
Lafay L, Mennen L, Basdevant A, Charles MA, Borys JM, Eschwege E, Romon M. Does energy intake underreporting involve all kinds of food or only specific food items? Results from the Fleurbaix Laventie Ville Sante (FLVS) study. Int J Obes Relat Metab Disord. 2000;24:1500-1506.


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Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables

JENNIFER L. MORRIS, PhD; SHERI ZIDENBERG-CHERR, PhD

Children's preferences for vegetables may be one of the strongest predictors of vegetable consumption (1-3). This study evaluated the effectiveness of a nutrition education program—based on the social cognitive theory (SCT) (4)—on improving children's vegetable preferences.

A garden supports the modeling of a program around SCT by providing continuous visual reinforcement. Earlier research has shown that exposure to nutrition lessons in combination with vegetable gardening activities improved the willingness of first-graders (students aged 6 to 7 years) to taste vegetables (5).

In addition, people with home gardens have a higher serum retinol concentration resulting from an increased intake of vitamin A from plant foods (6,7).

We hypothesized that nutrition lessons in combination with planting and harvesting a vegetable garden would have a greater effect on children's vegetable preferences than nutrition lessons alone.

The objective of this study was to evaluate the effectiveness of a comprehensive 1-year nutrition program designed to improve the nutrition knowledge and vegetable preferences of upper-elementary school-aged children.

METHODS

Three schools from a local school district participated in this study. This study was a quasi-experimental design because the schools, not the students, were assigned to treatment groups in a nonrandom manner (8,9). As randomization was not possible because of constraints of the school district, the schools were matched based on students' demographic profile.

The demographic breakdown of the students was as follows: 8.4% African American, 3.0% Asian-American, 17.2% Hispanic, 66.5% white; 25% of students qualified for free and reduced-price lunches. Three fourth-grade classrooms (students aged 9 to 10 years) participated at each site. Parental consent was obtained for 213 students before allowing their participation in the study. All procedures were reviewed and approved by the Committee on the Use of Human Subjects, University of California, Davis.

Intervention Materials

Nine nutrition lessons were developed: Plant parts, nutrients, Food Guide Pyramid (10), serving sizes, food labels, physical activity, goal setting, consumerism, and snack preparation. A gardening component was incorporated into each lesson: Indoor seed planting, worm bottles, etc.

Table 1

Influence of garden-enhanced nutrition education program on students' mean nutrition knowledge immediately following intervention and 6 months later for each treatment group

<table>
<thead>
<tr>
<th></th>
<th>Posttest (Mean±SEM)</th>
<th>Follow-up (Mean±SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (n)</td>
<td>17.1±0.4 (57)*</td>
<td>18.0±0.4 (62)*</td>
</tr>
<tr>
<td>NL (n)</td>
<td>20.5±0.4 (68)*</td>
<td>21.2±0.4 (65)*</td>
</tr>
<tr>
<td>NG (n)</td>
<td>20.8±0.4 (80)*</td>
<td>20.8±0.4 (75)*</td>
</tr>
</tbody>
</table>

*Mean scores are adjusted for pretest values. Maximum score was 30. Means with a superscript in common within each time point are not significantly different (P<.01).

*SEM=standard error of the mean.

CO=Control group. Students at this school received no formal gardening or nutrition education.

NL=School site where students received classroom-based nutrition education.

NG=School site where students received in-class nutrition lessons and participated in hands-on gardening activities.

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outdoor seed planting, weed identification, bug boxes, garden fertilization, seed dispersal, butterflies, crop harvest (respectively). The garden activities were designed to complement the nutrition lessons and provide students an opportunity to plant and harvest their own vegetable gardens. A detailed description of the lesson development and subsequent pilot testing is reported elsewhere (Morris and Zidenberg-Cherr, unpublished data).

**Evaluation Tools**

A nutrition knowledge questionnaire and a vegetable preference survey were used to evaluate the curriculum. The nutrition knowledge questionnaire consisted of 30 multiple-choice questions focusing on the objectives for each lesson. It was read aloud to each class to account for varied reading levels. Before using this questionnaire, its reliability was determined using a group of students that had not been exposed to the intervention and had demographics similar to the students included in this final study (r = 0.81). Content validity of the nutrition knowledge questionnaire was evaluated by several nutrition professionals (Morris and Zidenberg-Cherr, unpublished data).

The students completed the vegetable preference survey on their own. They were asked to taste and rate their preferences for 6 different vegetables (carrots, broccoli, spinach, snow peas, zucchini, and jicama). Several investigators have previously validated the methodology used for the preference survey (1,2,11). All students were presented with a tray of vegetables in whole and cut-up form and asked if they would like to taste the vegetable. Those students choosing to taste were asked to indicate their preference on a 5-point scale. A “5” indicated they “Really liked it a lot,” and a “1” indicated they “Really did not like it.” Details are reported elsewhere (Morris and Zidenberg-Cherr, unpublished data).

Of the 3 schools participating in the study, the students at one school, designated as the control site (CO), received no formal nutrition or gardening education (n=61). The 9 lessons were taught by an investigator at the NL and NG sites every other week for 17 weeks. Newsletters were sent home to students’ families (NL and NG sites only) on the weeks between lessons to reinforce concepts taught in class and instigate family discussion.

Posttest data were collected from students (n=205) during March and April following completion of the lessons. Follow-up data were collected during September and October of the next year when the students were in fifth grade (students aged 10 to 11 years, n=192).

Data from the nutrition knowledge questionnaire and the vegetable preference survey were analyzed separately. To control for differences observed for pretest scores among the sites, data were assessed using analysis of covariance with the posttest (or follow-up) score as the dependent variable, the treatment group as the fixed factor, and the pretest score as the covariate. The Bonferroni test was used for follow-up comparisons of the main effects of treatment group. For the nutrition knowledge questionnaire, each student was given a total score (maximum = 30 points). Students’ vegetable preference

### Table 2

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Posttest (Mean±SEM)*</th>
<th>Follow-up (Mean±SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO (n=49)</td>
<td>NL (n=60)</td>
</tr>
<tr>
<td>Broccoli</td>
<td>3.2±0.2</td>
<td>3.8±0.1</td>
</tr>
<tr>
<td>Carrots</td>
<td>4.4±0.1</td>
<td>4.7±0.1</td>
</tr>
<tr>
<td>Jicama</td>
<td>3.6±0.2</td>
<td>3.8±0.2</td>
</tr>
<tr>
<td>Snow pea</td>
<td>2.9±0.2</td>
<td>3.1±0.2</td>
</tr>
<tr>
<td>Spinach</td>
<td>3.1±0.2</td>
<td>3.2±0.2</td>
</tr>
<tr>
<td>Zucchini</td>
<td>3.1±0.2</td>
<td>3.2±0.1</td>
</tr>
</tbody>
</table>

*Mean scores are adjusted for pretest values. Means with a superscript in common within each vegetable and time periods are not significantly different (P<=.05). 5=“I really liked it a lot”; 4=“I liked it”; 3=“It was OK”; 2=“I did not like it”; 1=“I really did not like it.”

SEM=Standard error of the mean.

CO=Control group students at this school received classroom-based nutrition education.

NL=School site where students received formal gardening or nutrition education.

NG=School site where students received in-class nutrition education and participated in hands-on gardening activities.

Vegetables not grown in the garden at NG site.

influence of garden-enhanced nutrition education program on students' preferences for 6 vegetables immediately following and 6 months after intervention.

### Table 2

<table>
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<tr>
<th>Vegetable</th>
<th>Posttest (Mean±SEM)*</th>
<th>Follow-up (Mean±SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO (n=44)</td>
<td>NL (n=55)</td>
</tr>
<tr>
<td>Broccoli</td>
<td>3.2±0.2</td>
<td>3.7±0.1</td>
</tr>
<tr>
<td>Carrots</td>
<td>3.0±0.2</td>
<td>4.7±0.1</td>
</tr>
<tr>
<td>Jicama</td>
<td>3.2±0.2</td>
<td>3.4±0.2</td>
</tr>
<tr>
<td>Snow pea</td>
<td>3.0±0.2</td>
<td>3.6±0.2</td>
</tr>
<tr>
<td>Spinach</td>
<td>3.3±0.2</td>
<td>3.2±0.1</td>
</tr>
<tr>
<td>Zucchini</td>
<td>3.2±0.2</td>
<td>3.4±0.1</td>
</tr>
</tbody>
</table>
data were analyzed using ranked data, and each vegetable was analyzed separately. Preference scores were ranked on a scale of 1 to 5. All data were analyzed using the statistical program SPSS (Statistical Package for Social Sciences, version 10.0.5, 1999, SPSS Inc., Chicago, Ill.).

RESULTS AND DISCUSSION
The nutrition knowledge scores adjusted for pretest scores are shown in Table 1. Scores from students at the NL and NG sites were significantly greater than those at the CO site (F = 24.238, P < 0.0005). These improvements were maintained at the 6-month follow-up (F = 18.270, P < 0.0005).

The vegetable preference results are shown in Table 2. Posttest preference scores for the NL and NG sites were significantly greater than those at the CO site for carrots (F = 5.768, P < 0.005) and broccoli (F = 4.840, P < 0.01). Scores from the NG site were significantly greater than those at the NL and the CO sites for snow peas (F = 7.657, P < 0.005) and zucchini (F = 10.012, P < 0.0005). The NL site retained its significant difference for only carrots at 6 months following the intervention. The NG site retained its significant difference for broccoli, snow peas, and zucchini at 6 months after intervention. No significant differences were seen among the 3 sites in relation to the students' willingness to taste the vegetables.

Exposure to the nutrition education lessons significantly improved the nutrition knowledge of the students at the NL and NG sites. That these results were retained at 6-month follow-up suggests that the program had a long-lasting effect on the students' knowledge.

Exposure to the curriculum improved students' preferences for several vegetables. Students at the NL and NG sites increased their preferences for carrots and broccoli. However, students at the NG site also increased their preferences for snow peas and zucchini. Of those vegetables, however, only carrots, broccoli, and snow peas—not zucchini—were grown in the garden. This suggests that the intervention improved students' preferences for vegetables to which they were not directly exposed. Most of these improvements were sustained six months after the completion of the lessons.

The quasi-experimental design of the study resulted in some limitations. Because the groups were not randomly selected and assigned to treatment groups, schools may have differed in ways that were not measurable (8). An additional limitation of the study is that the schools, not the students, were assigned to specific treatment groups (9). Because only 3 schools participated, statistics were run using the students as the units of analysis, potentially resulting in a clustering effect of the data. Such a design was necessary to determine the initial effectiveness of the curriculum. Any differences in posttest scores seen between the schools were accounted for statistically by adjusting posttest and follow-up scores for pretest scores. These results show that this garden-enhanced nutrition education curriculum is an effective tool for improving the nutrition knowledge and vegetable preferences for school-aged children.

Administrators of future school garden projects are encouraged to include a wider variety of fruits and vegetables in their garden programs.

APPLICATIONS
These results lend support to the inclusion of vegetable gardens within the school setting. This report should encourage educators to include vegetable gardens as part of their students' learning experience. Administrators of future school garden projects are encouraged to include a wider variety of fruits and vegetables in their garden programs.

REFERENCES

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