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A Randomized Controlled Trial of Students for Nutrition and eXercise (SNaX): A Community-Based Participatory Research Study

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Abstract

Purpose—To conduct a randomized controlled trial of Students for Nutrition and eXercise (SNaX), a 5-week middle-school-based obesity-prevention intervention combining school-wide environmental changes, multimedia, encouragement to eat healthy school cafeteria foods, and peer-led education.

Methods—We randomly selected schools (five intervention, five wait-list control) from the Los Angeles Unified School District. School records were obtained for number of fruits and vegetables served, students served lunch, and snacks sold per attending student, representing an average of 1,515 students (SD=323) per intervention school and 1,524 students (SD=266) per control school. A total of 2,997 seventh-graders (75% of seventh-graders across schools) completed pre-and post-intervention surveys assessing psychosocial variables. Consistent with community-based participatory research principles, the school district was an equal partner and a community advisory board provided critical input.

Results—Relative to control schools, intervention schools showed significant increases in the proportion of students served fruit and lunch and a significant decrease in proportion of students buying snacks at school. Specifically, the intervention was associated with relative increases of 15.3% more fruit served ($p=0.006$), 10.4% more lunches served ($p<0.001$), and 11.9% fewer snacks sold ($p<0.001$) than would have been expected in its absence. Pre-to-post intervention, intervention school students reported more positive attitudes about cafeteria food ($p=0.02$) and tap water ($p=0.03$), greater obesity-prevention knowledge ($p=0.006$), increased intentions to drink

water from the tap ($p=0.04$) or a refillable bottle ($p=0.02$), and greater tap water consumption ($p=0.04$) compared to control school students.

Conclusions—Multi-level school-based interventions may promote healthy adolescent dietary behaviors.

Keywords

adolescent obesity; community participation; eating; intervention studies; schools

Introduction

Over 20% of U.S. adolescents aged 12-19 are obese (1). Policymakers have targeted schools as an ideal setting for obesity prevention. The 2010 Healthy Hunger-Free Kids Act (S.3307) (2) improves school food nutritional standards and requires free water provision at mealtimes (to reduce sugar-sweetened beverage [SSB] consumption) (3). School-based nutritional policy changes, as well as interventions that have improved the school nutritional environment, have shown encouraging results for reducing body mass index (BMI) and SSB consumption, and increasing fruit and vegetable intake (4-12). Expert medical committees have called on clinicians to advocate for school nutritional policy changes (13,14).

We used principles of community-based participatory research (CBPR), partnering with the Los Angeles Unified School District (LAUSD) to conduct a randomized controlled trial (RCT) of Students for Nutrition and eXercise (SNaX), a 5-week middle-school intervention combining school-wide environmental changes, multimedia, encouragement to eat cafeteria food (because of school policies to provide healthier food), and student advocacy (Table 1) (15-29). We used as a conceptual basis social-cognitive theories, which specify that changes in attitudes, norms, and self-efficacy lead to behavior change (22), and recognized the importance of ecological influences (e.g., food availability) in constraining and facilitating healthy behaviors (23). Because research suggests that peer leaders can be change agents in middle school, when peer influence is increasing (30), we trained peer leaders to promote and model healthy behaviors and engage other students in discussions to change eating and physical activity norms. Cafeteria managers offered chilled, filtered water and a greater variety of healthier options (sliced/bite-sized fruits/vegetables). In a SNaX pilot, students in an intervention school (versus a matched comparison school) selected more fruit and healthier entrées at lunch (17).

The purpose of the present study was to conduct an RCT of SNaX. We hypothesized that SNaX would lead to a higher proportion of students served in the cafeteria (because SNaX markets cafeterias' healthy foods); increased fruit and vegetable servings (because SNaX increases access to sliced/bite-sized fruits and vegetables); decreased school store snack sales; and greater water consumption. We also hypothesized that SNaX would lead to more positive attitudes about the cafeteria and water, improve obesity-prevention knowledge, and increase intentions to drink water.

Methods

Setting and Community Partnership

The main community partner for this research was LAUSD. LAUSD has a K-12 enrollment of ~665,000 students in 763 schools and serves >650,000 student meals daily. Students are 73% Latino, 10% Black, 9% White, and 6% Asian/Pacific Islander; 27% are English-language learners. Forty-six percent are obese/overweight. Although 79% of students are eligible for the National School Lunch Program's (NSLP) free-and-reduced-price meals, only 54% of eligible students obtain them.

Consistent with CBPR principles (18), school district administrators served on the study leadership team and were integral and equal partners in all research phases, including intervention development, intervention testing, data interpretation, and dissemination. A community advisory board (CAB) composed of local community and academic experts in adolescent obesity prevention (e.g., from LAUSD administration, parent groups, Los Angeles County's health department, youth-serving organizations, and research institutions) provided critical input and direction in regular in-person meetings.

Design

We conducted an RCT from January 2009-June 2012. Table 2 shows school socio-demographic characteristics. To control for seasonal variation in student eating, SNaX always occurred in the spring semester, when LAUSD cafeteria participation typically declines (17), consistent with prior research showing a downward seasonal trend in nutritional intake (31,32).

We evaluated intervention effects in the whole-school population, operationalized as proportion of: fruits and vegetables served, students obtaining lunch, and snacks sold, among attending students per day. Because seventh-graders received a more intensive intervention (e.g., peer-leader education), we surveyed seventh-graders pre-intervention and ~20-days post-intervention to assess psychosocial mechanisms through which SNaX operates.

School Selection

We identified 31 eligible schools with >50% NSLP-eligible students (a proxy for low-income) and <900 seventh-graders (a greater number of smaller schools provides more statistical power than a few larger schools). The number of schools selected (5 intervention, 5 wait-list control) was based on a pre-RCT power analysis for small-to-medium effects. We used stratified randomization of pairs of schools matched for baseline similarity for greater statistical efficiency than simple randomization (33). Post-randomization, each school was approached by a study coordinator who was blinded to condition. One school refused. All randomized schools were retained. Incentives for the evaluation included \$2,000 per school, \$100 gift-cards to school coordinators, \$50 gift-cards to seventh-grade teachers, fruit for classrooms achieving consent-return rates of 80%, and small gifts for teachers and students.

Participants

English and Spanish consent forms were distributed in-class for all seventh-graders to bring to parents. Parents provided informed consent for children; children provided assent. Passive consent was used for surveys; active consent was required for anthropometric and NSLP data collection.

Of 4,022 eligible students, 91% had parental consent for surveys and 344 parents declined. Of 3,211 who completed baseline surveys, 2,997 (93%) were retained at follow-up (75% of all eligible students); 681 missed 1 survey due to absence, field trip, or teacher refusal. Of 4,022 eligible students, 2,809 (70%) had consent for anthropometric and NSLP data collection; data were obtained for 2,606 (93%) and 2,693 (96%), respectively.

Seventh-graders were recruited via in-class presentations and informational tables for a peer-leader club in which they learned educational messages and conducted lunchtime giveaways (e.g., educational bookmarks) and cafeteria-food taste-tests (see Table 1). Based on diffusion of innovation theory, (34) 15% of a target group should be trained as advocates for optimal population diffusion of information. A different group of peer leaders was recruited each week; each leader was asked to recruit a partner for lunchtime activities. Across schools, 454 peer leaders and partners participated (23% of the 1,953 seventh-graders).

The research was approved by the institutional review boards of Boston Children's Hospital and RAND Corporation and the LAUSD Committee for External Research Review.

Facilitators

Two bachelor's-level facilitators led the peer-leader sessions. A PhD-level clinical psychologist conducted a 4-hour motivational interviewing training and annual booster sessions (29); a PhD-level public health researcher provided 20-hours of training on intervention content; and both provided weekly feedback using session recordings. Two quality assurance raters double-coded two-thirds (n=16) of the 25 sessions for 11 key session elements; they agreed that all elements were covered in 15 sessions, and 82% in the other.

Data Collection

School Records—We obtained NSLP-eligibility.

Anthropometric Measures—At baseline only, we measured height and weight with a portable stadiometer and electronic scale. We calculated BMI and classified youth as underweight, normal weight, overweight, or obese using age- and gender-normed charts (35).

Cafeteria and School Store Data—Each school provided cafeteria participation records (number of students obtaining lunch by NSLP eligibility; number of fruits and vegetables served) and school store sales data (number of snacks sold, e.g., cookies) for each day of the intervention semester. We divided these totals by the number of students in attendance to derive proportions representing number of fruits, vegetables, and meals served, and number

of snacks sold, per student each day. We calculated means of each proportion over the days before, during, and after the intervention. At two intervention and two control schools, the proportion of NSLP-eligible students was very high, such that LAUSD allowed all students to obtain free meals; therefore, daily served meals could not be divided by NSLP category.

Survey—Students reported age, gender, race/ethnicity, and US-born status. Because prior research has not measured cafeteria- and water-related psychosocial variables, we constructed items. Attitudes about the cafeteria were measured with the mean of two items: “I believe eating in the cafeteria is...” with responses 1=*unsatisfying*/7=*satisfying* and 1=*bad for my health*/7=*good for my health*. Attitudes about water were measured with, “On a scale from 0 to 10, how do you feel about drinking water?” with responses 0=*very negatively*/10=*very positively*. Knowledge about healthy eating and physical activity was measured with 6 true/false items (e.g., “Plain water does not contain any sugar”). Intentions to drink water were assessed with two items, “How likely is it that you will drink water [*or* drink water from a refillable water bottle] the next day you are in school?” with 5-point scales (*extremely likely/extremely unlikely*). Water consumption frequency was assessed with, “How often do you usually drink tap water?” and “How often do you usually use a refillable water bottle to drink water?” (*every day, a few times a week, once a week, twice a month, once a month, less than once a month, never*).

No significant differences emerged between intervention and control students on the socio-demographic variables of age, gender, race/ethnicity, BMI, or NSLP eligibility, or on the baseline versions of the outcome variables of cafeteria attitudes, attitudes about water, intentions to drink tap water, and water consumption frequency (from the tap or a refillable bottle). However, intervention students reported higher baseline knowledge [b(SE)=0.11(0.04), p=.01] and intentions to drink water from a refillable bottle [b(SE)=0.10(0.05), p=.04] and were less likely to be US-born (OR=0.84, p=.02).

Statistical Analysis

Cafeteria and Store Data—Cafeteria and store data were available in aggregate form (daily servings). Multiple linear regressions were used to predict daily proportions of fruits, vegetables, meals, free-and-reduced-price meals, full-price meals, and snacks served per attending student daily. We conducted an additional analysis on proportions of free-and-reduced-price meals and full-price meals served among students attending school each day. Model predictors included time-period (pre-, during, post-intervention), school (dummy-coded), and time-period by school interactions. This parameterization allowed us to test the intervention effect without assuming that school means did not vary within study arms. Contrasts of interaction terms were used to calculate the average change during or post-intervention (vs. pre-intervention) for intervention schools and control schools, and to compare the average intervention school change versus the average control school change. For example, the model tested whether a greater proportion of students attending intervention schools was served lunch during and after the intervention period relative to corresponding changes in control schools (average pre-to-post change differences within intervention schools versus parallel differences within control schools).

To illustrate the magnitude of any significant intervention effects, we present the percentage change in intervention schools relative to the change that would have been expected in the absence of intervention (Figure 1). The percentage change associated with the intervention was derived by first calculating the difference between the average change for intervention schools versus control schools, and then dividing that difference by what the intervention school mean would have been in the absence of intervention, that is, if the average intervention school changed by the same amount as the average control school.

Survey—Survey data were analyzed at the student-level. We conducted multiple regressions to determine pre-to-post change within control and intervention schools and compare changes in intervention schools with parallel changes in control schools. We predicted each outcome at follow-up using baseline outcome value, school indicators, socio-demographic characteristics, BMI category, and NSLP-eligibility. We constructed a test of the intervention effect as a linear contrast comparing intervention school to control school estimates. Our estimates are equivalent to what one would obtain with an intervention indicator, with between-school variance removed from the error term. A multiple logistic regression determined that Black race, older age, and school were significantly associated with nonresponse. Predicted probabilities from this regression were inverted to produce nonresponse weights for all survey analyses. Missing data for covariates were imputed using weighted school means. All but two predictors had very few missing values (<0.3%). A missingness indicator was used for BMI and NSLP eligibility (missing for 23% and 21%, respectively, mostly from lack of parental consent).

Results

Cafeteria Data

Table 3 shows regression coefficients testing average change over time in fruit and vegetable servings, cafeteria participation, and snack sales within intervention and control schools separately, and tests comparing intervention and control changes. Figure 1 illustrates the changes in these outcomes observed in the intervention schools, relative to what would have been expected in the absence of intervention.

Fruit and Vegetable Servings—The intervention resulted in increased fruit servings in intervention schools compared to control schools. Within control schools, models indicated a non-significant effect from pre-to-during the intervention, but a significant decline pre-to-post intervention, $b(SE) = -.04(.02)$, $p = .02$; specifically, fruit servings remained steady from before to during the intervention, but then decreased post-intervention, consistent with LAUSD cafeteria records from prior years. In contrast, within intervention schools, there was a large, significant increase in fruit servings from pre-to-during intervention $b(SE) = .09(.02)$, $p < 0.001$. The magnitude of the increase in fruit servings in intervention schools from pre-to-during intervention was 15.3% greater than parallel changes in control schools, a significant difference. Tests for vegetable servings were nonsignificant.

Cafeteria Participation—Intervention students were significantly more likely to obtain lunch during and after the intervention, relative to control students. Control schools showed

an expected decline in participation over time, from pre-intervention to during the intervention, $b(SE)=-.04(.01)$, $p<0.001$, and from pre-intervention to post-intervention, $b=-.08$, $SE=.01$, $p<0.001$. Intervention schools' participation remained steady from before to during the intervention, but significantly declined post-intervention, $b(SE)=-.04(.01)$, $p<0.001$. Tests comparing changes within intervention versus control schools were significant from before to during the intervention, and from pre-to-post intervention. Results suggest that the intervention stemmed a natural downward trend in participation seen in control schools during the intervention, and lessened the extent of the decline post-intervention; intervention school students obtained lunch in the cafeteria 10.4% more often during the intervention, and 8.9% more often after the intervention, than what would have been expected in the absence of intervention.

We examined participation among NSLP-eligible and full-price students. The proportion of NSLP students served lunch remained flat in control schools from before to during the intervention. From pre-to-post intervention, however, a natural and significant decline emerged, $b(SE)=-.04(.01)$, $p<0.001$. In contrast, the proportion of NSLP students served lunch in intervention schools significantly increased during the intervention, $b(SE)=.03(.01)$, $p=0.02$, although the effect from pre-to post-intervention was nonsignificant. Tests comparing changes among intervention versus control schools were significant from before-to-during the intervention, showing a 14.9% increase for intervention schools relative to what would be expected in the absence of intervention, and pre-to-post intervention, a 20.3% increase, suggesting that SNaX led to increased NSLP participation.

In control schools, full-price students showed a decrease in participation [before to during the intervention: $b(SE)=-.01(.003)$, $p<0.001$; pre-to-post-intervention: $b(SE)=-.01(.003)$, $p<0.001$]. In the intervention schools, full-price students' participation remained steady, with nonsignificant effects over time. Average change from before-to-during the intervention was significantly positive in intervention schools relative to control schools, and from before-to-after the intervention, again suggesting that the intervention stemmed a usual downward trend. Relative to what would have been expected in the absence of intervention, full-price lunch students in the intervention school obtained lunch 36.3% more often during the intervention and 38.0% more often after the intervention.

School Store Sales

Snack sales decreased in intervention and control schools, with a greater relative decrease in intervention schools. In control schools, snack sales per student remained steady through the intervention period and significantly decreased pre-to-post intervention, $b(SE)=-.05(.01)$, $p<0.001$ (Table 3). In intervention schools, snack sales significantly decreased [before to during intervention: $b(SE)=-.05(.01)$, $p<0.001$; post-intervention: $b(SE)=-.08(.01)$, $p<0.001$]. Intervention schools' snack sale reductions were significantly larger than control schools' changes (11.9% less than would be expected without the intervention before-to during the intervention and 9.6% less than expected before-to-after the intervention).

Survey

Table 4 shows regression coefficients of average pre-to-post intervention changes in survey outcomes within intervention and control schools, as well as coefficients comparing those changes. Cafeteria and tap water attitudes became less positive over time in control schools but remained similar in intervention schools; the intervention effect on changes in attitudes was significant pre-to-post intervention for both variables (Table 4). Although knowledge about healthy eating and physical activity increased significantly in both control and intervention schools, knowledge increased more in intervention schools.

Intervention school students had greater intentions to drink water from a refillable bottle from pre-to-post intervention, whereas control school students' intentions remained similar over time; this improvement was significantly greater for intervention versus control schools. The parallel test for tap water intentions was also significant, with a similar pattern of means. Moreover, control school students drank tap water less often from pre-to-post intervention, whereas intervention school students drank tap water more often; the difference between the intervention and control schools was significant. There was no significant change in drinking from a refillable water bottle.

Discussion

Our results indicate that a school-based obesity-prevention intervention can be effective at attracting students to the cafeteria and potentially encouraging students to eat healthfully. A major SNaX goal was to encourage greater cafeteria participation as a means of achieving healthier eating. Our findings bolster prior recommendations to change school food environments (36) and suggest that pairing environmental changes with education and awareness-raising among adolescents can change behavior. Our results are consistent with other studies finding positive effects from improvements to schools' cafeteria offerings (12,37).

SNaX generally resulted in changes in cafeteria and school store outcomes that were about 10%-15% in magnitude above what would be expected in the absence of the intervention, and effects for cafeteria participation and snack sales remained significant (albeit weaker) after the 5-week intervention period. However, fruit effects were not sustained beyond the intervention period. This suggests a need for permanent environmental changes, and that cafeterias need to sustain a variety of produce. Prior research similarly has found that increasing fruit and vegetable variety in the cafeteria can lead to greater consumption (25). We did not find effects for vegetables, consistent with studies indicating that youth prefer fruit; a more intensive intervention may be needed to improve vegetable intake (38).

The Healthy Hunger-Free Kids Act and California SB 1413 mandate water provision to students at mealtimes, another of SNaX's environmental changes. Student self-reports suggest that SNaX was effective at increasing students' tap water consumption and improving water-related intentions and attitudes. Programs such as SNaX, which pair water access with marketing, may be needed to foster change in students' attitudes as well as consumption.

A unique aspect of our study within the field of adolescent obesity prevention was the use of CBPR methods throughout all stages of the research, which contributed to community partner investment and led to ongoing efforts toward wide-scale program dissemination. For example, use of CBPR during the intervention development and pilot testing phases contributed to the long-term sustainability of some of the environmental aspects of SNaX, through policy changes both within the school district as well as the state. Specifically, following the pilot's success at increasing cafeteria servings of sliced/bite-sized fruits (17), LAUSD cafeterias began offering them routinely outside of the study schools, in part because LAUSD administrators felt ownership over the program that they had helped to create. Furthermore, a CAB member shared with a state elected official our pilot study finding that key school leaders said that free drinking water could not be made available with the school meal, and helped to draft legislation, informed by our formative work (15). Following testimony from project leaders, California SB 1413 was passed, requiring schools to provide free, fresh drinking water during mealtimes in student eating areas (39). In addition, the school district is currently committed to wide-scale, ongoing dissemination of the program and is working with the research team to develop a sustainable model to implement SNaX across the district.

SNaX showed effects on the entire school. However, we do not know whether whole-school effects were due solely to changes among seventh-graders, who received the largest intervention dose. We also do not know which aspects of SNaX led to behavior changes; whether the results for cafeteria servings were indicative of actual food consumed; or whether the observed short-term changes led to longer-term behavioral and BMI changes. In addition, because the sliced/bite-sized fruits and vegetables component was implemented district-wide shortly after the pilot, the RCT could not fully test this component, potentially leading to smaller effects. A limitation of not statistically accounting for clustering by school is that the standard error of intervention effects could be underestimated. Caution should be exercised in generalizing to other geographic areas, although we would hypothesize similar findings elsewhere, especially if the program were adapted for local cultures using CBPR. Our methods are consistent with a recommendation of implementation science, to work within an iterative, collaborative partnership to find the right mix of adaptation and fidelity to key program components (40).

In sum, SNaX led to changes in student body cafeteria serving patterns and attitudes in a large school district. Our research suggests that environmental changes must be sustained and supported by school-district stakeholders for maximal effect. Moreover, our research shows that rigorous intervention evaluations tested in real-world contexts that involve strong community partnerships can have both program and policy outcomes. In large part because of actions by CAB members and community partners, SNaX's findings contributed to a food services policy of sliced/bite-sized fruit across LAUSD, a California law to increase the availability of drinking water in schools, and district efforts to sustain the program. Future research should identify best CBPR practices for program dissemination in schools over the long-term, after demonstration of effectiveness.

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Trial Registration: A Randomized Controlled Trial of Students for Nutrition and eXercise, clinicaltrials.gov identifier NCT01914471

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Abbreviations

BMI	Body Mass Index
CBPR	community-based participatory research
LAUSD	Los Angeles Unified School District
NSLP	National School Lunch Program
RCT	randomized controlled trial
SNaX	Students for Nutrition and eXercise
SSB	sugar-sweetened beverage
USDA	United States Department of Agriculture

Implications and Contribution

Few studies have used rigorous community-based participatory research methods to test effects of middle-school-based obesity prevention interventions. We conducted a randomized controlled trial of SNaX, a middle-school-based obesity-prevention intervention combining school-wide environmental changes, multimedia, encouragement to eat healthy cafeteria foods, and peer-led marketing. SNaX showed effects on students' eating behaviors.

Figure 1.

Percentage Changes in Cafeteria Outcomes Associated with Intervention, Relative to Expected Change in the Absence of Intervention (During and After the Intervention).

Note: Bars represent the change in the outcome during (black) and after (grey) the intervention relative to what would be expected in the absence of intervention – that is, if the intervention schools experienced the same changes observed in control schools. For example, during the intervention, the average intervention school increased fruit servings from .453 to .539 servings per attending student, an increase of about .086 servings per student. During the same period, the average control school increased fruit servings by about .014 servings per student, meaning that intervention schools, relative to control schools, increased fruit servings by $.086 - .014 = .072$, and that in the absence of an intervention we would have expected the intervention schools to increase to $.453 + .014 = .467$. Therefore the effect of the intervention was a $(.072 / .467) = 15.3\%$ increase in fruit servings per attending student.

Table 1

SNaX Intervention Components

Component	Activity	Explanation
School Food Environment Changes	Greater variety of sliced/bite-sized fruits and vegetables at lunch ^a	Sliced/bite-sized fruits and vegetables (e.g., sliced apples, grapes, baby carrots) showed large effects in pilot; was adopted immediately by LAUSD (prior to RCT). Based on research showing that increased variety of food choices leads to greater purchasing and consumption (24-26).
	Free chilled filtered water in or near cafeteria at lunchtime	Water stations filled from filtered cafeteria tap; disposable cups available for students and reusable water bottles given to peer leaders. Based on SNaX's formative work showing students' poor access to water at mealtimes (15,16) and research in which household provision of water and other non-caloric beverages led to weight loss among obese/overweight youth, especially Latinos (27). SNaX's formative research prompted CA SBI413, which requires districts to provide free drinking water during mealtimes in cafeteria areas.
	Cafeteria point-of-sale food signage and posters	Developed in partnership with LAUSD; shows food offerings' nutritional values and food label explanations. Based on research showing that posting nutritional information is associated with youths' healthier eating (28).
Peer-Leader Club and Social Marketing	5-week peer-leader club and lunchtime sessions (2 sessions/week total), and peer-leader discussion of SNaX messages during lunch and at home	Facilitator conducts 5 weekly sessions in which 7 th grade peer leaders are taught to discuss SNaX messages (re: cafeteria, water, SSBs, fruits/vegetables, physical activity/inactivity) with peers and family using a motivational interviewing (MI) style. (MI is a nonconfrontational and nonjudgmental style for changing health behaviors (29).)
	<i>The SNaX League</i> : kick-off film	During lunchtime for 5 weeks, peer leaders (wearing tee-shirts with the SNaX logo) conduct taste tests and give out promotional items (SNaX wrist bands, key chains, etc.).
	<i>The SNaX League</i> : trailer	30-minute film shown in school-wide assembly; introduces key SNaX messages; scripted story provides examples of youth leadership on obesity prevention.
	Physical activity posters	Trailer for film; shown in-class to help recruit peer leaders/increase excitement for SNaX.
	Parent-student activities	Posted near gymnasium.
	Handouts	Given to all 7 th graders to bring home to parents.
	Bookmarks	Information on cafeteria and fast food nutrition, food labeling, and SNaX. Given by teachers to 7 th graders and by peer leaders to peers and family.
		Contain key SNaX messages; given by peer leaders to students and family.

^aBased on the success of our pilot, LAUSD began disseminating this component prior to the RCT test; thus, in the RCT we modified the sliced/bite-sized fruit and vegetable component to be tested as 50-100 additional servings/day of fruits and vegetables that were not on the planned cafeteria menu (e.g., if orange slices were already being served, SNaX added 50-100 servings of grapes).

Table 2
Descriptive Statistics of SNaX School Socio-Demographic Characteristics (from Los Angeles Unified School District Records)

	Asian/Pacific Islander (%)	Latino (%)	Black (%)	White (%)	English as a Second Language (%)	NSLP Eligible (%)	Physically Fit (%)	7 th -grade Enrollment [M(SD)]	Total Enrollment [M(SD)]
Intervention	5.0	76.9	13.6	4.5	43.5	85.5	17.7	494 (124)	1515 (323)
Control	5.0	72.5	16.6	5.9	38.6	83.6	20.5	498 (88)	1524 (266)
Overall	5.5	74.7	14.2	5.7	40.7	84.0	19.8	484 (100)	1485 (273)

Note: n = 5 intervention schools and n=5 control schools

Table 3
Multiple Regressions of Effects of SNaX on Proportions of Fruit and Vegetable Servings, Cafeteria Participation, and Snack Sales Per Attending Student Per Day from Cafeteria and School Store Data

	Control			Intervention			Intervention-Control Difference	
	Pre Mean (SD)	During Mean (SD)	Post Mean (SD)	Pre Mean (SD)	During Mean (SD)	Post Mean (SD)	During b (SE)	Post b (SE)
Cafeteria Servings								
Fruit	.54 (.17)	.55 (.15)	.49 (.13)*	.45(.25)	.54 (.21)***	.45 (.18)	.07 (.03)**	.04 (.02)+
Vegetables	.20 (.09)	.19 (.09)	.19 (.10)	.18 (.08)	.18 (.04)	.15 (.05)+	.004 (.03)	-.02 (.02)
All lunches	.53 (.12)	.49 (.08)***	.45 (.10)***	.54 (.17)	.54 (.17)	.49 (.15)***	.05 (.02)***	.04 (.01)**
Free/reduced lunch ^a	.44 (.11)	.43 (.11)	.40 (.14)***	.31 (.06)	.35 (.05)*	.33 (.04)	.04 (.02)**	.06 (.02)**
Full-price lunch ^a	.04 (.01)	.03 (<.01)***	.02 (.01)***	.05 (.05)	.05 (.05)	.05 (.05)	.01 (.004)***	.01 (.004)***
Snack Sales^b	.41 (.17)	.40 (.19)	.36 (.16)***	.41 (.18)	.36 (.12)***	.33 (.10)***	-.05 (.01)***	-.03 (.01)***

+ p < .10

* p < .05

** p < .01

*** p < .001

^a Includes 5 schools only (2 intervention and 3 control schools). Because of the high number of students who were eligible for the NSLP in 4 schools, LAUSD allowed all students to receive free meals at those schools. NSLP data were not collected for one intervention school.

^b Excludes one control school; one school's store was closed due to structural damage.

Table 4
Multiple Regressions of Effects of SNaX on Psychosocial Outcomes (Attitudes, Intentions, Behaviors) from Seventh-Grade Survey Data

	Control		Intervention		Intervention-Control Difference
	Pre Mean (SD)	Post Mean (SD)	Pre Mean (SD)	Post Mean (SD)	
Cafeteria attitudes ^a	4.08 (1.46)	3.93 (1.40) ***	4.02 (1.46)	4.03 (1.46)	0.13 (.05) *
Tap water attitudes ^b	8.81 (2.03)	8.48 (2.34) ***	8.70 (2.24)	8.64 (2.30)	0.20 (.09) *
Knowledge about healthy eating/physical activity ^c	1.95 (0.99)	2.06 (1.13) ***	1.87 (1.05)	2.15 (1.19) ***	0.12 (.04) **
Intentions to drink tap water ^d	3.32 (1.21)	3.30 (1.25)	3.24 (1.23)	3.37 (1.30) **	0.10 (0.05) *
Intentions to drink from refillable bottle ^d	2.61 (1.24)	2.63 (1.27)	2.67 (1.27)	2.76 (1.33) *	0.11 (0.05) *
Tap water consumption ^e	2.06 (2.31)	2.01 (2.27)	2.21 (2.46)	2.26 (2.44)	0.18 (0.09) *
Refillable bottle use ^e	2.53 (2.30)	2.54 (2.28)	2.66 (2.38)	2.70 (2.40)	0.12 (0.09)

⁺ p < .10

* p < .05

** p < .01

*** p < .001

^a Mean of 7-point scale responses unsatisfying/satisfying and bad for my health/good for my health

^b 0, very negatively, to 10, very positively, data from 8 schools only due to survey revisions after first intervention semester

^c Sum of correct responses to 6 true/false items

^d Response categories “extremely likely,” “likely,” “neither,” “unlikely,” and “extremely unlikely” the next day at school

^e Response categories “every day,” “a few times a week,” “once a week,” “twice a month,” “once a month,” “less than once a month,” and “never”

Note: Average of school-level means and standard deviations are shown. School-level means were imputed for missing covariates of age, gender, Latino, home language, and US-born (missing for only 0.0-0.3% of the sample); a missingness indicator was included in models for BMI and NSLP eligibility, which were missing 23.2% and 20.7%, respectively. Each outcome was predicted using the baseline outcome value, indicators for school, student socio-demographic characteristics, student BMI (underweight/normal, overweight, obese), and NSLP eligibility.