Research Article

LA Sprouts: A 12-Week Gardening, Nutrition, and Cooking Randomized Control Trial Improves Determinants of Dietary Behaviors

Jaimie N. Davis, PhD[1]; Lauren C. Martinez, MPH[2]; Donna Spruijt-Metz, PhD[3]; Nicole M. Gatto, PhD[4]

ABSTRACT

Objective: To evaluate the effect of an exploratory 12-week nutrition, cooking, and gardening trial (*LA Sprouts*) on preference for fruit and vegetables (FV); willingness to try FV; identification of FV; self-efficacy to garden, eat, and cook FV; motivation to garden, eat, and cook FV; attitudes toward FV; nutrition and gardening knowledge; and home gardening habits.

Design: Randomized controlled trial.

Setting: Four elementary schools.

Participants: Three hundred four predominately Hispanic/Latino third- through fifth-grade students were randomized to either the *LA Sprouts* group (n = 167 students) or control group (n = 137 students).

Intervention: Twelve-week after-school nutrition, cooking, and gardening intervention.

Main Outcome Measures: Determinants of dietary behavior as measured by questionnaire at baseline and postintervention.

Analysis: Analyses of covariance.

Results: After the 12-week program, compared with controls, *LA Sprouts* participants improved scores for identification of vegetables (+11% vs +5%; $P = .001$) and nutrition and gardening knowledge (+14.5% vs −5.0%; $P = .003$), and were more likely to garden at home (+7.5% vs −4.4%; $P = .003$).

Conclusions: The *LA Sprouts* program positively affected a number of determinants of dietary behaviors that suggest possible mechanisms by which gardening and nutrition education act to improve dietary intake and health outcomes.

Key Words: gardening and nutrition intervention, dietary intake, Hispanic/Latino children (*J Nutr Educ Behav*. 2016;48:2-11.)

Accepted August 13, 2015. Published online October 6, 2015.

INTRODUCTION

Hispanic/Latino children are disproportionately affected by obesity and obesity-related diseases such as heart disease, metabolic syndrome, nonalcoholic fatty liver disease, and type 2 diabetes.[1-5] The prevalence of overweight is 39.7% for Hispanic children aged 6–11 years in the US compared with 27.6% for non-Hispanic white children of the same age.[6] Fruit and vegetable (FV) intake in US children is well below recommended levels, and this problem may be exacerbated in low-income and Hispanic populations.[7] Numerous studies show that diets low in nutrient-dense FV are correlated with multiple chronic diseases including obesity, heart disease, type 2 diabetes, and metabolic syndrome in children and adults.[8-10]

School gardening programs have become popular approaches to increase FV intake. In 2010, the nonrandomized *LA Sprouts* pilot school gardening and cooking and nutrition program (with 104 fourth- and fifth-grade students) resulted in increased preference for FV intake and improved cooking and gardening skills.[11] A recent review of 13 school garden programs found that the majority were associated with increased FV intake. In addition, the majority of programs resulted in improved preference for vegetables; and attitudes toward, willingness to taste, identification of, and self-efficacy to prepare and cook FV, which are determinants of dietary behavior.[12] However, many were proof of concept studies and none were

[1]Department of Nutritional Sciences, University of Texas at Austin, Austin, TX
[2]Department of Preventive Medicine, University of Southern California, Los Angeles, CA
[3]Center for Economic and Social Research, University of Southern California, Los Angeles, CA
[4]Center for Nutrition, Healthy Lifestyles and Disease Prevention, School of Public Health, Loma Linda University, Linda Loma, CA

Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.

Address for correspondence: Jaimie N. Davis, PhD, Department of Nutritional Sciences, University of Texas at Austin, 103 W 24th St, Stop A2703, Austin, TX 78712-1249; Phone: (512) 471-0971; Fax: (512) 471-5630; E-mail: Jaimie.davis@Austin.utexas.edu

http://dx.doi.org/10.1016/j.jneb.2015.08.009

randomized.[11,13-22] Since that review was published, a recent cluster randomized, controlled trial (RCT) with 21 elementary schools in London found that school gardening programs led by external specialists, such as the Royal Horticultural Society, compared with teacher-led gardening programs resulted in increased identification of vegetables but a lower willingness to try new fruits.[23] A quasi-experimental Farm to School garden program resulted in increased willingness to try FV and improved knowledge of nutrition and agriculture in 1,117 third- to fifth-grade students over the academic school year.[24] Because of the popularity of garden-based educational approaches in school settings, more rigorous and well-designed studies are needed to understand whether such programs have an effect on determinants of dietary behaviors.

Numerous studies have used Social Cognitive Theory to explain child dietary behaviors.[25] Cullen et al[26] hypothesized that personal factors such as self-efficacy, preferences, and outcome expectations are linked to increased FV intake-related skills and FV intake. Similarly, several studies have shown that FV preference predicts FV consumption.[27,28] Rasmussen et al[29] reviewed 98 papers and identified a larger number of dietary determinants of FV intake in children, including knowledge, attitudes, liking of FV, self-efficacy, self-rated intake, habit, preferences, perceived barriers, and intention or willingness to try. McClain et al[30] reviewed 35 articles and found that intention to eat healthy, knowledge, and preferences were positively associated with FV intake in children and adolescents. Self-determination Theory (SDT), originally proposed by Ryan and Deci[31] and expounded on by others,[32,33] views the person as an active organism, and proposes that each person has 3 basic psychological needs: competence (feeling effective), relatedness (feeling connected to others), and autonomy (perception of self as the source of one's own behavior). A key principal of SDT is that behavior change results from enhanced autonomy and perceived competence, is consistent with a person's values and goals, and is more effective in changing behavior than a focus on controlled or extrinsic motivation and rewards such as pleasing others, fear of disease, or avoiding guilt, anxiety, or shame.

In 2012–2014, an exploratory 12-week cluster randomized, controlled extension of the *LA Sprouts* program was conducted.[34,35] The conceptual framework is a combination of Social Cognitive Theory and SDT (Figure 1; the solid arrow denotes the relationship examined here). The main outcomes findings were that compared with wait-listed controls, *LA Sprouts* participants had reductions in body mass index (BMI), BMI *z* scores, waist circumference, and increased intake of dietary fiber and vegetables.[34] The goal of this analysis was to evaluate the effect of the *LA Sprouts* program compared with wait-listed controls on changes in determinants of dietary behavior in predominately Hispanic/Latino third- to fifth-grade students. The hypothesis was that compared to wait-listed controls, *LA Sprouts* participants would have improvements in preference for FV; willingness to try FV identification of FV, self-efficacy to garden, eat, and cook FV, motivation to garden, eat, and cook FV, attitudes toward FV, nutrition and gardening knowledge; and gardening at home habits.

METHODS

Participants

LA Sprouts partnered with an existing after-school program (*LA's Better Educated Students for Tomorrow* [*BEST*]) within the Los Angeles Unified School District, which provides a free/low-cost on-site service for families. Four elementary schools in Los Angeles were identified as eligible (criteria included participation in the existing *LA's BEST* after-school program, ≥ 75% Hispanic/Latino ethnicity, ≥ 75% receiving free and reduced lunches, location within 10 miles of University of Southern California campus, and willingness to participate in the study. Investigators who were blinded to the study protocol performed randomization and drew numbers from a hat to assign the 4 schools randomly to either the *LA Sprouts* intervention (n = 2 schools) or the control group (n = 2 schools; delayed intervention).

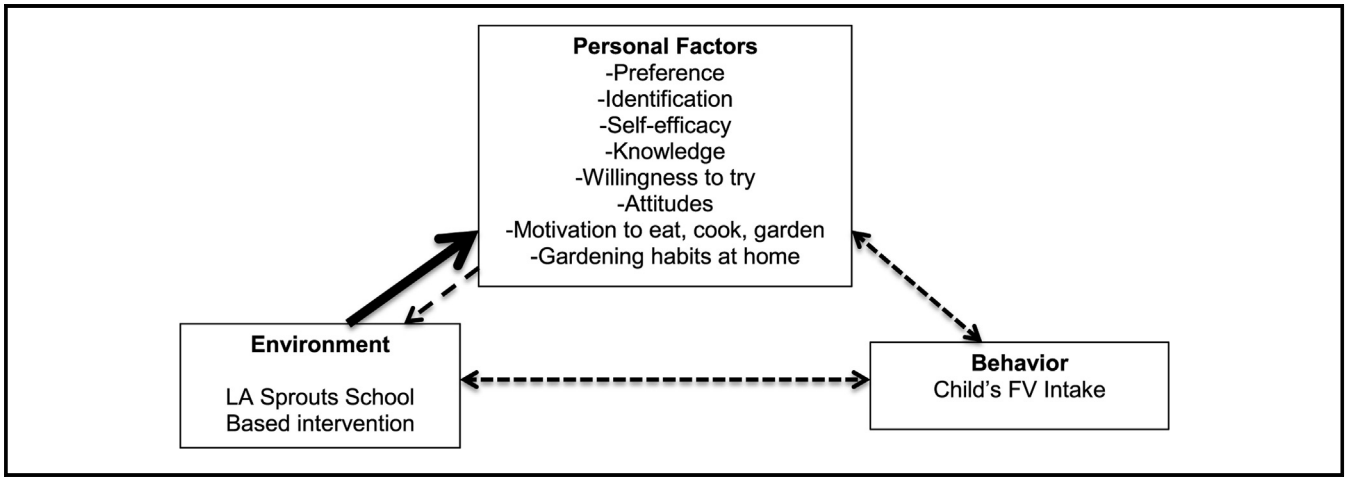

Figure 1. Conceptual framework of *LA Sprouts*. The solid arrow denotes the relationship for this data analysis. FV indicates fruit and vegetables.

The Institutional Review Boards of the University of Southern California, the University of Texas at Austin, and Loma Linda University approved the study. Informed written consent from parents and assent from children were obtained.

Description of Intervention

Gardens were designed and built for the schools and included a minimum of 5 raised beds, a designated teaching area that included demonstration space and seating, and ample gardening and cooking supplies.

The *LA Sprouts* intervention classes were taught after school in 90-minute sessions once a week to each grade level for 12 weeks during either a fall or winter/spring school semester. Sessions consisted of 2 45-minute segments each of interactive cooking/nutrition and gardening instruction taught by paid part-time nutrition and garden educators with strong backgrounds in cooking and nutrition, and gardening, respectively. Educators compiled weekly notes about the successes and challenges of lessons, in addition to documenting any omitted content to be revisited during later lessons. The project manager observed educators on at least 2 occasions to check for adherence to curriculum content and give feedback on pedagogical style.

Table 1 provides an overview of the *LA Sprouts* curriculum. Students

Table 1. Overview of *LA Sprouts* Curriculum

Week	Nutrition Lessons and Topics Covered	Gardening Lessons and Topics Covered	Recipe
1	Introduction: name game, overview of program, make class rules, kitchen safety and hand washing	Introduction: basic botany, importance of growing food, history of agriculture	Seasonal green salad
2	Real Food: real food vs packaged food, where you can find real food, reading ingredients label, number of ingredients in real food, cooking with real food	Planning a Garden: garden design, soil types and testing	Fresh veggies with yogurt dip
3	Sugar: natural vs added sugar, liquid candy (soda), demonstration of how much sugar is in popular drinks, low-sugar beverage taste test	Sowing and Transplanting: starting seeds for school garden and home, how-to use of garden tools	Apples with peanut butter, cucumber lemon water, *agua de jamaica*
4	Fruits: types of fruits, health benefits of eating a variety of colors of fruits, fruit intake recommendations, ways to add fruit to your diet, mystery fruit game	Composting: importance of recycling, greens and browns, hands-on starting and maintaining a compost pile	Fruit rainbows with yogurt
5	Vegetables: parts of plant you can eat, benefits of eating different colors of vegetables, vegetable intake recommendations, ways to add vegetables to your diet, mystery vegetable game	Recycling and Gardening at Home: review of composting, using items from home in the garden	Vegetable quesadillas with *pico de gallo*
6	Fiber: what fiber is, juice vs whole fruit, what foods have fiber, where you can find fiber on a nutrition label, adding fiber to your diet, fiber taste test	Watering: how-to, how much plants need, water cycle, measuring seedling progress	Whole grain pasta with veggies
7	Food and Family: importance of eating together as a family, family dining habits, dinner conversation starters	Botany: plant nutrition, plant life cycles, pollination	Breakfast taco
8	Garden to Table: eating in season, where our food comes from, shopping at the farmers' market activity	Garden Maintenance: weeding, fertilization, good and bad garden bugs	Beet, carrot, and avocado salad
9	Breakfast: school day skit (with and without breakfast), why breakfast is important, what a healthy breakfast is, choosing a healthy breakfast at school	Food Preservation and Seed Saving: preservation methods, herb drying, seed-saving history, plant genetics	Yogurt parfait
10	School Lunch: importance of a healthy lunch, choosing a healthy lunch at school, making your own lunch	Seasonal Crops: climate, length of day, seasonality, local vs imported foods, where our food comes from	Ultimate sandwich
11	Parties and Holidays: healthy vs unhealthy party foods, how to make parties healthier, planning your own party, tips for eating well at parties	Plant Anatomy: what we use plants for, parts of plants, edible parts of different plants, identifying plant parts in cut fruit	Bean dip and pita chips
12	Review: Jeopardy game	Harvesting: gardening awards	Cook-off (make your own snack)

worked in small teams led by the educator to cook and prepare the sample recipe each week, which emphasized FV. The cooking component took approximately 20 minutes and included easy to more complex recipes (ie, salads, broccoli quesadillas, vegetable pasta). The snack was eaten in a family-style manner (ie, together at a table, with a tablecloth, nondisposable plates, and silverware). The gardening activity also used a hands-on approach in which children learned and participated in planting, growing, maintaining, and harvesting organic FV. The nutrition curriculum reinforced ways and strategies to increase FV intake, such ways to incorporate FV into meals and snacks.

Description of Wait-Listed Control Group

Third- to fifth-grade students at the 2 control schools received no nutritional/cooking or gardening information from investigators between pretesting and posttesting, and schools were asked to refrain from augmenting their curriculum with similar lessons during the study period. Control schools received their standard after-school *LA's BEST* activities. After posttesting was completed, students at the control schools received the full *LA Sprouts* program (delayed intervention), including a school garden that was built.

Data Collection Measures

LA Sprouts and control participants completed questionnaires and had anthropometric data collected at baseline and at 12 weeks after the intervention (collected within 1 week of the final lesson) during after-school sessions. Data were collected in waves from spring, 2012 through spring, 2014.

Anthropometrics

Height was measured with a free-standing stadiometer (Seca, Birmingham, UK); weight was measured via bioelectrical impedance (Tanita TBF 300A, Arlington Heights, IL). The researchers determined BMI *z* scores and percentiles using Centers for Disease Control and Prevention cut points for age and sex.[36]

Questionnaire

A literature review identified measures relevant to nutrition, gardening, and cooking behaviors. Selections of survey instruments were based on existing literature and the conceptual model, and then adapted to relate to constructs of interest, simplify readability at grade level, and/or reduce participant burden. Questionnaires were administered only in English because the children at these schools all spoke and read English. Focus group testing of the resulting composite questionnaire with 6 Hispanic/Latino third- and fourth-grade students guided modifications for content, readability/comprehension, and clarity. A test-retest assessment for all questionnaire items was conducted with 19 third- to fifth-grade predominantly Hispanic/Latino students who were not enrolled in the study. Questionnaire scales were assessed for internal consistency (Cronbach alpha, using baseline data from participants in the RCT) and intra-rater reliability (bivariate correlations of averaged scale values for each rater, using the test-retest data from non-participants in the RCT) (Table 2). Internal consistency and intra-rater reliability were satisfactory ($\alpha > .70$), with the exception of the knowledge questions.[35] However, knowledge questions differ from others in that they test ability rather than measure individual characteristics, so psychometric principals are not as applicable. The final questionnaire included items to assess the following.

Demographics. Participants were asked basic demographic information including age, sex, and ethnicity. To ascertain family socioeconomic status, items queried the use of a computer at home and mother's ownership of a car.[37]

Fruit and vegetable preferences and identification. A 25-item scale assessed preference for and identification of FV.[27] Twelve questions asked about preferences for fruits (including apples, avocados, bananas, berries, grapes, melons, oranges, kiwis, peaches, pears, plums, tomatoes) and 13 questions asked about preference for vegetables (broccoli, carrots, cactus, cauliflower, corn, green beans, kale, lettuce, onions, peas, peppers, radishes, and zucchini) using a 4-point response scale. One response, *I don't know what this is*, was used to assess identification.

Self-efficacy. A 14-item scale adapted from Baranowski et al[38] assessed self-

Table 2. Validation of Determinants of Dietary Behavior Questions Used in Questionnaire Packet[a]

Item	Items, n	Internal Consistency	Intra-Rater Reliability
Motivation to eat FV	7	0.809	0.665
Motivation to garden	9	0.858	0.739
Motivation to cook FV	7	0.850	0.635
Self-efficacy for FV consumption and related behaviors	14	0.883	0.478
Fruit neophobia	6	0.800	0.521
Vegetable neophobia	6	0.901	0.542
Preferences for fruit	10	0.809	0.722
Preferences for vegetables	15	0.866	0.575
Cooking and gardening attitudes	8	0.842	0.912
Nutrition and gardening knowledge	8	0.472	0.400

FV indicates fruit and vegetables.

[a]The researchers used Cronbach alpha to determine interval consistency (n = 350) and correlations to evaluate intra-rater reliability (n = 19). All questionnaire items had 4 response options, with the exception of demographic questions and current home gardening practices, which ranged from 2 to 7 response options (not included in psychometric tests).

efficacy to eat, cook, and garden FV. One question from the Motivation to Eat FV scale was removed because of poor psychometric properties.

Knowledge. An 8-item scale was developed to assess nutrition and gardening knowledge, which was tailored to address content covered in lessons of the *LA Sprouts* curriculum.

Attitudes. The researchers developed an 8-item scale to assess attitudes about cooking and gardening and current home gardening practices.

Willingness to try. A 6-item Willingness to Try (also referred to as Neophobia) scale, adapted from Pliner et al,[39] was used to assess willingness to try FV (separately).

Motivation. Motivation to eat FV, cook FV, and garden were assessed with an adapted version of the Motivation for Healthy Behaving measure from the Treatment and Self-Regulation Questionnaire.[40,41] The original questionnaire was adapted to a 7-item scale for motivation to eat FV, a 7-item scale for motivation to cook FV, and a 9-item scale for motivation to garden. The instrument generates 2 main subscales: (1) autonomous/intrinsic motivation and (2) controlled/extrinsic motivation.

Statistical Analysis

The authors used histograms and box plots to assess normality; vegetable preference, fruit preference, and identification of vegetables were not normally distributed. Thus, the log-transformed values were used for all analyses of these variables. Untransformed means are provided in the tables and text for ease of interpretation. Average scores for individual scales were calculated. For FV preferences, means reflect recoding 1–3 and did not include the *don't know* response. The absolute and percentage change in measures from baseline to postintervention were calculated as the difference between postintervention and baseline measures and that difference divided by the baseline value of the measure and multiplied by 100. Differences between students completing both pre- and post-measures vs pre-measures only and between *LA Sprouts* and control participants in baseline demographic characteristics were assessed using *t* tests or chi-square tests; $P \leq .05$ was considered statistically significant for these comparisons. Analyses of covariance assessed the difference in determinants of dietary behavior change between *LA Sprouts* and control groups between pre-intervention and postintervention. Adjustments were made for covariates determined a priori including age, sex, ethnicity, season (fall or winter/spring), schools level, attendance at the intervention classes, English spoken at home (yes/no), and baseline value for the measure of interest (continuous variables). The researchers assessed correlations between the determinants of dietary behavior; with the exception of knowledge, attitudes, and gardening at home, the determinants were highly correlated with each other. Thus, a correction for multiple comparisons (18 variables) was applied for these variables and $P \leq .003$ was considered

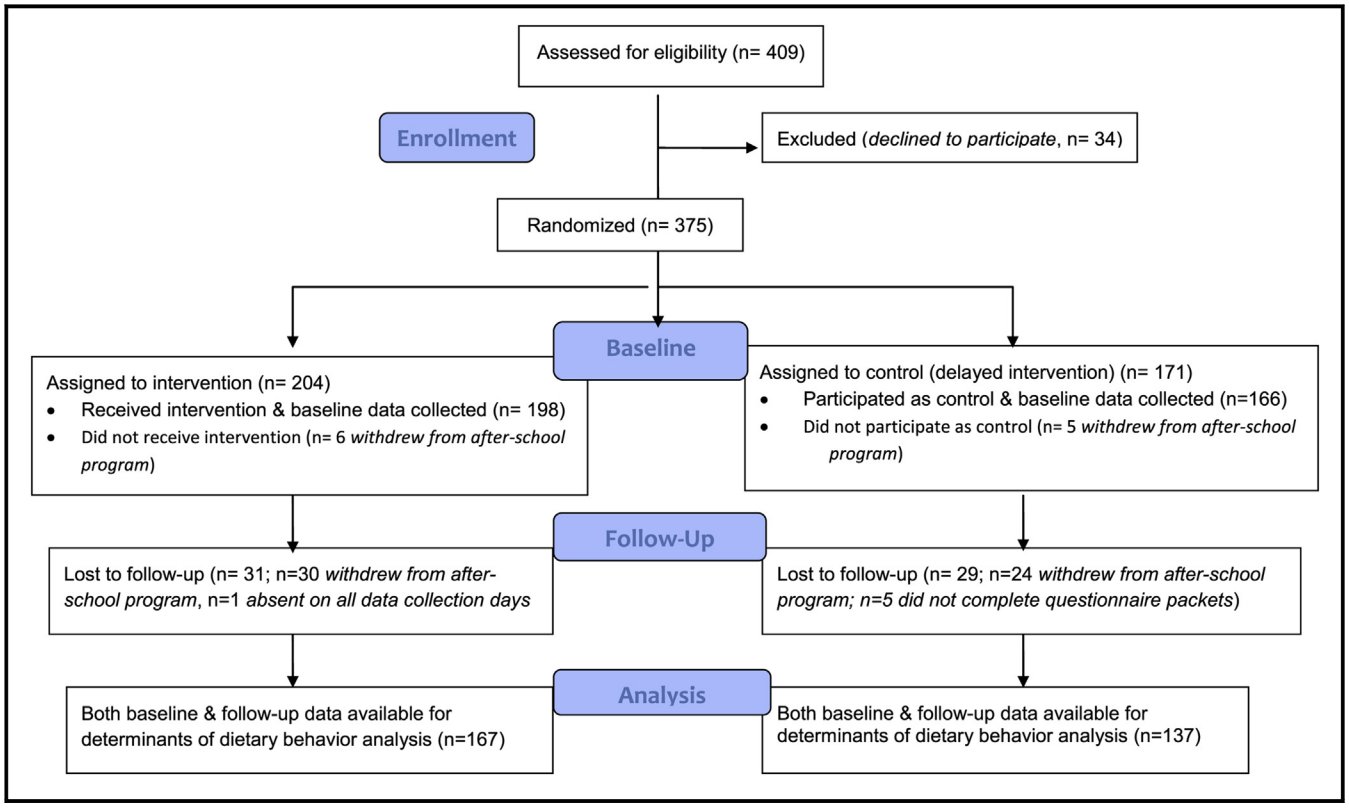

Figure 2. Flow of participants through the study, including participants included in enrollment, baseline, and follow-up testing and analysis.

statistically significant (SPSS, version 21.0, SPSS Inc, Chicago, IL, 2012).

RESULTS

All third- to fifth-grade students enrolled in an existing after-school care program (*LA's BEST*) at the elementary schools were invited to participate (n = 409); 375 agreed to participate (92%). Two schools were randomly assigned to receive the *LA Sprouts* intervention (n = 204 students), 2 schools were assigned to become controls (n = 171 students), and baseline data were collected on students. Because of the small size of the study (only 4 schools), demographic variables were not different between clusters of participants within treatment and control groups after randomization, before the initiation of the intervention. Postintervention data were missing for 55 students because they changed schools, withdrew from the after-school program, or were sick or absent on testing days. In addition, 5 more participants were missing questionnaire data used to define determinants of dietary behavior. Analyses discussed here are based on 304 children (n = 167, *LA Sprouts*; n = 137, controls) for whom both complete baseline and postintervention data were available (Figure 2). There were no statistical differences in any demographic data between participants who completed both baseline and postintervention measures compared with students who completed only baseline measures. ($P > .20$) Participants enrolled in the *LA Sprouts* program had demographics similar to children from the same schools not enrolled in the *LA Sprouts* program (eg, 51% male and 88.7% Hispanic ethnicity in the schools). On average, children attended 9.7 ± 2.3 intervention classes throughout the 12 weeks, and the minimum amount of classes attended was 3 classes. However, 71% of subjects attended at least half of the classes.

There were no significant differences between *LA Sprouts* and control participants at baseline for sex, race/ethnicity, age, BMI percentile, percent overweight/obese, computer at home, participation in the free and reduced lunch plan, or mothers having their own car (Table 3). *LA Sprouts* participants tended to speak English at home more often than controls ($P = .06$). There was also a trend for *LA Sprouts* participants to have lower BMI at baseline ($P = .09$) compared with controls.

Table 3. Baseline Characteristics of *LA Sprouts* and Control Participants

Characteristics	Control (n = 137)	*LA Sprouts* (n = 167)	*P*[a]
Sex, n (%)			
Male	69 (50.4)	78 (46.7)	.30
Female	68 (49.6)	89 (53.3)	
Race/ethnicity, n (%)			.49
Hispanic	119 (88.8)	148 (88.6)	
Asian	2 (1.5)	1 (0.6)	
Non-Hispanic black	0	4 (2.4)	
Non-Hispanic white	2 (1.5)	2 (1.2)	
Other	11 (8.2)	12 (7.2)	
Age, y (mean ± SD)	9.2 ± 0.9	9.3 ± 0.9	.66
Body mass index, kg/m^2 (mean ± SD)	20.7 ± 4.6	19.8 ± 4.1	.09
Body mass index percentile, (mean ± SD)	77.3 ± 25.9	73.7 ± 26.6	.24
Overweight/obese, n (%)	61 (45.5)	83 (50.6)	.42
English spoken at home, yes (n [%])	27 (20.0)	47 (28.7)	.06
Computer at home, yes (n [%])	32 (23.7)	41 (25.6)	.79
Mother has own car, yes (n [%])	38 (40.4)	56 (33.9)	.26
Free/reduced lunches, n (%)	125 (89.3)	152 (90.5)	.85

[a]*P* was calculated using *t* tests for continuous variables and chi-square tests for categorical variables.

At baseline, there were no significant differences in determinants of dietary behavior between *LA Sprouts* participants compared with controls (Table 4). After the 12-week program, compared to controls, *LA Sprouts* participants improved in identifying vegetables (+11% vs +5%; $P = .001$) and nutrition and gardening knowledge (+14.5% vs –5.0%; $P = .003$), and increased in the proportion that reported gardening at home (+7.5% vs –4.4%; $P = .003$) (Table 4).

DISCUSSION

Numerous quasi-experimental studies have shown that garden-based school programs improve determinants of dietary behavior.[11,13-17,19-21,42-45] A recent cluster RCT conducted with 21 London schools showed that garden programs taught by external specialists were more effective at increasing vegetable identification but resulted in lower willingness to try new fruits compared with teacher-led garden classes.[23] To the authors' knowledge, *LA Sprouts* is the first exploratory RCT of a garden-based school intervention compared with a wait-listed control leading to changes in determinants of dietary behavior including improved identification of vegetables, gardening and nutrition knowledge, and percentage of children gardening at home.

Several nonrandomized, garden-based programs have resulted in improved identification of FV.[13,15,18] As hypothesized, the *LA Sprouts* RCT intervention resulted in increased identification of vegetables (including those less typically familiar to children, such as cactus, cauliflower, kale, bell peppers, radishes, sweet potato, and spinach). These less typically familiar vegetables were highlighted in the *LA Sprouts* culturally tailored lessons and were used in the cooking activities and recipes, which may explain their improved identification. Each lesson was composed of a 20-minute cooking component and included a range of easy recipes such as salads and cut-up vegetables, to more complex recipes such as broccoli/spinach quesadillas and pasta with vegetables. Contrary to the hypotheses, however, *LA Sprouts* had no effect on the identification of fruit. One explanation for these findings could be that the majority of recipes

Table 4. Baseline, Post, and Change Determinants of Dietary Behavior in the *LA Sprouts* Randomized, Controlled Trial (mean ± SD)[a,b]

	Control			*LA Sprouts*				
Variables[c]	**Pre**	**Post**	**Change**	**Pre**	**Post**	**Change**	***P* for Baseline**	***P* for Change**
Preference								
Vegetable	2.2 ± 0.5	2.1 ± 0.5	−0.1 ± 0.5	2.2 ± 0.5	2.1 ± 0.5	−0.1 ± 0.6	.970	.950
Fruit	2.6 ± 0.3	2.6 ± 0.3	0.0 ± 0.4	2.6 ± 0.4	2.5 ± 0.4	−0.1 ± 0.5	.490	.220
Identification								
Fruit	2.0 ± 0.10	2.0 ± 0.1	0.02 ± 0.1	1.9 ± 0.2	1.9 ± 0.2	0.0 ± 0.20	.020	.010
Vegetable	1.9 ± 0.2	1.9 ± 0.1	0.01 ± 0.2	1.8 ± 0.2	1.8 ± 0.2	0.02 ± 0.2	.020	.001
Self-efficacy								
To garden	3.2 ± 0.8	3.4 ± 0.9	0.9 ± 0.1	3.2± 0.9	3.3 ± 0.9	1.0 ± 0.1	.360	.610
To eat fruit and vegetables	3.1 ± 0.9	3.0 ± 0.9	−0.2 ± 1.0	3.0 ± 0.9	3.1 ± 0.9	0.1 ± 1.1	.040	.020
To cook	3.2 ± 0.8	3.3 ± 0.9	0.1 ± 0.9	3.2 ± 0.9	3.3 ± 0.9	0.1 ± 1.0	.120	.710
Knowledge								
% Correct	47.8 ± 17.5	45.4 ± 18.5	−2.4 ± 21.4	43.3 ± 19.4	49.5 ± 20.4	6.3 ± 23.1	.050	.003
Willingness to try								
Fruit	3.3 ± 0.7	3.3 ± 0.7	0.00 ± 0.7	3.3 ± 0.6	3.2 ± 0.70	−0.12 ± 0.74	.480	.280
Vegetables	2.8 ± 0.9	2.8 ± 0.9	−0.1 ± 1.0	3.0 ± 0.9	2.9 ± 0.8	−0.1 ± 0.9	.070	.900
Attitudes								
Toward cooking	3.4 ± 0.7	3.4 ± 0.7	0.0 ± 0.7	3.3 ± 0.7	3.4 ± 0.9	0.0 ± 0.8	.760	.400
Toward gardening	3.1 ± 0.7	3.0 ± 0.7	−0.1 ± 0.7	3.2 ± 0.6	3.2 ± 0.8	0.0 ± 0.8	.150	.470
Gardening at home (%)	47.1	42.7	−4.4	37.5	45.0	7.5	.060	.003
Motivation								
To cook	3.1 ± 0.8	2.9 ± 0.8	−0.2 ± 0.9	3.2 ± 0.7	3.1 ± 0.8	−0.1 ± 0.9	.050	.050
Autonomous motivation to cook	3.3 ± 0.8	3.0 ± 0.9	−0.2 ± 1.0	3.2 ± 0.8	3.1 ± 0.9	−0.1 ± 1.0	.170	.070
Controlled motivation to cook	3.0 ± 0.8	2.8 ± 0.8	−0.2 ± 0.9	3.1 ± 0.8	3.0 ± 0.8	−0.1 ± 1.0	.050	.110
Motivation to garden	3.1 ± 0.7	2.8 ± 0.8	−0.3 ± 1.0	3.0 ± 0.7	2.9 ± 0.8	−0.1 ± 0.9	.010	.040
Autonomous motivation to garden	3.2 ± 0.8	3.0 ± 0.8	−0.2 ± 1.0	3.2 ± 0.8	3.2 ± 0.9	0.0 ± 1.0	.040	.009
Controlled motivation to garden	2.9 ± 0.8	2.7 ± 0.8	−0.3 ± 1.0	3.0 ± 0.8	2.8 ± 0.8	−0.3 ± 1.0	.090	.240
Motivation to eat FV	3.1 ± 0.7	2.9 ± 0.7	−0.3 ± 0.8	3.1 ± 0.7	3.0 ± 0.8	−0.2 ± 0.8	.080	.020
Autonomous motivation to eat FV	3.3 ± 0.8	3.1 ± 0.7	−0.2 ± 0.8	3.2 ± 0.8	3.2 ± 0.9	0.0 ± 1.0	.100	.008
Controlled motivation to eat FV	3.0 ± 0.77	2.7 ± 0.8	−0.4 ± 0.9	3.0 ± 0.8	2.8 ± 0.8	−0.3 ± 0.9	.070	.100

FV indicates fruit and vegetables.
[a]The researchers used ANCOVAs to assess differences in change scores between groups; [b]All pre, post, and change values were adjusted for sex, ethnicity, age (y), English language spoken at home (yes/no), school (as a categorical variable), attendance at the *LA Sprouts* lessons (average of classes attended), and season (fall/spring). All change scores were also adjusted for baseline value of the outcome variable; [c]Means for scales were used.

used in the lessons focused on vegetables, and more vegetables than fruit were planted in the garden.

Contrary to the hypothesis, the intervention did not result in significant improvements in self-efficacy to eat FV, garden, or cook. Evans et al[21] conducted a yearlong, nonrandomized, garden-based intervention with 246 adolescents and showed that those with the maximum exposure to the garden lessons, compared with those with the least exposure, had improvements in self-efficacy for eating FV. In a study across 9 European countries, positive self-efficacy to eat FV was related to daily FV intake in 11-year-old children.[46] Similarly, a US study with fourth- through sixth-grade students found that self-efficacy to eat FV was positively associated with fruit consumption.[47] Increasing children's self-efficacy to eat FV is one mechanism that could lead to increased FV intake and should continue to be a target of interventions. To the authors' knowledge, to date, this is the first study to examine self-efficacy to garden and cook, and more research is warranted in this

area. Because other studies support the value of self-efficacy, it should continue to be targeted in interventions.

The *LA Sprouts* program resulted in improved nutrition and gardening knowledge. Similarly, other school gardening programs have resulted in increased nutrition and gardening knowledge.[20,21,44] Numerous studies have shown that increased nutrition knowledge of FV is related to increased intake of FV in children[48-50] whereas others have shown no relation.[51,52] In a large cross-sectional European study with 963 11-year-old children, one of the strongest determinants for FV intake was knowledge of FV recommendations. Future analyses will examine whether changes in nutrition and gardening knowledge mediated the improvements in dietary intake.

Also, contrary to the authors' hypothesis and the existing literature, there were no significant differences in motivation to eat FV, garden, or cook between groups after the intervention. In a cross-sectional study with 92 children aged 9–11 years, concern for health in choosing what to eat (ie, autonomous motivation) predicted FV consumption.[51] Another study of over 1,200 adults participating in a self-help RCT showed that autonomous motivation (ie, self-image and personal health) was linked to positive changes in dietary intake.[53] Other research has shown that autonomous motivation is more influential than controlled motivation in promoting health behavior changes.[54,55] To the authors' knowledge, to date, this is the first study to examine how motivation to cook and garden changes in response to a garden-based intervention. Although these findings did not support changes in motivation, other studies support the value of motivation; thus, it still might have merit in examining in future intervention studies.

Surprisingly, the intervention did not lead to improvements in preferences or willingness to try FV. A number of school garden–based interventions found improvements in preferences for vegetables[11,14,15] and increases in willingness to try FV.[15,20] Ratcliff et al[15] conducted a 16-week nonrandomized garden-based intervention with 320 sixth-grade students and found both improved preference for and willingness to try vegetables. Morgan et al[20] conducted a 10-week quasi-experimental study with 127 fifth- and sixth-grade students comparing nutrition and gardening education with nutrition education alone and control groups, and found that nutrition and gardening compared with nutrition education alone and controls had increases in willingness to taste vegetables as well as preference ratings for vegetables. Both studies used taste-test evaluations in which students were asked to name, taste, and rate their preference for selected vegetables, which may be a more sensitive measure of willingness to try and preferences. It is possible that if the researchers had used a taste-test evaluation measure using FV emphasized in the curriculum, improvements in willingness to try and preference for FV might have been seen. Preferences for FV and willingness to try FV both have been linked to increased daily intake of FV in children and should still be considered targets for future interventions.[56,57]

Of note, the *LA Sprouts* intervention resulted in reductions in BMI parameters and waist circumference and increased intake of dietary fiber and some vegetables, and tended to increase whole grain intake.[34] The current analyses highlight the intervention effects on determinants of dietary behaviors and did not examine the effects of these determinants on dietary intake and health outcomes. These findings show that a garden-based intervention can improve a number of determinants linked to dietary intake, many of which encompassed gardening behaviors. Improving gardening at home and gardening knowledge are just some of the ways in which garden-based programs can improve health outcomes. Additional analyses to assess how changes in gardening behaviors mediate changes in dietary and health outcomes are warranted.

There are several limitations of this study. The intervention was only 12 weeks long and longer garden-based interventions are needed to address the long-term effects on determinants of dietary behaviors as well as to understand how to sustain the program and behaviors. However, this study shows that a relatively short intervention can result in short-term improvements in determinants of dietary behavior. This is an exploratory study with only 4 schools; larger cluster RCTs examining the impact of gardening programs on dietary behaviors and other health outcomes are warranted. This study was also conducted in predominately Hispanic/Latino children of low-income families, and results might not be generalizable beyond this study population. Garden-based programs should also consider using taste tests in their evaluation, which may be a more sensitive measure of identification, preference, and willingness to try in younger populations.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The intervention resulted in more *LA Sprouts* participants reporting gardening at home. In general, the percentage of children gardening at home was relatively high in both groups at baseline (38% to 47%). This is unexpected because a large portion of the participants live in apartments with little to no yard space to plant a garden. One explanation for this is that these families might grow their own food because it is more affordable. Another explanation is that many of these families have fruit trees around their homes. Qualitative data were collected on where participants grew FV at home at baseline and after the intervention. At baseline, 45% of participants said they grew FV in the ground at their house, 11% in pots at their house, 8% at a friend or relative's house, 7% in community gardens, and 5% in windowsills. After the intervention, 45% of participants grew FV in the ground at their house, 17% at a friend or relative's house, 16% at a community garden, 12% in pots at their house, and 8% in windowsills. Gardening programs could also extend their approach beyond teaching children to garden at school by teaching them to garden with their families in their communities. If children were gardening at school, but also with an emphasis on gardening with their families in their communities, this could offer more exposure and access

to FV, reinforce positive health behaviors, and sustain the positive health benefits for longer.

These findings highlight how a gardening, nutrition, and cooking program can improve many determinants of dietary behavior. These changes in determinants suggest possible mechanisms by which such an intervention acts to improve dietary intake and other health outcomes. Future interventions should focus on ways to improve identification of vegetables, gardening, and nutrition knowledge, and gardening at home in children.

ACKNOWLEDGMENTS

This study was supported by funding from National Institutes of Health grant 5R21DK094066 (ClinicalTrials.gov identifier NCT02291146). The authors thank Monica Solares De Chairez for being the project manager on this study. They also thank the participating families and children at each of the schools.

REFERENCES

1. Goran MI, Lane C, Toledo-Corral C, Weigensberg MJ. Persistence of pre-diabetes in overweight and obese Hispanic children: association with progressive insulin resistance, poor beta-cell function, and increasing visceral fat. *Diabetes*. 2008;57:3007-3012.
2. Goran MI, Nagy TR, Treuth MT, Nagy TR. Visceral fat in Caucasian and African-American pre-pubertal children. *Am J Clin Nutr*. 1997;65:1703-1709.
3. Goran MI, Walker R, Le KA, et al. Effects of PNPLA3 on liver fat and metabolic profile in Hispanic children and adolescents. *Diabetes*. 2010;59:3127-3130.
4. Cruz ML, Weigensberg MJ, Huang T, Ball GDC, Shaibi GQ, Goran MI. The metabolic syndrome in overweight Hispanic youth and the role of insulin sensitivity. *J Clin Endocrinol Metab*. 2004;89:108-113.
5. Goran MI, Bergman RN, Avilla Q, et al. Impaired glucose tolerance and reduced beta-cell function in overweight Latino children with a positive family history of type 2 diabetes. *J Clin Endocrinol Metab*. 2004;89:207-212.
6. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA*. 2012;307:483-490.
7. Lorson BA, Melgar-Quinonez HR, Taylor CA. Correlates of fruit and vegetable intakes in US children. *J Am Diet Assoc*. 2009;109:474-478.
8. Cooper AJ, Sharp SJ, Lentjes MA, et al. A prospective study of the association between quantity and variety of fruit and vegetable intake and incident type 2 diabetes. *Diabetes Care*. 2012;35:1293-1300.
9. Ventura EE, Davis JN, Alexander KE, et al. Dietary intake and the metabolic syndrome in overweight Latino children. *J Am Diet Assoc*. 2008;108:1355-1359.
10. Shi L, Krupp D, Remer T. Salt, fruit and vegetable consumption and blood pressure development: a longitudinal investigation in healthy children. *Br J Nutr*. 2014;111:662-671.
11. Gatto NM, Ventura EE, Cook L, Gyllenhammer LE, Davis JN. LA Sprouts: a garden-based nutrition intervention impacts motivation and preferences for fruits and vegetables in Latino youth. *J Acad Nutr Diet*. 2012;112:913-920.
12. Davis JN, Spaniol MR, Somerset S. Sustenance and sustainability: maximizing the impact of school gardens on health outcomes [Epub ahead of print]. *Public Health Nutr*; 2015 Feb 23:1-10.
13. Somerset S, Markwell K. Impact of a school-based food garden on attitudes and identification skills regarding vegetables and fruit: a 12-month intervention trial. *Public Health Nutr*. 2009;12:214-221.
14. Lineberger S, Zajicek J. School gardens: can a hands-on teaching tool affect students' attitudes and behaviors regarding fruit and vegetables? *HortTechnology*. 2000;10:593-597.
15. Ratcliffe MM, Merrigan KA, Rogers BL, Goldberg JP. The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice*. 2011;12:36-43.
16. Gibbs L, Staiger PK, Johnson B, et al. Expanding children's food experiences: the impact of a school-based kitchen garden program. *J Nutr Educ Behav*. 2013;45:137-146.
17. Parmer SM, Salisbury-Glennon J, Shannon D, Struempler B. School gardens: an experiential learning approach for a nutrition education program to increase fruit and vegetable knowledge, preference, and consumption among second-grade students. *J Nutr Educ Behav*. 2009;41:212-217.
18. Morris JL, Koumjian KL, Briggs M, Zidenberg-Cherr S. Nutrition to grow on: a garden-enhanced nutrition education curriculum for upper-elementary schoolchildren. *J Nutr Educ Behav*. 2002;34:175-176.
19. McAleese JD, Rankin LL. Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *J Am Diet Assoc*. 2007;107:662-665.
20. Morgan PJ, Warren JM, Lubans DR, Saunders KL, Quick GI, Collins CE. The impact of nutrition education with and without a school garden on knowledge, vegetable intake and preferences and quality of school life among primary-school students. *Public Health Nutr*. 2010;13:1931-1940.
21. Evans A, Ranjit N, Rutledge R, et al. Exposure to multiple components of a garden-based intervention for middle school students increases fruit and vegetable consumption. *Health Promot Practice*. 2012;13:608-616.
22. Wang M, Rauzon S, Studer N, et al. Exposure to a comprehensive school intervention increases vegetable consumption. *J Adolesc Health*. 2010;46:1-9.
23. Hutchinson J, Christian MS, Evans CE, Nykjaer C, Hancock N, Cade JE. Evaluation of the impact of school gardening interventions on children's knowledge of and attitudes towards fruit and vegetables: a cluster randomised controlled trial. *Appetite*. 2015;91:405-414.
24. Bontrager Yoder AB, Liebhart JL, McCarty DJ, et al. Farm to elementary school programming increases access to fruits and vegetables and increases their consumption among those with low intake. *J Nutr Educ Behav*. 2014;46:341-349.
25. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice Hall; 1986.
26. Cullen KW, Baranowski T, Rittenberry L, Olvera N. Social-environmental influences on children's diets: results from focus groups with

African-, Euro- and Mexican-American children and their parents. *Health Educ Res*. 2000;15:581-590.
27. Domel SB, Baranowski T, Davis HC, Thompson WO, Leonard SB, Baranowski J. A measure of stages of change in fruit and vegetable consumption among fourth- and fifth-grade school children: reliability and validity. *J Am Coll Nutr*. 1996;15:56-64.
28. Resnicow K, Davis-Hearn M, Smith M, et al. Social-cognitive predictors of fruit and vegetable intake in children. *Health Psychol*. 1997;16:272-276.
29. Rasmussen M, Krlner R, Klepp KI, et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act*. 2006;3:22-41.
30. McClain AD, Chappuis C, Nguyen-Rodriguez ST, Yaroch AL, Spruijt-Metz D. Psychosocial correlates of eating behavior in children and adolescents: a review. *Int J Behav Nutr Phys Act*. 2009 Aug 12;6:54-74.
31. Ryan R, Deci E. *Handbook of Self-determination Research*. Rochester, NY: University of Rochester Press; 2002.
32. Williams GC, Gagne M, Ryan RM, Deci EL. Facilitating autonomous motivation for smoking cessation. *Health Psychol*. 2002;21:40-50.
33. Williams GC, Freedman ZR, Deci EL. Supporting autonomy to motivate patients with diabetes for glucose control. *Diabetes Care*. 1998;21:1644-1651.
34. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA Sprouts randomized controlled nutrition and gardening program reduces obesity and metabolic risk in Latino youth. *Pediatr Obes*. In press.
35. Martinez LC, Gatto NM, Spruijt-Metz D, Davis JN. Design and methodology of the LA Sprouts nutrition, cooking and gardening program for Latino youth: a randomized controlled intervention. *Contemp Clin Trials*. 2015;42:219-227.
36. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC Growth Charts for the United States: methods and development. *Vital Health Stat 11*. 2002; 246:1-190.
37. Wardle J, Robb K, Johnson F. Assessing socioeconomic status in adolescents: the validity of a home affluence scale. *J Epidemiol Commun Health*. 2002;56: 595-599.
38. Baranowski T, Davis M, Resnicow K, et al. Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation. *Health Educ Behav*. 2000;27: 96-111.
39. Pliner P, Hobden K. Development of a scale to measure the trait of food neophobia in humans. *Appetite*. 1992;19: 105-120.
40. Ryan RM, Connell JP. Perceived locus of causality and internalization: examining reasons for acting in two domains. *J Pers Soc Psychol*. 1989;57:749-761.
41. Williams GC, Grow VM, Freedman ZR, Ryan RM, Deci EL. Motivational predictors of weight loss and weight-loss maintenance. *J Pers Soc Psychol*. 1996;70:115-126.
42. Wright W, Rowell L. Examining the effect of gardening on vegetable consumption among youth in kindergarten through fifth grade. *WMJ*. 2010;109: 125-129.
43. Hermann JR, Parker SP, Brown BJ, Siewe YJ, Denney BA, Walker SJ. After-school gardening improves children's reported vegetable intake and physical activity. *J Nutr Educ Behav*. 2006;38:201-202.
44. Morris JL, Zidenberg-Cherr S. Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables. *J Am Diet Assoc*. 2002;102:91-93.
45. Davis JN, Ventura EE, Cook LA, Gyllenhammer LE, Gatto NM. LA Sprouts: a gardening, nutrition and cooking intervention for Latino youth improves diets and attenuate weight gain. *J Am Diet Assoc*. 2011;111: 1224-1230.
46. De Bourdeaudhuij I, Brug J. Tailoring dietary feedback to reduce fat intake: an intervention at the family level. *Health Educ Res*. 2000;15:449-462.
47. Weber Cullen K, Baranowski T, Rittenberry L, et al. Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents: reliability and validity of measures. *Public Health Nutr*. 2000;3: 345-356.
48. Grosso G, Mistretta A, Turconi G, Cena H, Roggi C, Galvano F. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. *Public Health Nutr*. 2013;16:1827-1836.
49. Fischer C, Brug J, Tak NI, Yngve A, te Velde SJ. Differences in fruit and vegetable intake and their determinants among 11-year-old schoolchildren between 2003 and 2009. *Int J Behav Nutr Phys Act*. 2011;8:141-152.
50. Kristjansdottir AG, De Bourdeaudhuij I, Klepp KI, Thorsdottir I. Children's and parents' perceptions of the determinants of children's fruit and vegetable intake in a low-intake population. *Public Health Nutr*. 2009;12:1224-1233.
51. Gibson EL, Wardle J, Watts CJ. Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite*. 1998; 31:205-228.
52. Horodynski MA, Hoerr S, Coleman G. Nutrition education aimed at toddlers: a pilot program for rural, low-income families. *Fam Commun Health*. 2004;27: 103-113.
53. Satia JA, Kristal AR, Curry S, Trudeau E. Motivations for healthful dietary change. *Public Health Nutr*. 2001;4:953-959.
54. Sebire SJ, Standage M, Vansteenkiste M. Examining intrinsic versus extrinsic exercise goals: cognitive, affective, and behavioral outcomes. *J Sport Exerc Psychol*. 2009;31:189-210.
55. Shaikh AR, Vinokur AD, Yaroch AL, Williams GC, Resnicow K. Direct and mediated effects of two theoretically based interventions to increase consumption of fruits and vegetables in the Healthy Body Healthy Spirit trial. *Health Educ Behav*. 2011;38: 492-501.
56. Brug J, Tak NI, te Velde SJ, Bere E, de Bourdeaudhuij I. Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: results from observational studies. *Br J Nutr*. 2008;99(suppl 1): S7-S14.
57. Tsuji M, Nakamura K, Tamai Y, et al. Relationship of intake of plant-based foods with 6-n-propylthiouracil sensitivity and food neophobia in Japanese preschool children. *Eur J Clin Nutr*. 2012;66:47-52.

CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.