], suggesting that shifting toward plant-based dietary patterns could be a viable strategy for promoting both health and sustainability [5].

Despite these advantages, fruit and vegetable consumption in the U.S. remains suboptimal. The USDA Dietary Guidelines recommend filling half of the plate with fruits and vegetables, equating to 4–5 cups daily. However, only 12.3% of the population meets these recommendations [6]. Furthermore, studies show that on a typical day, just 11% of children aged 6–11 years consume dark green vegetables, and only 36% eat citrus fruits, melons, or berries [7]. Addressing this gap is essential to improving dietary habits and long-term health outcomes.

Food preferences are shaped by both innate tendencies and learned experiences. While sweet, salty, and fatty foods are widely accepted, bitter and sour tastes are often met with aversion. Infants naturally prefer sweet flavors, an evolutionary mechanism linked to energy intake from carbohydrates, while displaying an innate dislike for bitterness to avoid potentially toxic substances [8,9]. However, taste preferences can be modified through early

exposure and learning processes, which influence long-term dietary choices [10,11]. Introducing children to diverse foods and food preparation methods from an early age is critical in fostering healthy eating behaviors. These habits, in turn, can help reduce the risk of diet-related chronic diseases such as obesity, diabetes, cardiovascular disease, and autoimmune disorders [12].

Several studies have examined the effects of nutrition educational sessions, gardening, cooking, and food label literacy, either individually or in combination, on children's lifestyles. However, only a few comprehensive studies have evaluated the impact of integrating multiple educational components on children's eating patterns, particularly in underserved communities. Therefore, this study aims to address this gap by assessing the effects of a holistic program that combines nutrition educational sessions, cooking, gardening, and grocery shopping. This approach seeks to improve children's dietary habits and promote long-term health outcomes.

2. Methods

2.1. Study Design and Setting

This pilot study utilized a pre-post intervention design to evaluate the feasibility and preliminary impact of a multi-component nutrition education program. The intervention was implemented as part of an after-school initiative at an elementary school located in a designated food desert in Baltimore, Maryland. The program targeted students in 3rd to 5th grade and was delivered over two academic semesters, Fall and Spring.

2.2. Sampling Method

A convenience sampling approach was employed. All 3rd to 5th grade students who registered for the school's after-school program were invited to participate. Participation was voluntary, and written informed consent was obtained from parents or legal guardians prior to enrollment. Only students who attended the majority of program sessions and completed both pre- and post-intervention assessments were included in the final analysis.

2.3. Sample Size

As this was a pilot study designed to assess program feasibility and generate preliminary data, a formal sample size calculation was not performed. The sample size was determined by the number of students who registered for and completed the after-school program during each semester. In the Fall semester group, 17 students completed both the program and assessments. In the Spring semester group, 16 students met these criteria.

2.4. Inclusion and Exclusion Criteria

Students were eligible for inclusion if they were enrolled in 3rd, 4th, or 5th grade at the participating elementary school, registered in the after-school program, provided parental or guardian consent, and were willing to

participate in all program activities and assessments. Students were excluded if they had severe food allergies or medical conditions that precluded participation in cooking or tasting activities, were unable to attend both pre- and post-intervention assessments or withdrew from the after-school program before study completion.

2.5. Intervention Components

The nutrition education program consisted of four integrated components:

Educational Sessions: Facilitated by qualified trainers from the Nutritional Sciences program at Morgan State University, these sessions focused on evidence-based nutrition concepts, healthy eating behaviors, environmentally sustainable food choices, and community responsibility.

Cooking Activities: Led by a chef instructor with support from educational trainers, these hands-on sessions taught students essential cooking skills and involved the preparation of simple, nutritious meals using healthy ingredients.

Gardening Activities: Gardening trainers introduced students to the benefits of growing herbs such as basil and rosemary and led classroom-based planting demonstrations to foster a connection with the origins of food.

Grocery Shopping Experiences: Trainers organized guided tours of local grocery stores, teaching students how to read nutrition labels, identify nutrient-dense foods, and make healthier choices with an emphasis on whole foods and reduced processed food consumption.

2.6. Survey Instrument and Validation

A validated 25-question survey was used to assess changes in dietary habits, nutrition knowledge, and attitudes. This questionnaire was originally developed and validated for use in school-based nutrition education interventions and has demonstrated reliability and suitability for elementary school children [13].

2.7. Data Collection

The 25-question survey was administered to participants immediately before (pre-test) and after (post-test) the intervention. Participation incentives were provided to encourage completion of both assessments.

2.8. Statistical Analysis

Data were analyzed using SPSS version 25.0. The Wilcoxon Signed Ranks test was used to compare paired pre- and post-intervention survey scores within participants. The chi-square test was employed to assess differences in categorical dietary behavior changes between Fall and spring semester groups. Statistical significance was set at $p < 0.05$.

2.9. Ethical Considerations

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Morgan State University. All participants and their guardians provided written informed consent prior to enrollment.

Confidentiality of participant information was strictly maintained throughout the study.

3. Results

Results from both the Fall and Spring groups showed a significant increase in vegetable consumption, (Fall semester group: $z=-3.342$, $p=0.001$, Spring semester group: $z=-3.401$, $p=0.001$). Figure 1 (Fall and spring semester groups) illustrate the percentage of children consuming vegetables at various frequencies before and after participating in the nutrition education program. Prior to the program, 47.1% of children in Fall semester group and 43.8% in Spring semester group did not consume vegetables. After completing the program, these percentages dropped to 0% and 6.3%, respectively, demonstrating the program's positive impact. Additionally, at the start of the program, no children in either group consumed vegetables three or more times per day. After the intervention, 23.5% of children in Fall semester group and over 12.5% in Spring semester group reported consuming vegetables at least three times daily.

Both cohorts also demonstrated a significant increase in fruit consumption following the nutrition education program (Fall semester group: $z=-3.341$, $p=0.001$, Spring semester group: $z=-3.210$, $p=0.001$). Figure 2 (Fall and Spring semester groups) depict the percentage of children consuming fruits at various frequencies before and after the intervention. At the beginning of the program, 17.6% of children in Fall semester group and 18.8% in Spring semester group did not consume fruits. After completing the program, these percentages dropped to 0% and 6.3%,

respectively. By the end of the program, 29.5% of children in Fall semester group and 18.8% in Spring semester group consumed fruits five or more times per day, compared to only 11.8% in Fall semester group and none in Spring semester group at the beginning.

Moreover, the results revealed a significant increase in dairy consumption, including milk, yogurt, and cheese, following participation in the program (Fall semester group: $z=-2.970$, $p=0.003$, Spring semester group: $z=-3.407$, $p=0.001$) data not shown. In addition, the results revealed a significant increase in children's consumption of healthy protein foods, including fish, eggs, nuts, and peanut butter, in both cohorts after attending the program (Fall semester group: $z=-3.169$, $p=0.002$, Spring semester group: $z=-3.256$, $p=0.001$) data not shown.

Furthermore, children's attitudes toward drinking low-fat milk significantly improved after participating in the program (Fall semester group: $z=-3.213$, $p=0.001$, Spring semester group: $z=-2.968$, $p=0.003$). Table 1 presents the percentage of children in both cohorts who selected each response to the multiple-choice question regarding their interest in drinking low-fat milk before and after the program. At the start of the program, more than half of the children either disliked low-fat milk or were unsure about it. However, by the end of the program, this proportion decreased to 0% in Fall semester group and 12.5% in Spring semester group. Additionally, both cohorts showed a significant increase in their interest in drinking low-sugar beverages, such as water or plain milk, by the program's conclusion (Fall semester group: $z=-2.699$, $p=0.007$, Spring semester group: $z=-2.694$, $p=0.007$). Analysis of the data revealed no significant variations in diet improvement across different genders, ages, or cohorts.

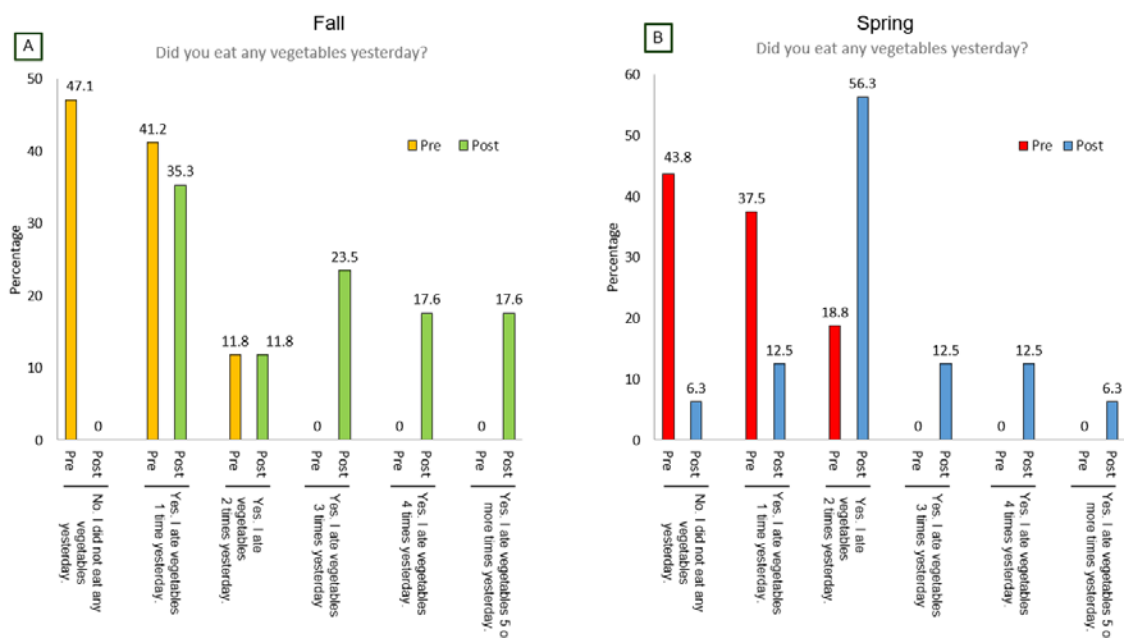


Figure 1. The data are presented as percentages of students' responses to different options on a multiple-choice question regarding vegetable consumption in the pre-test and post-test for Fall 2023 (A, Fall semester group) and Spring 2024 (B, Spring semester group). A significant increase in vegetable consumption was observed in both instances (A: $p=0.001$, B: $p=0.001$)

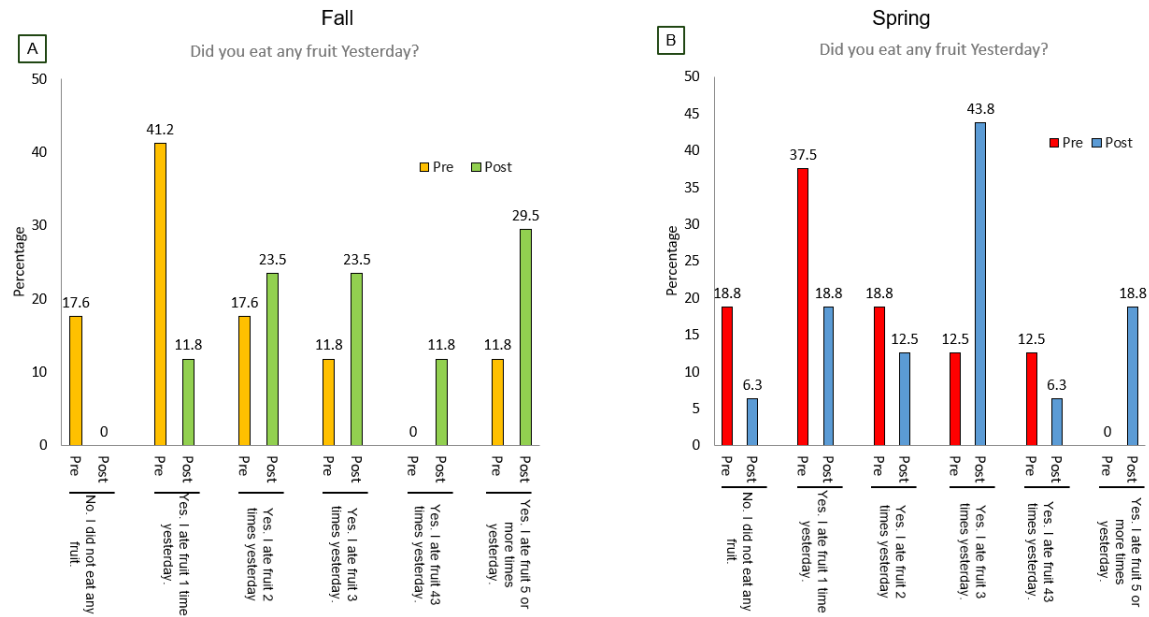


Figure 2. The data are expressed as percentages of students' responses to various options on a multiple-choice question about fruit consumption in the pre-test and post-test for Fall 2023 (A, Fall semester group) and Spring 2024 (B, Spring semester group). A significant increase in fruit consumption was observed in both cases (A: $p = 0.001$, B: $p = 0.001$)

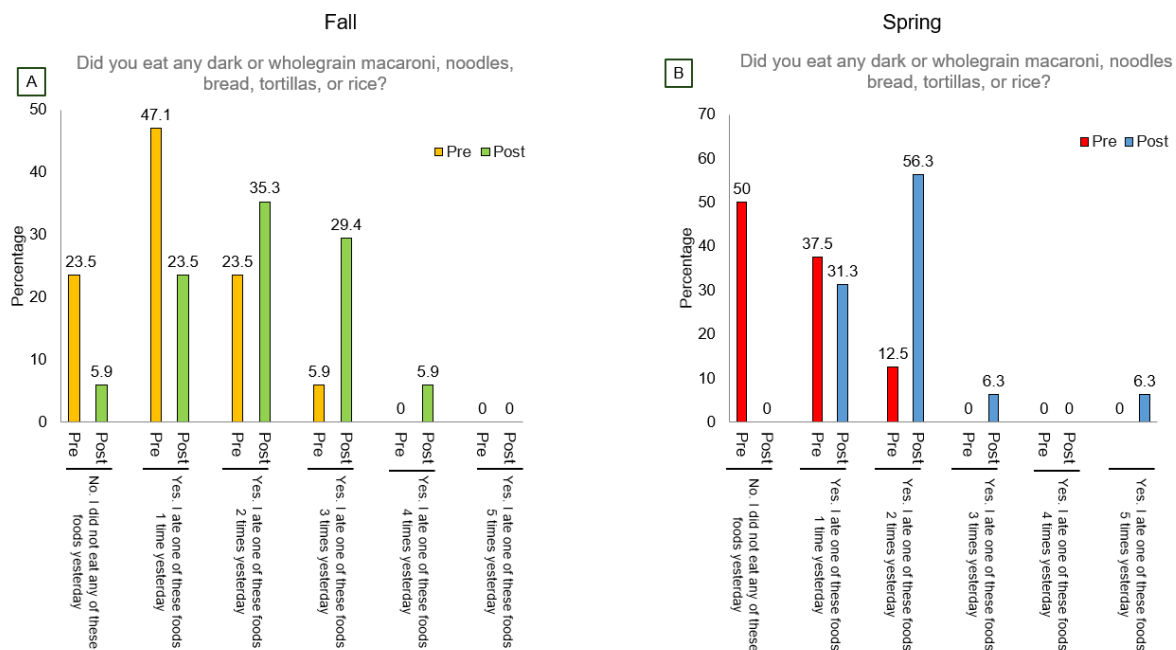


Figure 3. The data are shown as percentages of students' responses to various options on a multiple-choice question about wholegrain food consumption in the pre-test and post-test for Fall 2023 (A, Fall semester group) and Spring 2024 (B, Spring semester group). A significant increase in wholegrain foods consumption was observed in both periods (A: $p = 0.008$, B: $p = 0.002$)

Table 1. Percentage of children in both groups who selected each response to the multiple-choice question about their interest in drinking low-fat milk before and after the program

Questions		I really don't like to drink low fat milk.	I don't like to drink low fat milk.	I'm not sure if I like to drink low fat milk.	I kind of like to drink low fat milk	I really like to drink low fat milk
Fall	At the beginning of the program	5.9%	0%	64%	17.6%	11.8%
	At the end of the program	0%	0%	0%	64%	35%
Spring	At the beginning of the program	0%	12.5%	0%	62.5%	25%
	At the end of the program	43.3%	18.8%	6.3%	25%	6.3%

4. Discussion

This pilot study provides preliminary evidence that a well-structured, multi-component nutrition education program may positively influence children's dietary behaviors. Participants demonstrated increased intake of whole grains, dairy, vegetables, fruits, and healthy protein sources suggesting that experimental learning strategies, when combined with classroom-based instruction, hold promise for encouraging healthier food choices. These results are consistent with previous research demonstrating the potential of school-based interventions to improve children's dietary behaviors and attitudes [14,15]. Although the findings align with earlier work, this study also offers distinct contributions. For example, Melnick *et al.* focused on preschool-aged children and primarily measured willingness to consume fruits and vegetables. In contrast, our program targeted 3rd to 5th grade elementary students and evaluated changes across a broader set of outcomes, including actual dietary intake, nutrition knowledge, and attitudes toward multiple food groups. This broader scope offers a more comprehensive view of the potential effects of nutrition education at this developmental stage.

Likewise, while Schmidt *et al.* explored the effects of after-school culinary education with a focus on cooking, our intervention incorporated multiple experiential components cooking, gardening, grocery shopping, and classroom lessons. This holistic approach reflects a growing understanding that diverse, interactive experiences may be more engaging and impactful in shaping children's dietary behaviors.

The positive shift in attitudes toward low-fat milk and low-sugar beverages observed in this study further supports findings from similar interventions, which suggest that early exposure to nutrition education can foster healthier beverage choices [16]. Additionally, incorporating grocery shopping and label reading activities may have contributed to increased nutrition literacy, reinforcing children's ability to make informed food decisions [17].

Hands-on activities such as cooking and gardening likely played a meaningful role in promoting dietary improvements, as prior studies have linked experiential learning with increased acceptance of healthy foods [18,19]. These components not only helped reinforce nutrition concepts but also equipped children with practical skills that may support sustained behavior change. The observed changes are consistent with findings from Kendel Jovanović *et al.*, who reported improvements in diet quality and nutrition knowledge following structured education programs [18]. However, our program differed by emphasizing experiential components alongside traditional education, which may have enhanced engagement and real-world application of the content.

As a pilot study, these findings should be interpreted with appropriate caution. The primary aim was to assess the feasibility and potential impact of the intervention, rather than to draw definitive conclusions. Nonetheless, the observed trends suggest that experiential, after-school nutrition education programs may be a promising

avenue for improving dietary behaviors in elementary school-aged children.

4.1. Strengths and Limitations

This pilot study presents several notable strengths that enhance its contribution to the field of nutrition education. The program was thoughtfully designed to be comprehensive and multi-faceted, integrating classroom-based lessons with practical, hands-on activities such as cooking, gardening, and grocery shopping. This holistic approach reflects best practices in the literature, which emphasize that diverse, experiential learning opportunities are more effective in encouraging positive dietary behavior changes among children than isolated, single-focus interventions. The semester-long duration of the program allowed for sustained engagement, reinforcing nutrition concepts over time and giving participants repeated opportunities to apply healthy behaviors in meaningful ways. Implementing the program within an afterschool setting further demonstrates its real-world feasibility and adaptability, showing that impactful nutrition education can be successfully delivered outside traditional classroom hours. Additionally, the use of a validated 25-item survey to assess knowledge, attitudes, and behaviors enhances the credibility and reliability of the study's outcome measures.

While exploratory in scope, the study also provided valuable lessons that can guide future research and program development. The relatively small sample size is typical of pilot studies, which prioritize feasibility, acceptability, and iterative improvement over definitive statistical conclusions. These characteristics allowed for close monitoring of implementation and participant engagement in a real-world setting. The limited number of participants and instances of attrition were shaped by the structure of the voluntary afterschool program—insights that are useful for improving future recruitment and retention strategies. Although the study did not include a control group, the focus on program delivery and outcome measurement serves as an essential foundation for designing future randomized controlled trials. The single-site setting in a Baltimore elementary school may limit generalizability, but it also provided rich, context-specific insights that can inform adaptations across diverse educational environments.

As with many school-based interventions, this study did not specifically assess the influence of students' home food environments or family dietary behaviors. Including these factors in future research may offer even deeper insights into the broader context of children's nutrition and further strengthen program outcomes.

Overall, this pilot study offers both evidence of promise and practical guidance, strengthening the case for continued investment in community-based nutrition education initiatives.

5. Conclusion

This pilot study suggests that a structured, experiential nutrition education program may positively influence children's dietary habits. Participants demonstrated

notable improvements in the consumption of fruits, vegetables, whole grains, dairy, and healthy protein sources findings that align with the value of hands-on learning experiences such as gardening, cooking, and grocery shopping in promoting healthier food choices.

The observed increase in children's preference for low-fat milk and low-sugar beverages also highlights the program's potential to support healthier beverage consumption an important factor in reducing the risk of childhood obesity and diet-related chronic conditions.

These preliminary results underscore the promise of early, practical nutrition education in fostering healthy eating habits. By building both knowledge and skills, such programs may not only encourage immediate behavior change but also support long-term health and disease prevention. Future studies with larger and more diverse populations, and more rigorous designs, will be essential to confirm these findings and expand their public health relevance.

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