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RESEARCH ARTICLE

Nutrition Education Intervention Improves Vegetable-Related Attitude, Self-Efficacy, Preference, and Knowledge of Fourth-Grade Students

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ABSTRACT

BACKGROUND: Impact of a classroom-based, standardized intervention to address limited vegetable consumption of fourth graders was assessed.

METHODS: A 4-lesson, vegetable-focused intervention, revised from extant materials was repurposed for Pennsylvania fourth graders with lessons aligned with state academic standards. A reliability-tested survey was modified, then examined for face and content validity and test-retest reliability. Lessons and evaluation materials were modified through an iterative testing process with educator feedback. A nonequivalent control group design was stratified by local Supplemental Nutrition Assistance Program Education (SNAP-Ed) partnering organizations with random assignment of participating elementary schools as control (N = 68) or intervention (N = 72) treatments. Independent *t*-tests compared control and intervention group changes. A mixed effects model was created to account for classroom effects from the nested sampling method of selecting classrooms within SNAP-Ed partnering organizations. General linear model univariate analyses of variance were conducted to assess intervention effects considering gender, and food preparation/cooking experience.

RESULTS: During a 3- to 5-week time frame, 57 intervention classrooms (N = 1047 students) and 51 control classrooms (N = 890) completed pre- and post-testing. Intervention students improved in vegetable-related attitude, self-efficacy, preference, and knowledge scores ($p < .001$). For example, intervention vegetable preference increased 1.56 ± 5.80 points; control group mean increase was only 0.08 ± 4.82 points. Group differences in score changes were not affected by gender or interactions between gender and food preparation/cooking experience with family.

CONCLUSIONS: A defined intervention delivered in a SNAP-Ed setting can positively impact mediators associated with vegetable intake for fourth-grade students.

Keywords: nutrition education; vegetables; evaluation.

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Vegetable intake is correlated with children's health and weight status.[1-3] Despite the established benefit of vegetables, children's intake does not meet recommended amounts. According to a 2009 study using 1999-2002 National Health and Nutrition Examination Survey (NHANES) data, 16.2% of school-age children (6-11 years old) met MyPyramid vegetable recommendations, and only 8% of vegetables consumed by children (2-19 years old) are dark green or orange.[1] Pennsylvania Supplemental Nutrition Assistance Program Education (SNAP-Ed) needs assessment revealed low intake of vegetables by middle and high school students; only 16.7% of students reported consuming vegetables 3 or more times per day in the preceding week.[4]

Focusing an intervention on elementary school-age children impacts behaviors before they are established which may, in turn, lead to more permanent effects.[5] Another benefit of focusing an intervention toward students in this age range is that children 7-12 years old have cognitive capacity to understand the health benefits of foods and can identify specific taste differences.[6]

Children's low vegetable intake can be attributed to a variety of psychosocial and environmental factors that mediate behavior.[7] Preference may be one of the most important factors in predicting fruit and vegetable intake.[8,9] Interventions that improve preference may result in increased fruit and vegetable consumption.[9] Knowledge and self-efficacy may also mediate fruit and vegetable consumption; previous brief interventions

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have had significant impacts on these mediators.[10] Change in knowledge is desirable in an intervention, but is not a single predictor because it interacts with other mediators before behavior change occurs.[11] Task self-efficacy, ability to perform a specific task (eg, eat raw vegetables once or twice per week, eat a serving of cooked vegetables once or twice per week), has also been shown to influence intake of fruits and vegetables in children, that is children with higher self-efficacy have greater intake of vegetables.[12] Other state SNAP-Ed school-based programs have measured these mediators; results are mixed, but mostly positive, and underscore the need for well-designed impact studies.[13]

In Pennsylvania, SNAP-Ed is delivered in schools by local organizations (local partners). To address the aforementioned need to educate children about vegetables, and considering the cognitive abilities of the 7- to 12-year-old audience, a workgroup of state and local partner nutritionists identified fourth-grade students (approximate age 9 years) as the target audience and determined 4 lessons to be feasible for delivery of a classroom-based, standardized, vegetable education intervention and impact evaluation. The workgroup examined existing curricula; however, none of these fully focused on vegetables. Most available curricula (eg, Team Nutrition) covered multiple topics and did not include sufficient material for 4 vegetable lessons.[14] Others, such as California's Harvest of the Month, focus on vegetables, but not vegetables available in Pennsylvania.[15] Components of national (eg, Level 2 Team Nutrition) and local curricula were revised, repurposed, and compiled to form the vegetable intervention. Lessons were aligned with Department of Education State Academic Standards and included food tastings, worksheets, handouts, and activities (Table 1). Educator feedback following implementation informed curricular revision. Revisions included modifying Lesson 1 and Lesson 4 activities to allow more time for pre- and post-test administration, revising Lesson 2 food tasting activity to reduce preparation time, and simplifying Lesson 3 math activities.

Table 1. **Fourth-Grade Vegetable Intervention Overview**

Lesson 1. Surprising Veggies

- My Pyramid for Kids Review
- Activities: Vegetable Identification, Added Sugars and Solid Fats Content of Vegetables
- Food Tasting: Crunchy Sugar Snaps
- Key Message Review
  - Vegetables are a quick and easy snack.

Lesson 2. Veggie Math

- Vegetable Intake Recommendations, Cup Equivalents
- Activities: Salad Ingredients Measurement, Math
- Food Tasting: Colorful Crunch Salad
- Key Message Review
  - Boys and girls your age need 2 ½ cups of vegetables every day.
  - A salad is a quick and easy snack that you can make yourself.
  - Romaine lettuce is an excellent source of vitamin A. Tomatoes are an excellent source of vitamin C and green peas provide vitamins A and C. Vitamin A keeps eyes and skin healthy and helps keep us from getting sick. Vitamin C helps heal cuts and wounds and keeps gums and teeth healthy.

Lesson 3. The Veggie Subgroups

- Vegetable Subgroups
- Activity: Vegetable Categorization into Subgroups
- Food Tasting: Southwestern-Style Salsa
- Key Message Review
  - Eating a variety of vegetables is important. Different vegetables contain different important nutrients and almost all vegetables contain fiber.
  - Adding beans and corn to salsa is a quick and easy snack that you can make at home.
  - Beans are a great source of fiber and protein.
  - Corn is a great source of energy and tomatoes give you vitamin C.

Lesson 4. Vary Your Veggies

- Activities: Vegetable Vitamin A Content, Vegetable Vitamin C Content
- Food Tasting: Colorful Crudités
- Key Message Review:
  - Orange and dark green vegetables are rich in Vitamin A.
  - Vitamin A keeps eyes and skin healthy and helps keep us from getting sick.
  - Vitamin C helps heal cuts and wounds and keeps teeth and gums healthy.

METHODS

Participants

SNAP-Ed is funded by the United States Department of Agriculture Food and Nutrition Service and is delivered to Supplemental Nutrition Assistance Program eligible audiences. In Pennsylvania, the SNAP-Ed state-level management entity subcontracts with local organizations (local partners) to deliver nutrition education. Local partners establish relationships with eligible sites in their service area, for example, schools where ≥50% of students are receiving free or reduced-price meals through the National School Lunch Program.

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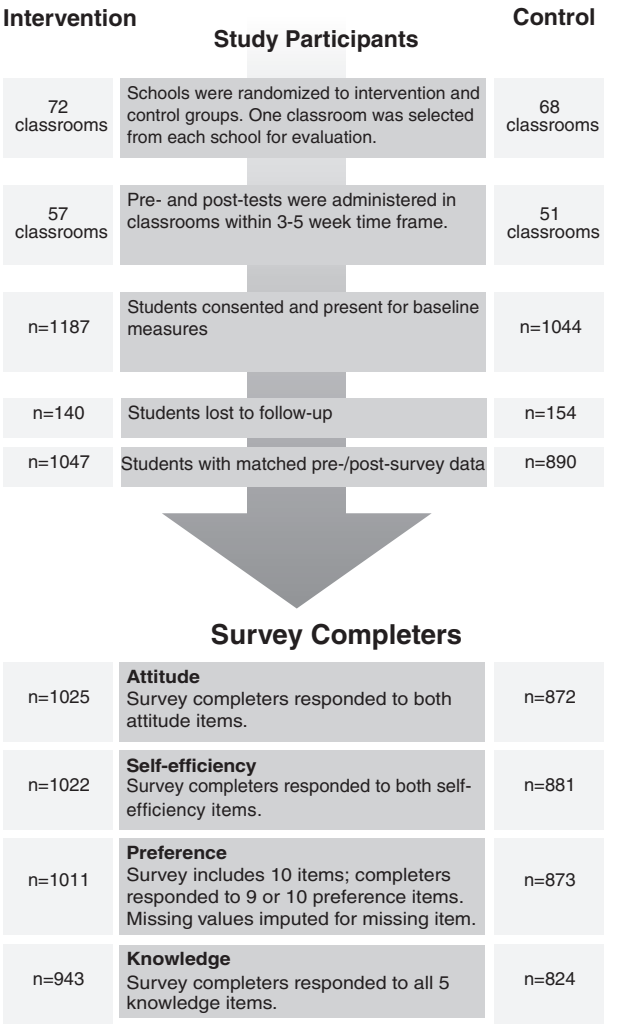
A nonequivalent control group design stratified by 14 local partners was used. Sampling and random assignment for this study considered only SNAP-Ed participating schools. Approximately 200 elementary schools from 22 school districts were identified for study participation. One of the school districts represented approximately 65% of the total number of schools identified. To allow for geo-diverse distribution, schools were stratified by the 6 local partners serving this district—if a local partner had fewer than 12 schools, 1 control and 1 intervention school was randomized; if a local partner had between 12 and 40 schools, 2 control and 2 intervention schools were randomized; if a local partner had more than 40 schools, 3 control and 3 intervention schools were randomly selected. The other 8 local partners utilized a sampling structure where 50% of their schools were randomly assigned to intervention and the remaining 50% were assigned to control.

Following stratification and according to the designated sampling structure, 68 elementary schools were randomly assigned to control and 72 to intervention (Figure 1). Local partners selected 1 classroom of fourth-grade students (N = 2231) from each school. The study was sufficiently powered to detect a change of 0.5 for each survey with a power of 0.9.

Figure 1. **Participation and Attrition in Intervention and Control Groups**



Instruments

Food preference, attitude, and self-efficacy survey items developed for a SNAP-Ed intervention (Cooking With Kids) in New Mexico were used with permission and modified to align with lesson content (eg, removal of fruit items, modification or removal of items related to cooking).[16] Knowledge items were created to assess key messages from the lessons.

Survey administration was piloted in 2 fourth-grade classrooms. Reading survey items aloud to students was preferred because reading ability varied among students and between classrooms. Cognitive interviews, conducted with fourth-grade students (N = 30) recruited from SNAP-Ed eligible sites, informed revision of survey items and instructions for comprehension improvement. For example, the original item: ''What is the recommended amount of vegetables for you to eat each day'' was revised to ''What amount of vegetables is best for me to eat each day'' because students had difficulty with the word ''recommended.'' The attitude item: ''How do you feel about tasting vegetables'' was revised to ''How do you feel about the taste of vegetables'' because 2 interpretations of the word ''tasting'' emerged—tasting new vegetables and the taste of vegetables in general. Items and response choices appear in Table 2.

To examine test-retest reliability, 147 students completed the revised survey at 2 time points, from 10 to 14 days apart, with no intervening SNAP-Ed. Test-retest scores were strongly correlated for attitude, self-efficacy, and vegetable preference surveys and moderately correlated for knowledge survey (Pearson correlation coefficients (r) were 0.71, 0.60, 0.85, and 0.30, respectively). All survey correlations were statistically significant ($p < .001$). Cronbach's α coefficients revealed internal consistency for attitude, self-efficacy and vegetable preference surveys (0.74, 0.65, and 0.71, respectively).

Procedure

One classroom from each school was selected to participate in impact evaluation; classroom selection was at the discretion of the local partner. Training in lesson and survey administration was delivered to local partner educators using Webinar. The intervention and evaluation time frames were September-December 2008 and September-December 2009. Control classrooms did not receive vegetable-related instruction; however, non-vegetable-related instruction (eg, whole

Table 2. **Survey Items and Response Choices***

Survey Items	Response Choices
Background	
• Do you make food with your family?	Yes, No
• How often do you choose your own snacks?	I almost always choose my own snacks. I usually choose my own snacks. I sometimes choose my own snacks. I hardly ever or never choose my own snacks.
Attitude	
• How do you feel about the taste of vegetables?	I really like the taste of [making snacks with] vegetables.
• How do you feel about making snacks with vegetables?	I kind of like the taste of [making snacks with] vegetables. I don't like the taste of [making snacks with] vegetables. I really don't like the taste of [making snacks with] vegetables. I'm not sure if I like the taste of [making snacks with] vegetables.
Self-efficacy	
• I can make a snack with vegetables.	YES! Yes No NO! Not Sure
• I can eat many kinds of vegetables each week.	
Preference	
Romaine lettuce, Peppers, Celery, Corn, Carrots, Broccoli, Black beans, Peas, Tomato, Spinach	
Knowledge	
• Broccoli has vitamin C which helps keep my gums and teeth healthy.	True, False
• Carrots and corn are in the same vegetable subgroup.	
• Vegetables help keep me from getting sick.	
• Beans are high in fiber.	
• What amount of vegetables is best for me to eat each day?	Amounts that equal 4 ½ cups Amounts that equal 1 cup Amounts that equal 2 ½ cups Amounts that equal 6 cups

*Instructions for survey administrator: Administer the survey 1 page at a time. Read the instructions for the page as indicated. When noted, read survey items aloud. Educators may decide, on an individual classroom basis, to also read the response choices aloud. Allow adequate time for students to fill in their answers before continuing to the next question. Read questions 2-8 aloud and allow adequate time for each student to fill in his/her answer before continuing to the next question. Read questions 9-13 aloud and allow adequate time for each student to fill in his/her answer before continuing to the next question.

grains, physical activity) was not prohibited in this time frame.

The evaluation tool, comprised of 4 surveys (attitude, self-efficacy, preference, and knowledge), was administered at the start of the first lesson for intervention classrooms; an identical post-test was administered at end of the fourth lesson. Instructions and survey items were read aloud according to protocol; response choices were read aloud based on reading ability of individual classrooms. Control classrooms completed the survey at 2 time points with no intervening vegetable-related SNAP-Ed.

Data Analysis

Item scales were summed and resulting scores were analyzed at the student level. Baseline demographic and survey data were compared between students who completed pre- and post-surveys and those who were lost to attrition; only age statistically differed between the 2 groups. However, the difference was only 0.13 years, which does not carry practical significance. Only students completing surveys at both time points within the specified time frame were included in the analyses. The 2008 and 2009 participant characteristics and baseline survey scores were compared using t tests and χ^2 tests as appropriate. The only significant differences were for age (2008 = 9.33 years, 2009 = 9.28 years; $p < .024$) and baseline preference score (2008 = 35.49, 2009 = 36.34; $p < .027$); these differences did not have practical significance. Results from these comparisons showed that data from the 2 time frames were similar and could be combined into 1 dataset for analyses.

Cases with 1 preference survey item missing (out of 10 possible items) were examined and determined to be missing completely at random. Missing values were estimated using the expectation maximization method for 125 cases.

Data were analyzed with paired t tests comparing mean pre- and post-test scores within each study

group. Independent *t* tests compared score changes for control group with the intervention group. Effect size (Cohen's *d*) was calculated for the mean score change between control and intervention group. The difference in score changes was divided by the control group standard deviation to determine effect size. Mixed effects models were created to account for classroom effects from the nested sampling method of selecting classrooms within local partners. General linear model univariate analysis of variance was conducted for each survey to assess effects of study group, gender, and food preparation/cooking experience with family. SPSS version 18.0 was used for data analysis (SPSS, Chicago, IL).

RESULTS

During a 3- to 5-week time frame within the study period, 57 intervention classrooms and 51 control classrooms completed pre- and post-testing; 2231 students were consented and presented for baseline measures. Figure 1 shows that 13.2% (N = 294) of the total sample was lost to follow up. Attrition followed from failure to administer the protocol within 3-5 weeks, incomplete surveys, absent or missing for post-test or declined participation. Intervention impact was assessed with 1937 students (control group N = 890, intervention group N = 1047). Each survey (attitude, self-efficacy, preference, knowledge) was examined separately. Specific survey sample size varied because of missing responses. Baseline survey responses were not significantly different between intervention and control groups. Pre- and post-score change was significantly different ($p < .001$) between control and intervention groups for all surveys (Table 3). Mean age of the sample was 9.31 ± 0.52 years; 51.2% were female.

Table 4. **Intervention Impact Controlling for Classroom Effects**

	Intervention effect	*t* Statistic	p-value
Attitude	0.48	5.0	<.001
Self-efficacy	0.47	4.1	<.001
Preference	1.50	4.9	<.001
Knowledge	0.98	10.7	<.001

Mixed Effects Model

A mixed effects model accounts for any variation among local partners and for schools within partners; number of schools per local partner ranged from 1 to 18. The model included a random effect for schools nested within local partner, and study group (control/intervention) was included as a fixed effect. The random effect accounts for similarities among students within schools. A model was run separately for each survey (Table 4). Intervention effect was attributed to treatment group indicating analyses did not require controlling for local partner or school factors. Thus, data analyses were conducted at the student level.

Univariate Analysis

The intervention resulted in a significant improvement in attitude, self-efficacy, preference, and knowledge scores ($p < .001$). Score changes were not affected by gender or interactions between gender and food preparation/cooking experience with family.

DISCUSSION

Results show that a carefully designed and implemented intervention and evaluation that addresses mediators of behavior change using approaches

Table 3. **Mean Score (SD) of Attitude, Self-Efficacy, Preference, and Knowledge for Control and Intervention Groups**

Survey	Pre-Test	Post-Test	Difference Score	p Value*	Effect Size (Cohen's *d*)
Attitude (N = 1897)†					
Control (N = 872)	7.84 (2.09)	7.65 (2.12)	−0.18 (1.72)	<.001	0.27
Intervention (N = 1025)	7.77 (2.04)	8.07 (2.02)	0.29 (1.87)		
Self-efficacy (N = 1903)‡					
Control (N = 881)	7.65 (2.30)	7.63 (2.31)	−0.02 (1.89)	<.001	0.24
Intervention (N = 1022)	7.59 (2.26)	8.02 (2.13)	0.43 (2.06)		
Preference (N = 1884)§					
Control (N = 873)	35.86 (8.40)	35.94 (8.41)	0.08 (4.82)	<.001	0.31
Intervention (N = 1011)	35.82 (8.06)	37.28 (8.21)	1.56 (5.80)		
Knowledge (N = 1767)‖					
Control (N = 824)	2.84 (1.09)	2.97 (1.05)	0.17 (1.21)	<.001	1.03
Intervention (N = 943)	2.78 (1.11)	3.92 (1.04)	1.42 (1.42)		

*p value represents independent *t* test of pre- and post-differences between control and intervention groups.
†Attitude score ranges from 2 to 10 points, with a higher score indicating better attitude.
‡Self-efficacy score ranges from 2 to 10, with a higher score indicating better self-efficacy.
§Preference score ranges from 10 to 50, with a higher score indicating better preference.
‖Knowledge score ranges from 0 to 5, with a higher score indicating greater knowledge.

recommended by nutrition education experts (eg, learner-centered activities, vegetable food tastings) can positively impact mediators of vegetable intake in fourth graders.[17] Our short-term intervention (3-5 weeks) was effective, which is heartening given that delivering standardized interventions in a large geo-diverse SNAP-Ed program is challenging.

Survey items, carefully developed by nutrition education experts, aligned with the intervention and were shown to have content validity. For example, Lesson 3 included a black bean and corn salsa food tasting; this led to inclusion of black beans and corn as preference survey items. Key messages in Lesson 3 targeted the fiber and protein content of beans; thus, ''Beans are high in fiber,'' was included as a true/false knowledge survey item. Survey findings appeared to reflect an alignment with the intervention.

Our intervention keyed on vegetables as snacks. Thus, survey items relating to snacks contributed more to the overall score. For example, the mean difference between pre- and post-survey response for the attitude item addressing making snacks with vegetables contributed more to the overall survey score change than the attitude item about taste of vegetables. However, the contribution of the snacks item to total score change was not significantly greater than the contribution of the taste item. The contribution of the snack item to total attitude score change suggests intervention fidelity, since key messages about vegetables as tasty, quick, and easy snacks are included in Lessons 1, 2, and 3; messages are reinforced during food tastings.

Examination of individual preference items showed impact was not related to just 1 item. A good example of this is change noted in black bean preference, which had the largest effect size (Cohen's $d = .445$). Preference was low at baseline in intervention and control groups (2.58 ± 1.48 and 2.61 ± 1.45, respectively). However, recalculating preference score to remove black beans still resulted in significantly larger improvement ($p < .001$) for intervention (0.90 ± 5.18) as compared to control (0.05 ± 4.42).

Developing a knowledge assessment remains a challenge. As previously mentioned, test-retest responses were not as strongly correlated for knowledge as the other surveys, possibly stemming from guessing and/or learning effects. Knowledge was measured with 5 items; 4 true/false questions and 1 multiple choice question with 4 response options (Table 2). The item with the greatest contribution to total knowledge score change was the multiple choice question about recommended vegetable amounts. This could follow from the difference in question format (number of response options) rather than the intervention.

Another challenge of knowledge assessment is creating items with the appropriate level of difficulty for a student audience with a diverse knowledge base. For the true/false item ''Broccoli has vitamin C which helps keep my gums and teeth healthy'' 61.5% of control and 67.2% of intervention respondents answered correctly at baseline and follow-up, indicating they knew the correct answer at both time points. Similarly, 69.8% control and 68.1% intervention respondents correctly answered at baseline and follow up the true/false item ''Vegetables help keep me from getting sick.'' The other knowledge item responses indicated less than 50% of respondents answered correctly at both time points; the multiple choice item had the lowest percentage of correct response at pre- and post-testing (11.9% and 23.1% for control and intervention, respectively).

Our research design included randomization of schools and ensured a statewide, geographically diverse sample. Local partners received training specific to this intervention and evaluation protocol. A key strength of this study was that it was conducted under typical SNAP-Ed field conditions; for example, student absences, school calendar changes, and staff turnover. To address field conditions, we monitored progress and provided partner-specific support throughout the study.

An additional strength is that our intervention focused on specific nutrition behaviors for improving attitude, self-efficacy, and preference to empower students to choose and enjoy vegetables as snacks. Food tastings offered familiar vegetables and introduced new vegetables in a well-accepted format. This is compatible with sound nutrition education principles, that is, effectiveness is more likely when focused on specific behaviors.[17]

Limitations

Our findings cannot be generalized to all Pennsylvania fourth-grade students because the intervention was limited to schools where 50% or more students were receiving free/reduced meals through the National School Lunch Program (a requirement for participation in SNAP-Ed).[18] Classroom selection for impact assessment was at the local partner's discretion to accommodate willingness of classroom teachers to participate. This flexibility may have introduced bias; however, no significant difference was noted between baseline scores for control and intervention classrooms. Another limitation is that all data were self-report; vegetable intake was not directly assessed, rather we relied on preference as a mediator to gauge behavior. Preference is a good proxy for intake; studies have shown that students with higher preference for fruits and vegetables also have higher average daily intake of these foods.[8,9,19] Children's preferences have a strong influence on vegetable selection and purchase for family meals.[20] Our results suggest that classroom interventions that include exposure to new vegetables, and new ways to eat familiar vegetables, could

positively impact students' preferences and thereby increase vegetable variety for family meals.

Conclusion

A defined intervention delivered in a SNAP-Ed setting can positively impact mediators associated with vegetable intake for fourth-grade students. Social and technical capital directed to intervention development using sound nutrition education principles and an iterative research process led to our ability to detect impact of vegetable-focused education on fourth-grade students in SNAP-Ed eligible schools.

IMPLICATIONS FOR SCHOOL HEALTH

This study revealed that a short-term classroom-based intervention, encompassing state education standards and sensitive to limitations and structure of the school setting improved self-efficacy, attitude, and preference toward vegetables and knowledge of healthful outcomes for fourth-grade students. Improving a child's response to vegetables offered and consumed has the potential to improve health including weight normalization.

For the purpose of impact assessment, lessons were delivered by trained SNAP-Ed local partner educators in school classrooms; however, the educator guide supports lesson delivery by school teachers in their classrooms or by program staff at after-school sites. Pennsylvania SNAP-Ed has conducted the intervention using these alternate delivery methods and settings and found it to be feasible. The intervention fosters collaboration among school staff, for example, teachers and administrative staff may work with food service to obtain foods for tastings during lessons. This tested curriculum is available to schools and teachers seeking to address vegetable intake and health for fourth-grade students.

Human Subjects Approval Statement

This study was reviewed and approved by The Pennsylvania State University Office for Research Protections.

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