Research and Professional Briefs

Garden-Based Nutrition Education Affects Fruit and Vegetable Consumption in Sixth-Grade Adolescents

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ABSTRACT

Schoolyard gardens are emerging as a nutrition education tool in academic settings. The purpose of this study was to investigate the effects of garden-based nutrition education on adolescents' fruit and vegetable consumption using a nonequivalent control group design. Sixth-grade students (n=99) at three different elementary schools made up a control and two treatment groups. Students in the treatment groups participated in a 12-week nutrition education program, and one treatment group also participated in garden-based activities. Students in all three groups completed three 24-hour food-recall workbooks before and after the intervention. A repeated-measures analysis of variance showed that adolescents who participated in the garden-based nutrition intervention increased their servings of fruits and vegetables more than students in the two other groups. Significant increases were also found in vitamin A, vitamin C, and fiber intake. Although further research is needed, the results of this study seem to indicate the efficacy of using garden-based nutrition education to increase adolescents' consumption of fruits and vegetables.
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Research supports the role of fruit and vegetable consumption in cancer and heart disease prevention (1-3). Increasing scientific evidence also suggests a protective role for fruits and vegetables in strokes and possibly cataract formation, chronic obstructive pulmonary disease, diverticulosis, and hypertension (1). Despite this evidence, poor dietary patterns, combined with other unhealthful behaviors, such as sedentary lifestyles, have contributed to the epidemic of overweight and obesity affecting not only adults, but also children and adolescents in the United States (4).

Studies have shown that eating patterns (specifically of food choices regarding fruits and vegetables) are developed at an early age and can be traced into and through adulthood (5,6). Proper adolescent nutrition can reduce overweight and obesity and can reduce risk factors for diet-related diseases later in life (6-8). As a result, experts suggest developing interventions and effective nutrition programming early in a child's life as a tool for increasing healthful dietary patterns and reducing the risk of chronic disease later in life (5,9). School-based programs represent an important venue for nutrition behavior change. There is great potential for affecting behaviors and health risks that persist into adulthood, such as food choices and obesity (10-13). Schoolyard gardens are emerging as health education tools in academic settings (14-16). A study of California teachers found that school gardens were perceived as an effective tool for promoting healthful eating habits (15). Morris and Zidenberg-Cherr (17) found that garden-enhanced nutrition education was effective in improving nutrition knowledge and vegetable preferences of fourth-grade students. In a related study, third-grade and fifth-grade students' attitudes toward vegetables became more positive after gardening, but fruit and vegetable consumption did not improve significantly (18).

The current study was designed to measure the effects of garden-based education on fruit and vegetable consumption. The primary study hypothesis was to determine whether adolescents who participated in a garden-based nutrition intervention would increase their fruit and vegetable consumption more than those participating in a nutrition education intervention without any garden activities. A control school was included for comparison.

METHODS

Subjects included 122 sixth-grade students at three similar elementary schools in southeast Idaho. The ages ranged from 10 to 13 years, with a mean age of 11.11 years. The sample populations at each school contained a similar representation of ethnic, cultural, and socioeconomic traits. Selected schools were convenience samples. A nonequivalent control group design was used. A control school and one experimental school (experimental school 1) were randomly assigned, and a second experimental school (experimental school 2) was assigned based on

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garden availability. Approval for the study was received from the Human Subjects Committee at Idaho State University. Participants in the study were required to be in grade six attending Public School District 25 in Bannock County, Pocatello, ID. In addition, subjects were only eligible if they had turned in signed parental consent and child assent forms.

After confirmation of student eligibility, participants completed three consecutive 24-hour food-recall workbooks before as well as after the 12-week intervention. The workbook was developed and validated by Barbara Jendrysik (19). Food-recall workbooks were administered in assigned classrooms by the sixth-grade teachers. Teachers received training before the study and were encouraged to respond to student questions without guiding student answers. Before the first food-recall workbook administration, subjects received instructions from the principal investigator on how to report food intake accurately. Food-recall workbooks also included age-appropriate instructions, portion size illustrations, and other explanations that assisted in completion of the workbooks. After the workbooks were completed, students placed them in a manila envelope, which was then sealed and given to the principal investigator at the end of the day. Food recalls were checked for completeness by the principal investigator, ensuring confidentiality as required by the Institutional Review Board.

Subjects at the control school completed three food-recall workbooks before and three after the intervention. No further intervention was carried out at the control school. In addition to the food-recall workbooks, the subjects at one experimental school also participated in a 12-week nutrition education program. The nutrition curriculum guide, *Nutrition in the Garden*, developed by Lineberger and Zajicek (20), was used. The curriculum provided lessons and activities that combined nutrition and horticulture. At a second experimental school, the subjects completed three food-recall workbooks before and three after the intervention, and participated in the 12-week nutrition education program. In addition, at the experimental school 2 subjects participated in hands-on, garden-based activities designed to correspond with the nutrition curriculum.

The school garden was within walking distance of experimental school 2. It was approximately 25×25 feet with two raised strawberry beds, a large herb garden, and a variety of fall crops including potatoes, corn, peppers, peas, beans, squash, cantaloupe, cucumbers, broccoli, tomatoes, spinach, lettuce, and kohlrabi. Subjects participated in maintaining the garden over the 12-week period through weeding, watering, and harvesting. They also engaged in other garden activities that included but were not limited to a salsa making workshop, class cookbook, "add a veggie to lunch day," planting and harvesting, herb drying, and food experiences with fruits and vegetables harvested from the garden.

Participants who did not complete at least two food-recall workbooks before and two food-recall workbooks after the intervention were dropped from the behavioral analysis. As a result, a total of 99 subjects were included in the statistical analyses. Food consumption and nutrient intake were determined using the Diet Analysis Plus software program (version 6.1, 2004, Thomson Wadsworth, Atlanta, GA). A repeated-measures one-way factorial analysis of variance (ANOVA) was conducted using the number of fruit and vegetable servings consumed and the daily intake of vitamin A, vitamin C, and fiber before and immediately after the 12-week intervention. Data were analyzed using the Statistical Package for the Social Sciences (version 13.0, 2004, SPSS Inc, Chicago, IL). A P value of 0.05 was selected to indicate statistical significance.

The ANOVA was conducted using the daily number of servings of fruits and vegetables, vitamin A intake (μg retinol activity equivalents [RAE]/day), vitamin C intake (mg/day), and fiber intake (g/day) as the dependent variables. The ANOVA compared fruit and vegetable consumption and selected nutrient intake at two different times for subjects at three different elementary schools. The within-subjects factor was the time of measurement (before vs after), and the between-subjects factor was the school (control, experimental school 1, and experimental school 2). The ANOVA showed a significant interaction effect between fruit and vegetable consumption, vitamin A intake, vitamin C intake, and fiber intake and school before and after the intervention. The ANOVA was followed up with a post hoc analysis using a Bonferroni adjustment to determine where the interaction occurred.

RESULTS AND DISCUSSION

Schoolyard gardening programs are springing up across the country. There are currently 1,100 projects in the registry for school garden projects at www.kidsgardening.com (21). There are also numerous Web sites devoted to encouraging and helping schools implement schoolyard gardening programs. French and Wechsler (22) examined various school-based interventions to promote fruit and vegetable consumption. They suggest that school gardens are a new direction in the school-based promotion of fruit and vegetable consumption, but point to the lack of research examining the effectiveness of such programs. Our study's findings show that garden-based nutrition education did have a significant effect on adolescents' consumption of fruits and vegetables and selected nutrient intake.

Forty-four percent of the subjects were male, and 56% were female. The ages ranged from 10 to 13 years, with 88% of all participants being 11 years old. There were no significant differences in fruit servings, vegetable servings, vitamin A, vitamin C, or fiber intake based on sex or age.

When comparing fruit servings, vegetable servings, vitamin A intake, vitamin C intake, and fiber intake before and after the intervention, all values increased significantly for the students at experimental school 2 (Table). Students participating in the nutrition education curriculum along with garden-based activities increased their numbers of fruit servings, vegetable servings, vitamin A intake, vitamin C intake, and fiber intake more than those students attending the control school and more than those students who participated in the nutrition education curriculum without garden activities.

Fruit consumption significantly increased (before to after) by 1.13 servings ($P<0.001$) for students at experimental school 2, and vegetable consumption significantly increased by 1.44 servings ($P<0.001$). Combined, the number of servings of fruits and vegetables more than

Table. Intakes of fruits, vegetables, fiber, and vitamins A and C of sixth-grade adolescents at three schools in southeast Idaho, before and after study interventions, using repeated-measures analysis of variance and Bonferroni post hoc analysis (n=99)

	CS[a] (n=25)		ES1[b] (n=25)		ES2[c] (n=45)			
	Before	After	Before	After	Before	After	F[d]	*P* value
	← mean±SD[e] →							
Fruits (servings)	0.7±0.6	0.6±0.7	0.3±0.5	0.5±0.7	0.8±0.8	1.9±1.4	10.98	<0.001
Vegetables (servings)	1.7±0.7	1.4±0.7	1.8±1.1	1.7±1.0	1.2±0.6	2.6±1.7	15.00	<0.001
Vitamin A (μg RAE[f])	621.4±294.1	549.5±248.9	428.5±247.9	358.8±273.3	430.4±244.1	612.4±359.6	5.86	0.004
Vitamin C (mg)	83.1±115.6	76.2±129.5	47.5±48.5	60.8±126.6	58.2±62.2	143.4±144.5	4.31	0.016
Fiber (g)	15.3±6.0	12.6±8.0	10.7±5.2	9.9±5.0	12.7±4.6	16.9±7.4	8.21	0.001

[a]CS=control school, children did not participate in nutrition education curriculum or gardening activities.
[b]ES1=experimental school 1, children participated in nutrition education curriculum only, no gardening activities.
[c]ES2=experimental school 2, children participated in nutrition education curriculum and corresponding gardening activities.
[d]F statistic for interaction of school and before-and-after test results from repeated-measures analysis of variance.
[e]SD=standard deviation.
[f]RAE=retinol activity equivalents.

doubled, from 1.93 to 4.50 servings per day. This is slightly below the recommended intake of five servings per day.

The mean vitamin A intake increased significantly at experimental school 2 by 181.99 μg RAE to 612.35±359.60 μg RAE/day (P=0.004). The dietary reference intake (DRI) of 600 μg RAE per day for 9-year-old to 13-year-old children was met (23). Vitamin C mean consumption also increased significantly at experimental school 2 by 85.27 mg/day (P=0.016) and exceeded the DRI of 45 mg (24). The mean fiber intake of students at experimental school 2 significantly increased by 4.24 g to 16.90±7.40 g/day (P=0.001). This amount is still lower than the DRI of 31 g for 9-year-old to 13-year-old boys and 26 g for girls ages 9 to 13 years (25).

No significant changes occurred in fruit, vegetable, vitamin A, vitamin C, or fiber intakes at the control school or at experimental school 1.

To ensure that home gardens and access to garden activities outside the school did not impact the results, participants were asked whether they had a fruit and/or vegetable garden at home. Using the $\chi 2$ test of independence, it was found that the "garden effect" was not significant and that there was no school that had proportionally more individuals with home gardens than the other schools.

In our subjects, the garden-based activities along with nutrition education resulted in significant increases in fruit and vegetable consumption. In addition, vitamin A, vitamin C, and fiber intakes showed significant increases. These results help to show the importance of hands-on activities when attempting to change nutrition-related behavior such as fruit and vegetable consumption. Similar studies have shown the importance of exposure to fruits and vegetables, building self-efficacy regarding the preparation of fruits/vegetables, increasing nutrition knowledge and awareness, and creating experiential opportunities with fruits and vegetables (9,18,26,27). The results from this study hopefully will aid future researchers in their development of effective nutrition education programs.

This study is not without limitations. Although the sixth-grade participants at experimental school 2 significantly increased their intakes of fruits and vegetables during this study, it is important to note that prolonged behavior change cannot be implied because of the nature of the study time (12 weeks). Complete behavior change is difficult to evaluate after only 12 weeks. Thus, to accurately measure prolonged behavior change regarding the increased consumption of fruits and vegetables, future studies should be conducted. Because this was a nonrandomized trial, the scope of inference is limited to the specific study population. In addition, these results should be approached cautiously because of the nature of self-reported data as well as other influences on the students' fruit and vegetable intake. Factors such as eating at home, parental influences, and additional classroom activities could have affected the results.

CONCLUSIONS

The results from this study illustrate the efficacy of using garden-based nutrition education when attempting to increase adolescents' consumption of fruits and vegetables. The persistent annual increase in adolescent overweight/obesity must be addressed to meet the goals and objectives of Healthy People 2010 (2), as well as many other governmental initiatives, including the *Dietary Guidelines for Americans* (28), and to decrease the risk factors for many chronic diseases. It is heartening to speculate that garden-based nutrition education, when implemented during adolescence, may be one small tool with tremendous impact.

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