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LA sprouts randomized controlled nutrition, cooking and gardening programme reduces obesity and metabolic risk in Hispanic/Latino youth

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Summary

Background: Many programmes for children that involve gardening and nutrition components exist; however, none include experimental designs allowing more rigorous evaluation of their impact on obesity.
Objectives: The objective of this study is to explore the effects of a novel 12-week gardening, nutrition and cooking intervention {'LA Sprouts'} on dietary intake, obesity parameters and metabolic disease risk among low-income, primarily Hispanic/Latino youth in Los Angeles..
Methods: This study used a randomized control trial involving four elementary schools [two randomized to intervention {172, 3rd–5th grade students}; two randomized to control {147, 3rd–5th grade students}]. Classes were taught in 90-min sessions once per week for 12 weeks. Data collected at pre-intervention and post-intervention included dietary intake via food frequency questionnaire, anthropometric measures {body mass index, waist circumference}, body fat, and fasting blood samples.
Results: LA Sprouts participants compared with controls had significantly greater reductions in body mass index z-scores {−0.1 vs. −0.04, respectively; $p = 0.01$} and waist circumference {−1.2 vs. 0.1 cm; $p < 0.001$}. Fewer LA Sprouts participants had the metabolic syndrome after the intervention than before, while controls with metabolic syndrome increased. LA Sprouts participants compared with controls increased dietary fiber intake {+3.4% vs. −16.5%; $p = 0.04$}. All participants decreased vegetable intake, but decreases were less in LA Sprouts than controls {−3.7% vs. −26.1%; $p = 0.04$}. Change in fruit intake did not differ between LA Sprouts and controls.
Conclusions: LA Sprouts was effective in reducing obesity and metabolic risk; however, additional larger and longer-term studies are warranted.

Keywords: BMI, fruit and vegetable consumption, gardening, Hispanic/Latino.

Abbreviations: FFQ, frequency questionnaire; BMI, body mass index; WC, waist circumference; MetSyn, metabolic syndrome; CVD, cardiovascular disease; LA, Los Angeles; SES, socioeconomic status; SBP, systolic blood pressure; RCT, randomized control trial; USC, University of Southern California; LAUSD, Los Angeles Unified School District; BP, blood pressure; HOMA-IR, Homeostatic model assessment

Introduction

The increased prevalence of childhood obesity in the USA is concerning and has led to projections that one in three male and two in five female children born in the year 2000 will develop diabetes in their lifetime (1). Nearly one-third {31.8%} of US children and adolescents aged 2–19 years were overweight or obese in 2011–2012, including 16.9% who were obese (2). Paediatric obesity is associated with an increase in cardiovascular disease risk factors, asthma and psychological problems during childhood (3).

Adolescent Hispanic/Latinos have higher obesity rates than their Caucasian counterparts (2). Low intakes of dietary fibre, specifically from fruits and vegetables, coupled with high consumption of refined grains and added sugar are linked to obesity and related disorders in Hispanic/Latino youth aged 8–18 years in Los Angeles {LA} (4), highlighting modifiable dietary behaviours to be targeted in interventions (4).

Socioeconomic status {SES} is an important determinant of access to healthy, high-quality fresh fruits, vegetables and other foods (5); low SES residents of 'food desert' neighbourhoods in urban areas are less likely to have access than residents of higher SES neighbourhoods.

Food preferences are shaped when children are young, and children's preferences for vegetables are strong predictors of consumption (6). Having direct experiences with growing food enhances children's understanding of foods and their relationship to health (6). Many programmes for children that involve gardening and nutrition components exist (7–12), and many have led to improvements in fruit but not vegetable consumption (13). However, none have included experimental designs allowing more rigorous evaluation of their impact on obesity and metabolic risk factors (14).

In 2010, a non-randomized 12-week after-school gardening, nutrition/cooking intervention called 'LA Sprouts' was pilot-tested in predominantly low-income Hispanic/Latino elementary school children in LA and was associated with reductions in body mass index {BMI} and systolic blood pressure {SBP} (7), and with increases in dietary fibre intake and preferences for vegetables(7,15). These preliminary findings led to the development and implementation of a small randomized control trial of LA Sprouts during 2012–2014 in this population (16). This novel study hypothesizes that LA Sprouts participants compared with controls would experience reductions in adiposity and metabolic risk factors and increases in intake of fruit, vegetables and overall dietary fibre.

Methods

Participants

A description of the LA Sprouts study design and eligibility criteria is provided elsewhere (16). Briefly, during 2011–2013, four elementary schools in Los Angeles Unified School District were identified as eligible because they (i) offered an after-school programme {'LA's BEST'}; (ii) had a student body ≥75% Latino; (iii) had ≥75% of students participating in the free lunch programme; (iv) were within 10 miles of University of Southern California {USC}; (v) were interested in a school garden/hosting a gardening programme and (vi) could make an administrative commitment. Students at two schools were randomly assigned to receive the intervention, and students at two served as controls. All 3rd, 4th and 5th grade students enrolled in LA's BEST were invited to participate (Fig. 1). Institutional Review Boards of USC, the University of Texas at Austin, Loma Linda University and Los Angeles Unified School District approved the study. Informed written consent from parents and assent from children were obtained.

Description of the intervention

LA Sprouts was taught in school gardens constructed on campus (16). Raised bed planter boxes were placed on unpaved, grassy areas of the school yard or on areas where asphalt was removed; gardening tools were provided. An outdoor modular kitchen was outfitted with cooking supplies. Classes were held once a week for 12 weeks during either the fall or winter/spring school semester. Separate classes were offered to each grade level. The classes consisted of a 45-min interactive cooking/nutrition lesson and a 45-min gardening lesson taught by an educator with a nutrition or gardening background. The programme's curriculum and theoretical framework based in part on Bandura's 'self-efficacy' (17) are described elsewhere (7,15,16). Students worked in small teams led by the educator to cook/prepare a snack recipe each week that emphasized fruit and/or vegetable ingredients. Gardening activities also used a 'hands-on' approach, where children participated in planting, growing and harvesting organic fruits and vegetables. Parallel classes were offered to parents bimonthly on mornings, evenings and weekends.

Description of control group

Students at two control schools did not receive any nutrition, cooking or gardening information from investigators between pre-testing and post-testing, and schools were asked to refrain from augmenting their curriculum with similar lessons during the study period. Following post-testing, control schools received a delayed LA Sprouts intervention, including a school garden.

Data collection occurred during the week prior to instruction {baseline measures} or 7–14 days after the final day of instruction {for post-intervention}. Study personnel who were not blinded to group assignment were trained to perform data collection

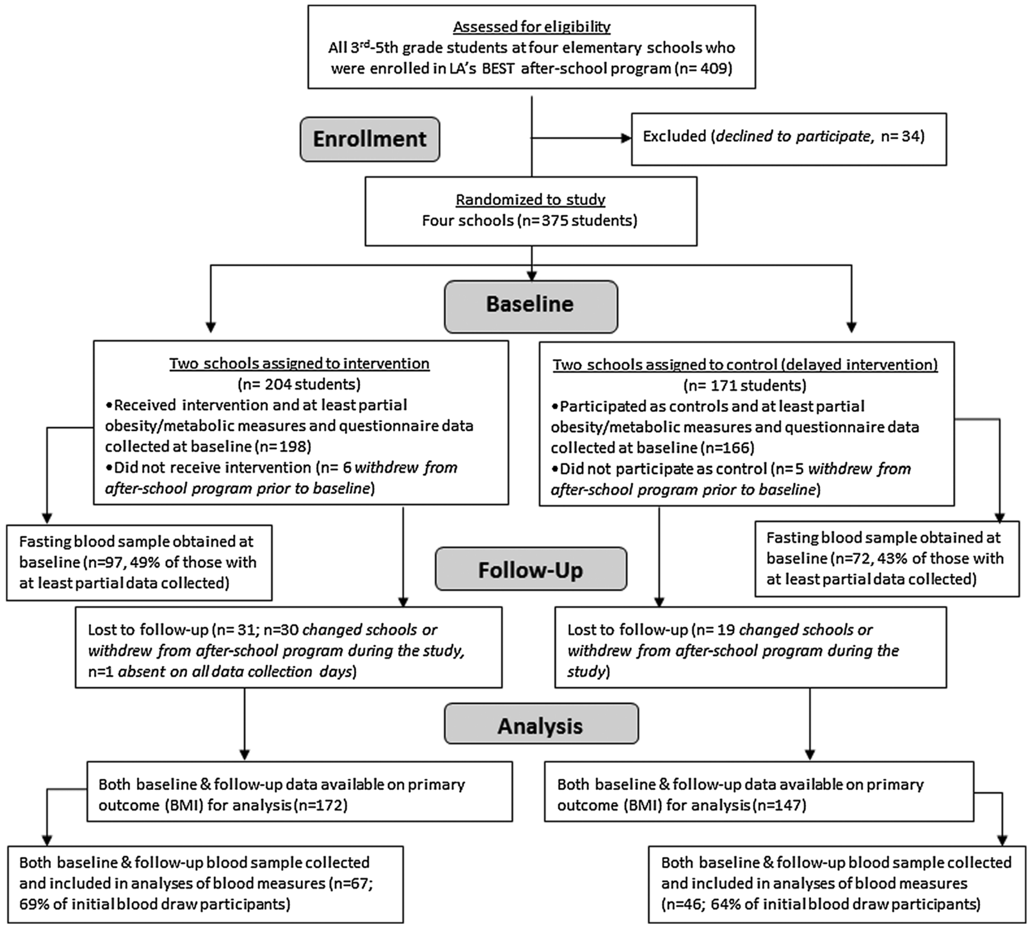

Figure 1 Flow of participants through the LA Sprouts study.

using standardized protocols. Staff were directed to review protocols; participated in demonstrations by the principal investigator and or project manager; and were observed to ensure proper technique. A principal investigator or project manager was present to supervise data collection.

Anthropometric and metabolic disease

Height was measured with a free-standing stadiometer {Seca, Birmingham, UK} and weight and percent body fat via bioelectrical impedance {Tanita TBF 300A, Arlington Heights, IL, USA}. BMI *z*-scores and percentiles were determined using Centers for Disease Control and Prevention (CDC) cut-points for age and sex. Blood pressure was measured with an automated monitor with appropriate child cuffs {Omron, Schaumberg, IL, USA}; waist circumference {WC} measures followed NHANES protocol (18).

The Child Questionnaire included items on demographics and SES. Dietary intake was measured using the Block Kids Food Screener {'last week' version}. This 41-item screener was developed and adapted from the Block Kids 2004 FFQ {NutritionQuest, Berkeley, CA, USA} and is validated in metropolitan area youth (19). NutritionQuest uses screener data to derive variables reflecting nutrient, food, and food group estimates.

Optional Fasting Blood Samples were collected off-campus in the morning before school or on weekends by licensed phlebotomists with experience drawing blood in overweight children. Samples were processed and stored at USC until they were delivered to the Ritchey lab at USC {glucose and insulin} and the Gower lab at the University of Alabama {lipids} for analysis.

Glucose was assayed using a Yellow Springs Instruments analyzer {Yellow Springs, OH, USA}. Total cholesterol, high-density lipoprotein cholesterol {HDL} and triglyceride levels were measured using enzymatic methods on a Stanbio Sirrus analyzer {Stanbio Laboratory, Boerne, TX, USA}; Low-density lipoprotein {LDL} was calculated using the Friedewald equation. Insulin was quantified using an

ELISA kit {EMD Millipore, St. Charles, MO, USA}. Homeostatic model assessment (HOMA-IR) was calculated as a measure of insulin resistance.

Metabolic Syndrome {MetSyn} was identified using the definition of Cook *et al*. which was adapted in adolescents using the National Cholesterol Education Programme's criteria for adults (20).

Statistical analyses

Preliminary analyses

Anthropometric and metabolic data were screened for plausibility by conducting residual analyses examining how the baseline value of a given variable predicted that at follow-up. Original data was checked to resolve possible measurement errors for participants with standardized residuals $> |3|$, otherwise if errors could not be corrected and it was concluded that the observation was an outlier, it was removed from analyses. Dietary screener variables were selected as relevant to study hypotheses. Excluded as implausible or outlying were observations for which the change in reported intake between pre-intervention and post-intervention was $\leq$ the 1st or $\geq$ the 99th percentile. The number of observations set to missing varied by the dependent variable, yet fewer than 2.2% of observations were excluded. Variables were examined for normality, and data transformations were attempted for SBP, HDL and fasting insulin, but improvements were not substantial. Thus, analyses used the original data.

Primary analyses

Frequencies were tabulated for categorical socio-demographic variables at baseline; mean ± standard errors for continuous variables at baseline and follow-up were calculated, adjusting for age {continuous}, sex, Hispanic/Latino {yes or no}, English spoken at home {yes or no}, school {Monte Vista, Loreto, Sierra Park or Euclid}. Means for nutrients and foods/food groups were additionally adjusted for energy intake. Repeated measures mixed effects linear models with school as a random effect and a variance components covariance structure assessed whether adjusted mean changes in anthropometric, clinical and dietary variables over the 12-week study period differed between intervention and control groups. Sensitivity analyses examined the effect of additional adjustment for baseline BMI in models where dietary variables and clinical variables were the dependent variable. Analyses were conducted in the overweight/obese subsample to examine whether results were similar to those for the total study sample. Because this study is intended to inform the development of a larger scale and longer term randomized control trial, adjustment for multiple comparisons was not done. Because of the small size of the study {only four schools randomized}, analyses were anticipated to be underpowered to detect differences in change measures between students in schools (21). Calculations of intraclass correlations for the main outcome variables were all small in magnitude {intraclass correlations < 0.05} suggesting very low degrees of clustering within schools. After verifying that demographic and anthropometric variables, plus energy intake, were not different between schools within treatment groups after randomization/prior to initiation of the intervention, unadjusted mean change scores were calculated in the outcome variables {from pre-intervention to post-intervention} for intervention and control schools. *T*-tests examined whether the average scores for schools were different between treatment groups. Results are provided as supplemental files (S1–S3). All analyses used SAS version 9.4 {SAS Institute Inc., Cary, NC, USA}.

Results

By design (16), the study population was ~89% Hispanic/Latino and ~90% eligible for free lunch at school (Table 1). The majority {>50%} were overweight {BMI $\geq$ 85th percentile}, and more than one-third were obese {BMI $\geq$ 95th percentile}, which is higher than the national average for this ethnic group (2). Average SPB and DBP may have been higher than national averages (22), dietary fibre intake was lower (23) while fruit and vegetable intake was approximately comparable (24). LA Sprouts participants and controls did not differ at baseline in age, sex, ethnicity, BMI and most socio-demographic factors examined. There was a trend for LA Sprouts participants compared with controls to be less likely to speak English at home {$p = 0.06$}.

After the 12-week programme, LA Sprouts participants had significantly greater reductions in BMI *z*-score than controls [−0.1{9.9%} vs. −0.04{3.8%}, respectively; $p = 0.01$]. LA Sprouts participants had a 1.2 cm {1.7%} reduction in WC, while controls had a 0.1 cm {0.1%} increase after the intervention {$p < 0.001$} (Table 2). The number of students overall who fit criteria for the MetSyn was small. However, there were fewer LA Sprouts participants with the MetSyn after {$n = 1$} the intervention than before {$n = 7$}, while the number of controls with the MetSyn was essentially the same between pre-intervention {$n = 3$} and post-intervention {$n = 4$}. For percent body fat, SBP and DBP, and blood measures, the change between pre-intervention and post- intervention was not statistically different between LA Sprouts participants and

Table 1 Demographic characteristics of LA Sprouts and control participants at baseline

Characteristic, n (%) or mean ± SD	LA Sprouts (n = 172)	Controls (n = 147)	p-value[a]
	Pre	Pre	
Male	82 (47.7)	71 (48.3)	0.91
Hispanic/Latino[b]	153 (89.0)	127 (88.8)	0.97
Age, years	9.3 ± 0.9	9.3 ± 0.9	0.9
Height, cm[c]	135.0 ± 8.5	135.0 ± 8.5	0.96
Weight, kg[d]	36.9 ± 10.6	38.1 ± 12.6	0.30
BMI, kg/m^2[i]	19.8 ± 4.1	20.6 ± 4.6	0.13
Overweight (≥85th percentile)[e]	82 (51.3)	73 (53.3)	0.73
Obese (≥95th percentile)[e]	54 (33.8)	54 (39.4)	0.31
Systolic blood pressure, mmHg[j]	109.4 ± 12.1	112.3 ± 14.3	0.07
Diastolic blood pressure, mmHg[g]	64.3 ± 11.1	66.7 ± 13.6	0.11
Socioeconomic factors			
No English spoken at home[d]	48 (28.7)	27 (19.6)	0.06
No computer at home[f]	42 (26.1)	32 (23.2)	0.56
No internet at home[g]	39 (23.2)	32 (23.2)	0.99
Mother does not have own car[g]	57 (34.3)	38 (27.1)	0.17
Eligible for free lunch at school[h]	152 (90.5)	125 (89.3)	0.73

[a]p-value for difference between groups from chi-squared tests (categorical variables) or independent t-tests (continuous variables). [b]n = 315 [c]n = 304 [d]n = 305 [e]n = 297 [f]n = 299 [g]n = 306 [h]n = 308 [i]n = 301 [j]n = 307 BMI, body mass index.

controls. Adjustment for BMI did not appreciably alter the change estimates or impact conclusions about the effect of the intervention on obesity or metabolic measures {data not shown}. Results in the overweight/obese strata were similar to those in the total sample {data not shown}.

LA Sprouts participants increased dietary fibre intake by 0.4 g/d {3.4%}, compared with a 2.0 g/d {16.5%} decrease in controls {p = 0.04} (Table 2). Both LA Sprouts participants and controls had decreased vegetable intake, but the decreases were smaller in LA Sprouts than controls [−0.03 CE/d {3.7%}, vs. −0.2 CE/d {26.1%}; p = 0.04]. LA Sprouts tended to increase intake of whole grains and green beans and peas, while controls decreased their intake {$p \leq 0.10$}. Change in fruit intake overall and intake of apples, bananas and oranges did not significantly differ between LA Sprouts and control subjects.

Discussion

This study suggests that the LA Sprouts programme, the first randomized controlled school gardening, nutrition and cooking intervention, was effective in reducing obesity risk in predominantly Hispanic/Latino elementary school aged children. While the reductions were relatively small in magnitude {decreases of 0.1 in BMI z-score and 1.2 cm in WC}, it is notable that changes were observed over a 12-week period. The modest reduction in BMI may also be interpreted relative to those observed in previous more intensive RCTs of dietary modifications, rigorous nutrition education, intense and monitored physical activity sessions or clinic-based with or without healthcare professionals, which have demonstrated inconsistent successes (25). A 12-week behavioural modification programme for Hispanic/Latino children aged 7–15 years and their families that provided alternative foods to substitute for those with high glycemic index, dietary prescriptions and physical activity sessions found a 0.156 point reduction in BMI z-scores after 3 months (26). Furthermore, as the prevalence of overweight and obesity in our study population was higher than national averages (2), this suggests that even small risk reductions represent progress in tackling the problem.

LA Sprouts may have led to changes in dietary intake, with an observed increase in dietary fibre. Some (7–12) but not all (11,27) previous non-randomized studies of school-garden-based educational programmes have demonstrated an effect on increasing fruit or vegetable intake in children. With over 90% of our students eligible for free or reduced cost meals, as much as two-thirds of their daily dietary intake may be determined by what is offered at schools. This contextualizes an interpretation of the magnitude of change in dietary intakes associated with the intervention.

Table 2 Adjusted mean ± SE[a] anthropometric, clinical characteristics and intake of select foods and nutrients of LA Sprouts participants and controls before and after intervention, and adjusted mean (percent) change between pre-intervention and post-intervention

Characteristic, mean ± SE	LA Sprouts (n = 172)				Controls (n = 147)				p-value[c]
	Pre	Post	Absolute change	Percent change	Pre	Post	Absolute change	Percent change	
Anthropometrics									
BMI percentile	74.3 ± 2.1	72.3 ± 2.1	−2.0	−2.7	76.4 ± 2.3	75.3 ± 2.3	−1.0	−1.4	0.13
BMI *z*-score	0.91 ± 0.08	0.82 ± 0.08	−0.1	−9.9	1.05 ± 0.09	1.01 ± 0.09	−0.04	−3.8	*0.01*
Waist circumference, cm	70.6 ± 0.4	69.4 ± 0.4	−1.2	−1.7	71.1 ± 0.5	71.2 ± 0.5	0.1	0.1	*<0.001*
Body fat, %	24.7 ± 0.3	24.2 ± 0.3	−0.5	−2.0	25.1 ± 0.4	24.5 ± 0.4	−0.6	−2.4	0.82
Clinical characteristics									
Systolic blood pressure, mmHg	109.6 ± 0.9	109.0 ± 0.9	−0.5	−0.6	111.8 ± 1.0	111.5 ± 1.0	−0.3	−0.3	0.87
Diastolic blood pressure, mmHg	64.5 ± 0.8	63.8 ± 0.8	−0.7	−1.1	66.4 ± 0.9	63.9 ± 0.9	−2.5	−3.8	0.28
Cholesterol									
Total	158.6 ± 3.0	164.2 ± 3.2	5.6	3.5	156.0 ± 3.8	157.7 ± 4.1	1.7	1.1	0.31
LDL-C	85.7 ± 2.5	87.0 ± 2.7	1.3	1.5	85.3 ± 3.2	85.0 ± 3.4	−0.3	−0.4	0.60
HDL-C	58.7 ± 1.2	60.9 ± 1.3	2.3	3.8	56.3 ± 1.5	57.6 ± 1.6	1.3	2.3	0.41
Triglycerides	68.2 ± 3.2	72.5 ± 3.6	4.3	6.3	72.4 ± 4.0	74.5 ± 4.5	2.1	2.9	0.64
Insulin, μU/mL	11.1 ± 0.8	11.7 ± 0.9	0.6	5.4	10.4 ± 1.0	10.8 ± 1.1	0.4	3.8	0.88
HOMA-IR	2.6 ± 0.2	2.7 ± 0.2	0.1	3.9	2.4 ± 0.2	2.4 ± 0.3	0.05	0.0	0.85
Glucose, mg/ dL^{-1}	91.9 ± 0.7	93.9 ± 0.8	2.1	2.2	90.9 ± 0.8	92.3 ± 1.0	1.4	1.5	0.56
Metabolic Syndrome	7 (4.2)	1 (0.6)	−6	85.7	3 (2.1)	4 (2.72)	1		
WC ≥90th percentile, age-specific, sex-specific	45 (27.4)	41 (24.4)	−4	−8.9	47 (34.1)	49 (34.0)	2	4.2	
Fasting glucose ≥110 mg dL^{-1}	0	0	—	—	0	1 (2.3)	1	100	
Triglycerides ≥110 mg dL^{-1}, age-specific	9 (10.5)	8 (12.9)	−1	−11.1	12 (19.4)	8 (18.2)	−4	−33.3	
HDL-C ≤40 mg/ dL^{-1}	3 (3.5)	2 (3.2)	−1	−33.3	6 (9.7)	5 (11.4)	−1	−16.7	
BP ≥90th percentile, age-specific, sex-specific, height-specific	66 (39.8)	56 (32.9)	−10	−15.2	72 (52.2)	68 (47.2)	−4	−5.6	
Nutrient									

(Continues)

Table 2 (Continued)

Characteristic, mean ± SE	LA Sprouts ($n = 172$)				Controls ($n = 147$)				p-value[c]
	Pre	Post	Absolute change	Percent change	Pre	Post	Absolute change	Percent change	
Energy, kcal[b]	1318.8 ± 88.7	1315.0 ± 88.7	−3.8	−0.3	1321.3 ± 100.0	1171.5 ± 100.0	−149.7	−11.3	0.25
Protein, g/d	56.0 ± 2.7	54.9 ± 2.7	−1.1	−2.0	55.3 ± 3.0	46.1 ± 3.0	−9.2	−16.6	0.15
Fat, g/d	54.9 ± 2.7	53.0 ± 2.7	−1.9	−3.5	54.0 ± 3.0	46.2 ± 3.0	−7.7	−14.4	0.30
Carbohydrates, g/d	155.0 ± 6.6	159.4 ± 6.6	4.4	2.8	159.0 ± 7.5	147.6 ± 7.5	−11.4	−7.2	0.26
Added sugar, tsp/d	7.6 ± 0.5	8.4 ± 0.5	0.8	10.5	8.0 ± 0.6	7.4 ± 0.6	−0.7	−7.5	0.11
Dietary fibre, g/d	11.7 ± 0.6	12.1 ± 0.6	0.4	3.4	12.7 ± 0.7	10.6 ± 0.7	−2.0	−16.5	*0.04*
Food or food group									
Meat, OE[d]	2.8 ± 0.2	2.7 ± 0.2	−0.1	−3.6	2.8 ± 0.2	2.2 ± 0.2	−0.6	−21.4	0.17
Dairy, CE[e]	1.5 ± 0.1	1.4 ± 0.1	−0.1	−6.7	1.4 ± 0.1	1.3 ± 0.1	−0.1	−7.1	0.56
Whole grains, OE	0.51 ± 0.04	0.55 ± 0.04	0.04	7.8	0.53 ± 0.04	0.45 ± 0.04	−0.08	−15.1	*0.10*
Vegetables, CE	0.82 ± 0.05	0.79 ± 0.05	−0.03	−3.7	0.92 ± 0.06	0.68 ± 0.06	−0.2	−26.1	*0.04*
Fruit and fruit juice, CE	1.4 ± 0.08	1.4 ± 0.08	−0.04	0.0	1.4 ± 0.09	1.3 ± 0.09	−0.1	−7.1	0.56
Apples, bananas and oranges, CE	0.45 ± 0.04	0.47 ± 0.04	0.02	4.4	0.48 ± 0.04	0.40 ± 0.04	−0.08	−16.7	0.12
Lettuce salad, CE	0.18 ± 0.02	0.18 ± 0.02	0.0	0.0	0.20 ± 0.02	0.16 ± 0.02	−0.04	−20.0	0.28
Green beans and peas, CE	0.03 ± 0.01	0.04 ± 0.01	0.01	33.3	0.04 ± 0.01	0.02 ± 0.01	−0.01	−50.0	*0.08*
Tomatoes, CE	0.05 ± 0.01	0.04 ± 0.01	−0.01	−20.0	0.06 ± 0.01	0.04 ± 0.01	−0.02	−33.3	0.21

[a]Means are adjusted for age (continuous), sex, ethnicity (Hispanic/Latino vs. not), English spoken at home (yes or no), school (Monte Vista, Loreto, Sierra Park or Euclid Elementary), energy(kcal) [b]not adjusted for energy (kcal) [c]p-value for multiplicative interaction term indicating change from pre to post for each measure between groups from mixed effects regression models [d]OE, ounce equivalent [e]CE, cup equivalent BMI, body mass index; BP, blood pressure; HOMA-IR, Homeostatic model assessment; WC, waist circumference.

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The number of students with the MetSyn was small, yet a decrease in MetSyn among LA Sprouts participants from pre-intervention to post-intervention was observed. While this finding should be interpreted with caution, it may indicate that LA Sprouts had an effect on biochemical processes associated with this clustering of metabolic risk factors. The importance of our WC finding is further supported by the emphasis placed on the role of abdominal obesity by the International Diabetes Foundation, which advocates that WC be used to identify children aged < 10 years to target weight reduction and be a criterion to diagnose the MetSyn for children aged 10– <16 years.

LA Sprouts was designed to be culturally tailored by including recipes that targeted foods familiar to the study population such as salsas and vegetable quesadillas. An effect of the intervention on fruit consumption was not observed, which is not in line with the study hypothesis but is concordant with some other non-randomized school-garden-based educational interventions targeting fruit intake (9,11,28). The food screener did not provide a broad dietary assessment, or of fruits and vegetables, which may be more commonly consumed by cultures reflected in our study population [i.e. papayas and nopales {cactus}]. Thus, the null findings for fruits may reflect inadequate sensitivity of our data collection instrument. Furthermore, FFQs are not able to precisely quantify intake of nutrient consumption or differences among varieties of foods that may be captured in a single food item question. Funding, time and sample size limitations prevented collection of 24-h dietary recalls. Nevertheless, the Block screener demonstrated good validity against three, 24-h dietary recalls in 99 youth in a metropolitan area, with de-attenuated correlations between the two instruments ranging from 0.526 for vegetables to 0.878 for potatoes (19).

LA Sprouts was developed to take place during the after-school hours because this time is ideal for implementing such health programmes. Students who remain on campus after school are captive audiences for 3 to 4 h. Data suggest that 50% of school children in K-8th grade aged 5–13 years are regularly in non-parental care before and after school (29). Many after-school care providers include scheduled time for enrichment in their programming and seek activities. The after-school hours are an opportunity to enhance students' academic achievement. It is possible to incorporate fun hands-on activities such as cooking or gardening that may not be feasible in a classroom setting. Afterschool programmes do not compete with required academic instruction and are not required to meet standards. Nevertheless, the LA Sprouts curriculum has been mapped on school standards {i.e. math, science, language arts and health} and could be utilized during the school day.

Because this was a small study of four schools, analysis of change measures between clusters of students in schools would be underpowered (21), and the current approach may lead to false positive results. Data are not available on long-term sustainability of the programme or results beyond the 12-week study period. Trained educators taught the programme; it is uncertain whether similar results can be expected when taught by after-school staff. However, several train-the-trainer workshops were held, and all educational resources and supplies were provided to the schools to help sustain the programme. Building partnerships with school teachers, staff, parents and community members were a practice initiated at the outset of working with each school (16). Because of the labour intensiveness of the study relative to its budget, trained staff involved in collection of questionnaire and anthropometric data could not logistically be blinded to treatment assignment. However, measurement bias is not a significant concern because data collection tasks were not necessarily the same for pre and post measurements, and staff did not have the knowledge of data on pre measurements when collecting post. Furthermore, the focus was on change measures, and given the aforementioned, it is difficult to imagine a scenario in which pre measures were consistently overestimated while post measures consistently underestimated in intervention subjects {i.e. for WC} with the reverse true for controls. There was a smaller sample size for optional blood measures {<50% of the total}, which led to reduced statistical power, and could explain null findings. While the importance of involving parents is recognized, parent classes were poorly attended. Future efforts should be directed to increasing parental support and should obtain evaluation measures on parents, as the home food environment reinforces material taught to children (30). Gardening is a source of physical activity, and future studies may want to supplement the exercise component of their programmes to include more high intensity activities such as digging and weeding, which were not emphasized in the intervention.

In conclusion, LA Sprouts, a novel school garden-based, nutrition, cooking and gardening experimental intervention resulted in a decreased risk of obesity and metabolic disease and improvements in dietary intake in high-risk Hispanic/Latino youth. These findings suggest that teaching children to grow, prepare and eat fruits and vegetables may be an efficacious approach to reducing disease risk. These findings set the stage to evaluate whether larger and longer term gardening and nutrition interventions can lead to greater change in obesity parameters and other health effects and to understand the sustainability of associated health benefits.

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Conflicts of interest

No conflict of interest was declared.

Author contributions

Authors N. M. G. and J. N. D. designed and conducted the research and have primary responsibility for final content. N. M. G. and L. C. M. analyzed data and performed statistical analysis. N. M. G., J. N. D., L. C. M. and D. S. M. wrote the paper.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Characteristics of LA Sprouts and control participants at baseline by schools.
Table S2. Mean ± standard deviation (SD) change between pre- and post-intervention in anthropometric and clinical characteristics of LA Sprouts participants and controls by schools.
Table S3. Mean ± SD change between pre- and post-intervention in intake of select foods and nutrients of LA Sprouts and control participants by schools.