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This article reports on the outcomes of the Teens Eating for Energy and Nutrition at School (TEENS) study, a 2-year intervention study conducted in 16 middle schools with a goal of increasing students' intakes of fruits, vegetables, and lower fat foods. Despite positive interim results for students randomized to intervention schools, the positive effects of the intervention were not seen for the primary outcomes at the end of the 2nd year. Positive effects were seen only for a food choice score (suggesting that the students usually choose lower versus higher fat foods) and not for measures of food intake. Future studies may need to take a step back toward more controlled efficacy studies in working with this age-group. In addition, future work may consider the use of peer leaders, more intensive teacher training, ongoing formative assessment, and the testing of more powerful environmental change intervention strategies.

Keywords: *adolescent; nutrition; dietary behaviors; middle schools*

BACKGROUND

Adolescents' diets put them at risk for both immediate and chronic disease. Low intakes of fruits, vegetables, whole grains, and calcium and excessive intakes of fat, satu-

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rated fat, and sodium in adolescents are well documented.[1-4] Although the association between diet and adult-onset chronic disease risk has long been recognized,[5-8] recent epidemiological findings also show evidence of increased risk of obesity, Type 2 diabetes, and low bone mass associated with diet during the adolescent period.[9-13]

Healthy People 2010;[14] national guidelines from the Centers for Disease Control;[15] the surgeon general's reports on nutrition and physical activity;[16] and, most recently, the surgeon general's report on obesity[17] call for community-wide efforts to positively influence adolescents' food intakes. Schools, in particular, have most often been solicited to help reverse the trends of adolescents' unhealthy food choices, due to their ready access to adolescents; the amount of time adolescents spend at school; and the powerful influence of the physical, social, and normative environments within the school.

Although several large-scale school-based intervention trials have been conducted with elementary-age students and schools to effect dietary change,[18-21] less research has been conducted with middle school students and environments. This early adolescent period is particularly critical to health; adolescents face new challenges in making healthier choices as their physical and social environments change due to school transitions and as they become more autonomous in their food choices.[22]

The Teens Eating for Energy and Nutrition at Schools (TEENS) study was an intervention study funded by the National Cancer Institute with the goal of developing and evaluating the effectiveness of classroom, schoolwide, and family programs to increase fruit and vegetable intake and decrease fat intake among seventh and eighth graders to reduce their future risk of cancer.[23] The outcomes of TEENS, following the 1st year of intervention,[24] showed positive effects on student food choices. Specifically, students who were peer leaders for the TEENS curriculum reported eating one additional serving of fruits and vegetables each day, whereas students who had the TEENS curriculum but were not peer leaders reported consuming almost one-half an additional serving of fruits and vegetables each day. Similar positive intervention effects were seen for a food-choice score, used to represent choices between higher and lower fat food items. The purpose of this article is to describe the student-level outcomes of TEENS at the end of the 2-year intervention period.

METHOD

Study Design

TEENS was a group-randomized trial occurring in 16 middle schools in the Twin Cities, Minnesota, metropolitan area from 1997 to 2000. Participating schools were required to have at least 20% of students in their district qualify for free or reduced-price school lunch, have both seventh and eighth graders attend their school, and have at least 30 students in each of those grades. Schools agreeing to be in the study committed to the measurement protocol, randomization to condition, and if randomized to the intervention condition, to the following intervention protocol: (1) Offer all 10 sessions of the TEENS curriculum in each of the seventh and eighth grades, (2) allow the designated teacher to attend a full day of training each year, (3) allow for provision of a family education component, and (4) allow school food service staff to be trained on modifying the school food environment. Thirty-three schools were eligible to participate in TEENS, and 20 schools agreed to participate. Reasons cited for not participating included time constraints, lack

of interest in the proposed cafeteria changes, and expected changes in school personnel. Three of the 20 schools meeting study criteria and agreeing to participate were excluded due to anticipated difficulties in scheduling the classroom component. One school was enlisted as the pilot school, leaving 16 schools in the study. Sample size calculations, based on fruit-, vegetables-, and fat-intake data from prior school-based studies, indicated that with 16 schools and at least 30 students measured per grade, we had 80% power to detect differences of 1.1 servings of fruits and vegetables and a 1.9% difference in energy from total fat intake between treatment groups. All students who were in seventh grade during the baseline data collection period were considered eligible to participate in TEENS.

The primary outcome measures for evaluating the effectiveness of TEENS were student-level intake of fruits, vegetables, and energy from fat based on 24-hour dietary recalls. Secondary outcomes included (1) student-level fruit and vegetable intake and food choices via a student survey;[25] (2) food available at home assessed by a parent survey; and (3) school-level changes including changes in fruits and vegetables offered and sold in school lunch, snack foods and beverages available and sold à la carte, and snacks and beverages available in vending machines at school. This article will discuss only the student-level outcomes and the effects of TEENS on students' fruit, vegetable, and fat intake from the 24-hour recalls and the student survey.

Schools were randomly assigned from within matched pairs to either control or intervention condition. Schools were matched on both the proportion of seventh graders expected to receive the TEENS curriculum and on the proportion receiving free or reduced-price school lunch; randomization was constrained so that the four smallest schools were distributed with two in each of the two conditions. The eight intervention schools received the TEENS intervention and related training for 2 consecutive years beginning when the grade cohort was in the seventh grade (1998 to 1999) and continuing through the eighth-grade year (1999 to 2000). The eight control schools received intervention materials and training after the follow-up survey (fall 2000).

Intervention

The TEENS intervention was developed using a theory-based approach to program planning.[23] The program planning process[26] involved examining the empirical research for factors associated with adolescents' fruit, vegetable, and fat intake and also identifying behavioral theory that has been successful in explaining dietary intake. Social Cognitive Theory (SCT) was the behavioral theory used to inform our intervention plans.[27] Factors associated with adolescent dietary patterns, identified in the existing literature, were classified into the three sets of factors that make up the construct of reciprocal determinism in SCT: individual or personal, behavioral, and environmental factors. A detailed description of the intervention development and content is published elsewhere.[23]

Three channels were selected for delivery of the intervention including classroom, family, and schoolwide components. The classroom component included 10 behaviorally based nutrition education lessons in each of the seventh and eighth grades. Both years of the TEENS curriculum included self-monitoring, goal setting, hands-on snack preparation, and skill development for choosing healthy foods and for overcoming barriers to making healthful choices. Trained peer leaders were involved in seventh grade to help deliver segments of the classroom lessons.[28] In eighth grade, behavior modification activities were included to help students see connections between cues, reinforcements,

and their eating behavior. In the eighth grade, student groups completed projects related to nutrition topics, including vending machines in school, foods available in convenience stores, vegetarianism, and food advertising.[23] Most schools chose to deliver the TEENS curriculum in Family and Consumer Science; however, in some schools, it was offered in health or science class. The regular classroom teacher delivered the lessons after a full-day training for each grade level.

The TEENS family component consisted of three newsletters and sets of behavioral coupons in both the seventh and eighth grades delivered in conjunction with the TEENS curriculum. The newsletters included a short lead article on how parents could help students eat more fruits, vegetables, and less fat; a question/answer column; and simple behavioral tips or a family quiz. In addition, each parent packet included a set of 10 behavioral coupons with simple, specific messages such as "Serve a fruit or vegetable with dinner tonight." For completing 10 coupons, families received a $10 gift certificate, and there was a drawing for a larger prize for families completing more than 10 behavioral coupons. In seventh grade, students had assignments related to the family newsletters that were turned in as homework.

The schoolwide channel included working with district food service directors and local school food service managers and staff to increase the offerings and promotion of fruits and vegetables (the emphasis in seventh grade) and healthier snacks à la carte (the emphasis in eighth grade) and to create schoolwide councils to help foster a school environment where a healthy food choice was the easier and more normative food choice. The School Nutrition Advisory Councils (SNACS) were made up of school administrators, school staff (teachers, counselors, nurses), parents, students, and TEENS staff. Most met monthly and worked on self-selected topics such as school policy related to the availability of healthful foods in schools, food used as fund-raisers, and ways to promote healthier food choices.[29-30]

Although all students enrolled in a TEENS intervention school received the schoolwide or environmental components, schools' scheduling of Family Consumer Science and health and sciences classes resulted in a condition whereby it was possible that targeted students in an intervention school might not receive the seventh- or eighth-grade curriculum.[31] In some schools, the classes offering TEENS were not full-year classes, and in some schools, students had requirements to take a course in seventh or eighth grade but not both years. The potential for variability in intervention dose was handled in three ways. First, we determined that of the 20 schools that agreed to be in the study, 3 schools had the potential of offering the TEENS curriculum in both seventh and eighth grade to less than 50% of the students in their school. These schools were eliminated from the study prior to baseline data collection. Second, realizing that the random sampling of the student population for the 24-hour recalls might result in a sample that had minimal exposure to both years of the intervention, we randomized prior to baseline data collection in order to oversample in the schools randomized to intervention. Schools' treatment condition was not revealed to schools or evaluation staff during baseline data collection. Finally, secondary data analysis was performed examining the dose of the intervention received by students. Details are included in the Data Analysis section.

Outcome Evaluation Procedures and Measures

The University of Minnesota Committee on the Use of Human Subjects in Research approved all data collection procedures.

24-Hour Recalls

Students were randomly selected to participate in the 24-hour recalls using class lists and with sampling proportional to class size. At baseline, of the 820 students selected for the 24-hour recalls, 640 (78%) completed the recalls. Approximately one-fifth (21.3%) were missed due to absence or other scheduling problems, and 6 students (0.7%) were excluded due to parent or student refusal. Analyses show that those selected for and completing 24-hour recalls at baseline were representative of the total sample. At follow-up, complete recalls were obtained from 509 (80%) of the original sample of 640 students. Approximately 18% had moved from the district, and about 2% were not available due to absence or other scheduling problems. Attrition analysis (data not shown) indicates that those who were lost to follow-up were more likely to be minority students, not live with both parents, and have parents who were not as fully employed or as well educated as those who remained. Differential attrition by condition was less evident. Only two statistically significant ($p < .05$) differences by condition occurred; one favored control and one favored intervention students.

Trained and certified interviewers conducted recalls using laptop computers and the Minnesota Nutrition Data System (NDS Version 2.6/8a/23, Nutrition Coordinating Center, University of Minnesota). Interviewers were trained and certified on the use of the direct data entry system, interviewing techniques, and study-specific protocol for data-entry rules. Dietary recalls were conducted Monday through Thursday, and students who were absent were interviewed later in the week if possible. All interviews were conducted individually in a quiet location at the school during the school day and took between 15 and 30 minutes to complete. Food models and other portion-size prompts were available.

The NDS system provides data at the nutrient level. Therefore, the proportion of energy from fat was provided automatically, as was total caloric intake (kcal). Servings of fruits and vegetables were determined by adapting a previously used system of assigning serving sizes based on gram weights of fruits and vegetables identified in the NDS food codes.[32] The counting algorithm allowed for proportions of servings of different food items to be combined and totaled and allowed quantification of fruits, fruit juices, vegetables including and excluding potatoes, and combinations of the categories.

Student Survey

All students in the seventh grade in the fall of 1998 were eligible to participate in the TEENS baseline student survey. A total of 4,050 students were eligible for the survey, 3,878 (95.8%) completed the survey at baseline, 95 (2.3%) were absent from school on two survey attempts, and 77 (1.9%) were excluded due to parental or student refusal. At the end of seventh grade (the interim survey), all students in the grade cohort were asked to participate, and 3,503 (90.3%) of the baseline participants completed the survey. The remainder, 375 (9.7%) were either absent, moved out of the area, or were parental or student refusals. At the end of eighth grade (follow-up survey), 3,010 (77.6%) of the baseline participants provided survey data, whereas the remainder were either absent, moved out of the area, or were parent or student refusals. Attrition analyses (data not shown) indicated that those students who did not provide follow-up data were more likely to be minority students, from single-parent households, in the free or reduced-price lunch program, less likely to have two parents working full-time, and less likely to have parents with higher educational attainment. Differential attrition by condition was less evident.

Where differences were seen ($p < .05$), one comparison favored the control condition, whereas one comparison favored the intervention condition.

The TEENS survey was administered in classrooms by trained TEENS evaluation staff. As required by law, teachers stayed in the room during the survey administration but did not participate in any way with the administration of the survey. The survey took approximately 40 minutes to complete; scannable survey forms were used.

The fruit and vegetable screener used was a modified and validated version of the Behavioral Risk Factor Surveillance System measure.[33] This version includes six items assessing the frequency of consuming fruit juices, fruit, green salad, potatoes (excluding fried), carrots, and vegetables during the past year. The items were weighted and summed to estimate the average number of daily servings of fruits, vegetables, and fruits and vegetables combined. Usual food choices were assessed using a modified version of a scale previously used with adolescents.[34] This scale presents students with nine pairs of foods and asks them to indicate which of the foods in the pair they would choose to eat most of the time. The items are coded so that higher scores reflect lower fat, healthier choices and then are summed to create a single score. Information on the psychometric properties of the scales developed and used for the TEENS student survey is published elsewhere.[25]

Demographic variables assessed included gender, race, number of parents the student lives with, parents' educational attainment, parents' employment status, and participation in the free or reduced-price lunch program.

Process Evaluation Procedures and Methods

A variety of process evaluation measures were conducted to assess the dose, fidelity, and completeness of the delivery of the intervention. Process evaluation for the delivery of the classroom curriculum included lesson checklists (completed by the teacher following each classroom session), observation of selected classroom sessions, and student and teacher evaluations of the curriculum. In addition, to determine student-level dose of the intervention, process data were collected to determine whether students received the classroom curricula in each grade, were peer leaders in seventh grade, or were in intervention schools but did not receive either year of the TEENS classroom curriculum.

Process evaluation for the family component included documentation of the number of families that returned behavioral coupons, the number of coupons returned, and the number of student homework cards returned in seventh grade (student homework cards were not used in eighth grade). Process evaluation for the schoolwide components included food service visit and SNAC meeting logs.

Data Analysis

All data were analyzed using mixed-model analysis of covariance (ANCOVA), using the methods described by Murray;[35] all ANCOVA models were implemented in SAS PROC MIXED, Version 6.12. In the primary analyses, the follow-up value of the variable of interest was the dependent variable. We modeled condition as a fixed effect (intervention vs. control) and school and residual error as nested random effects. Fixed-effect covariates included the baseline value of the dependent variable; the demographic measures described above; and for dietary recall variables, total energy intake (kcal). The intervention effect was estimated as the adjusted mean difference between the intervention and control conditions and assessed against the variation among the schools nested

within each condition, with 1 and 14 degrees of freedom. We examined residuals for all models and confirmed that the assumption of normality for residual errors was appropriate.

Dose-response analyses were conducted as secondary analyses to help us understand the results of the primary analysis. The dose-level analyses substituted a four-level dose variable for the two-level condition variable used in the primary analysis. Students who were exposed to both the seventh- and eighth-grade curriculum were classified as *high*; those exposed to the seventh- or eighth-grade curriculum, but not to both, were classified as *medium*; those in the intervention schools but exposed to neither curriculum were classified as *low*; and those in the control schools were classified as *none*. A priori contrasts were constructed to compare high versus low, high versus no exposure, and low versus no exposure. The medium-dose students were not included in these contrasts because they represented a mixture of students who got either just the seventh-grade curriculum or just the eighth-grade curriculum, making any findings involving that dose level difficult to interpret.

We also examined the dose response by creating seven more detailed student-level exposure categories: (1) control group, (2) environment only—no curriculum in either grade, (3) environment plus seventh-grade curriculum, (4) environment plus eighth-grade curriculum, (5) environment plus seventh- and eighth-grade curriculum, (6) environment plus seventh-grade curriculum and being a seventh-grade peer leader, and (7) environment plus seventh- and eighth-grade curriculum and being a seventh-grade peer leader. All students attending a TEENS intervention school were coded as having received the environmental intervention.

RESULTS

Sample

The sample for the analysis of the primary outcomes was limited to students who had complete and reliable 24-hour recalls and survey data at baseline and follow-up. Of the original 640 students with complete recall data at baseline, 71% or 455 recalls were used in the final analysis; cases were eliminated from the baseline sample and the final sample if there were no student survey data available or if the recalls were judged to be unreliable. Unreliability of recall results were determined by viewing scatter plots for selected nutrients and by examining outliers by reviewing the dietary record. The sample for the analysis of the survey data was limited to students who had survey data at baseline and follow-up, resulting in a sample of 2,883 students.

Table 1 shows the demographic characteristics of the sample used in the analysis. There were significant differences between control and intervention students' race/ethnicity and parents' educational level in both the 24-hour recall and student survey sample and in parents' employment for the survey sample. As a result, we controlled for these demographic differences in analyzing the intervention effects.

Primary and Secondary Outcomes

Table 2 shows the primary and secondary outcomes from the 24-hour recalls, the fruit and vegetable scores from the screeners, and the food choice score. The data suggest that

Table 1. Demographic and Behavioral Characteristics of Recall and Survey Samples

	Recall Sample					
	Intervention[a]		Control		Total	
	(n = 288)		(n = 167)		(N = 455)	
Variable	Frequency	%	Frequency	%	Frequency	%
Sex						
Male	147	51.0	76	45.5	223	49.0
Female	141	49.0	91	54.5	232	51.0
Race/ethnicity[b]						
African American	16	5.6	22	13.2	38	8.4
Asian or Pacific Islander	35	12.2	3	1.8	38	8.4
Hispanic/Latino	9	3.1	5	3.0	14	3.1
Multiracial	11	3.8	12	7.2	23	5.1
Native American	4	1.4	3	1.8	7	1.5
White	200	69.4	111	66.5	311	68.4
Other	13	4.5	11	6.6	24	5.3
Household structure						
Lives with two parents	214	74.3	123	73.7	337	74.1
Does not live with two parents	74	25.7	44	26.3	118	25.9
Free or reduced-price lunch						
Receives	67	23.3	37	22.2	104	22.9
Does not receive	221	76.7	130	77.8	351	77.1
Parents' full-time employment						
Two parents	127	44.1	86	51.5	213	46.8
One parent	105	36.5	58	34.7	163	35.8
Neither parent	56	19.4	23	13.8	79	17.4
Parents' highest education[b]						
Both high school or less	35	12.2	18	10.8	53	11.6
One trade school/some college	37	12.8	34	20.4	71	15.6
One college or more	55	19.1	32	19.2	87	19.1
Both college or more	63	21.9	41	24.6	104	22.9
Other/unknown	98	34.0	42	25.1	140	30.8
	M	*SD*	*M*	*SD*	*M*	*SD*
Past-day total servings of						
Fruits only	1.34	1.53	1.42	1.61	1.37	1.56
Vegetables only	2.05	1.77	2.36	2.01	2.16	1.87
Fruits and vegetables	3.39	2.35	3.78	2.75	3.53	2.51
Percentage energy from fat	30.56	7.25	30.60	8.09	30.58	7.56

(continued)

there were no significant differences between treatment groups for the primary end points or for all other recall-based end points. The only statistically significant difference by treatment condition was seen for the food choice score from the student survey; students in intervention schools had slightly higher scores, indicative of making lower fat choices. Analyses were run to evaluate the effect of differential attrition on the results; no systematic bias from dropout was observed (data not shown).

Table 1 (continued)

	Survey Sample					
	Intervention[a]		Control		Total	
	(*n* = 1,452)		(*n* = 1,431)		(*N* = 2,883)	
Variable	Frequency	%	Frequency	%	Frequency	%
Sex						
Male	742	51.1	729	50.9	1,471	51.0
Female	710	48.9	702	49.1	1,412	49.0
Race/ethnicity[b]						
African American	103	7.1	127	8.9	230	8.0
Asian or Pacific Islander	134	9.2	51	3.6	185	6.4
Hispanic/Latino	45	3.1	28	2.0	73	2.5
Multiracial	73	5.0	74	5.2	147	5.1
Native American	20	1.4	15	1.0	35	1.2
White	1,018	70.1	1,083	75.7	2,101	72.9
Other	59	4.1	53	3.7	112	3.9
Household structure						
Lives with two parents	1,047	72.1	1,072	74.9	2,119	73.5
Does not live with two parents	405	27.9	359	25.1	764	26.5
Free or reduced-price lunch						
Receives	323	22.2	247	17.3	570	19.8
Does not receive	1,129	77.8	1,184	82.7	2,313	80.2
Parents' full-time employment[b]						
Two parents	676	46.6	755	52.8	1,431	49.6
One parent	519	35.7	522	36.5	1,041	36.1
Neither parent	257	17.7	154	10.8	411	14.3
Parents' highest education[b]						
Both high school or less	210	14.5	155	10.8	365	12.7
One trade school/some college	233	16.0	260	18.2	493	17.1
One college or more	275	18.9	298	20.8	573	19.9
Both college or more	260	17.9	391	27.3	651	22.6
Other/unknown	474	32.6	327	22.9	801	27.8
	M	*SE*	*M*	*SE*	*M*	*SD*
Usual daily servings of						
Fruits only	2.42	2.09	2.43	2.04	2.43	2.07
Vegetables only	1.95	2.20	1.93	2.02	1.94	2.11
Fruits and vegetables	4.37	3.75	4.36	3.54	4.37	3.64
Food choices score (higher score reflects lower fat choices)	5.70	2.08	5.91	2.13	5.81	2.10

a. Students from intervention schools were oversampled for 24-hour dietary recalls.
b. Significant differences ($p < .05$) between intervention and control.

Dose Response Analysis

Table 3 shows comparisons of the mean intakes and scores between the students with high and low dose of intervention and the control condition. The only statistically signifi-

Table 2. Primary and Secondary Outcomes

	Mean		Intervention-Control	
	Intervention	Control	Difference	Confidence Interval
Primary end points				
Total fruits and vegetables[a]	3.60	4.09	–0.492	–1.032, 0.049
Energy from fat[a]	30.92	30.28	0.635	–0.866, 2.137
Secondary end points				
All fruits and vegetables per 1,000 kcal[a]	1.67	1.81	–0.141	–0.425, 0.144
Fruits only[a]	1.48	1.62	–0.143	–0.711, 0.425
Vegetables only, including potatoes[a]	2.08	2.46	–0.383	–1.000, 0.233
Fruits and vegetables, no potatoes[a]	2.62	2.94	–0.326	–0.910, 0.259
Fruit score[b]	2.34	2.40	–0.060	–0.309, 0.190
Vegetable score[b]	1.73	1.70	0.031	–0.250, 0.312
Food-choice score[b]	6.15	5.78	0.375	0.038, 0.713

NOTE: All analyses are mixed-model ANCOVAs, adjusted for gender, race, household structure, parental work status, parental educational attainment, receiving free or reduced-price lunch, and the baseline level of the dependent variable. All 24-hour recall variables, except energy from fat and fruits and vegetables per 1,000 kcal, are also adjusted for energy (kcal).
a. Based on 24-hour recalls (n = 455).
b. Based on survey (n = 2,883 for fruit and vegetable scores, n = 2,929 for choices score).

cant comparison by dose occurs for the food-choice score, with the high-dose students scoring significantly higher than the control and the lower dose students.

Table 4 shows the ranking and mean scores for the more detailed dose categories. The only significant finding that emerged was for the food-choice score (omnibus test p = .01). In general, a greater level of exposure resulted in a higher food-choice score. We also examined the primary and secondary outcomes adjusting for dose and found no statistically significant findings except with the food-choice score (the only secondary outcome that showed intervention effects with other covariates considered). Those analyses show that students with the highest exposure to the intervention score significantly higher than students with no or low exposure.

Process Data: Curriculum, Family, and School Environment

As seen in Table 5, fidelity to the intervention as assessed by teacher checklists was mixed. Fewer than one-third of the lessons in the seventh-grade year and less than one-half of the lessons in the eighth-grade year were implemented with all of the activities as planned. In about two-thirds of the lessons, teachers completed at least some of the activities, according to teacher checklists. Observation of lessons by TEENS evaluation staff suggested higher fidelity, with more than 80% of activities completed in the classrooms when lessons were being directly observed.

About one-third of families participated to some extent in the behavioral coupon activity, and about half of the expected family homework cards were returned in seventh grade. In addition to providing food service training, TEENS staff made approximately 10 and

Table 3. Dose Response Analysis Outcomes

	Mean					
	High Dose (H)	Low Dose (L)	Control (C)		Difference	Confidence Interval
Primary end points						
Total fruits and vegetables[a]	3.93	3.83	4.10	High dose (H-C)	–0.16	–0.57, 0.25
				High v. low (H-L)	0.10	–0.82, 1.02
				Low dose (L-C)	–0.26	–1.21, 0.68
Energy from fat[a]	31.50	30.67	30.77	High dose (H-C)	0.73	–0.88, 2.34
				High v. low (H-L)	0.83	–2.30, 3.61
				Low dose (L-C)	–0.10	–3.21, 3.01
Secondary end points						
Fruit and vegetable score[b]	4.15	3.78	4.14	High dose (H-C)	0.01	–0.34, 0.35
				High v. low (H-L)	0.40	–0.21, 0.95
				Low dose (L-C)	–0.36	–0.93, 0.21
Food-choice score[b]	6.38	5.84	5.89	High dose (H-C)	0.49	0.19, 0.80
				High v. low (H-L)	0.54	0.16, 0.93
				Low dose (L-C)	–0.05	–0.48, 0.37

NOTE: All analyses are mixed-model ANCOVAs, adjusted for gender, race, household structure, parental work status, parental educational attainment, receiving free or reduced-price lunch, and the baseline level of the dependent variable. Total fruits and vegetables is also adjusted for energy (kcal). High dose = received both seventh- and eighth-grade curricula plus environmental interventions; low dose = received environmental interventions only (neither curriculum).

a. Based on 24-hour recalls ($n = 455$).

b. Based on questionnaire ($n = 2,883$ for fruit and vegetable scores, $n = 2,929$ for choices score).

Table 4. Dose Response by Detailed Categories

A. Scores for the total fruits and vegetables by detailed dose categories[a]	Omnibus *p* value .11
Peer leader and seventh-grade curriculum	5.85
Control group	4.08
Seventh-grade curriculum	4.04
Peer leader, seventh- and eighth-grade curriculum	3.89
Environment only	3.79
Seventh- and eighth-grade curriculum	3.68
Eighth-grade curriculum	3.07
B. Scores for energy from total fat by detailed dose categories[a]	Omnibus *p* value .90
Peer leader and seventh-grade curriculum	32.57
Peer leader, seventh- and eighth-grade curriculum	31.61
Seventh- and eighth-grade curriculum	31.45
Control group	30.76
Environment only	30.63
Eighth-grade curriculum	30.47
Seventh-grade curriculum	29.66
C. Food-choice score by detailed dose responses[b]	Omnibus *p* value .01
Peer leader and seventh-grade curriculum	7.39
Eighth-grade curriculum	6.36
Seventh- and eighth-grade curriculum	6.35
Seventh-grade curriculum	5.93
Peer leader, seventh- and eighth-grade curriculum	5.93
Control group	589
Environment only	5.81

a. Based on 24-hour recall (n = 455).
b. Based on questionnaires (n = 2,883).

26 visits in the seventh- and eighth-grade intervention years, respectively, to school food service staff for on-site consultation and extended training and support. By the eighth-grade year, a seventh school convened a SNAC.

DISCUSSION

The TEENS student-level outcomes are disappointing. The positive effect in fruit and vegetable consumption seen by examining dose response at interim was not maintained at follow-up.[24] The only statistically significant change was in the food-choice score; that choice score is a nonvalidated instrument that is potentially more subject to response bias than the 24-hour recalls. However, one would expect that response bias to be driven by individuals' knowledge of what is a healthier food. A similar pairing of foods was used to create a Knowledge Scale (students were asked to choose which food in the pair was better for their health); the Knowledge Scale and the Food Choice Scale were only moderately correlated at .29. Furthermore, when this knowledge score was used as the dependent variable and examined for an intervention effect, no statistically significant differences were seen between treatment groups (p = .26; data not shown).

What happened between the end of the 1st year of the intervention, when we saw statistically significant changes in the fruit and vegetable scores and the food-choice score, and the end of the eighth-grade intervention year? One possibility is that the use of peer

Table 5. Process Evaluation Results

Measure	Seventh-Grade Intervention		Eighth-Grade Intervention	
	%	*n*	%	*n*
Classroom curriculum				
% session checklists reporting all activities completed	28.7	44	40.3	71
% session checklists reporting all or partial completion of activities	66.5	44	70.8	71
% of activities completed based on classroom observation	84.0	70	83.5	120
Family component				
% of families sending in at least one set of behavioral coupons	36.7	1,225	26.3	1,898
% of behavioral coupons returned	26.6	36,750	18.0	56,790
% of family homework cards returned	49	3,675	NA	
School environment				
Mean numbers of visits to school service staff per school	9.5		25.6	
Mean number of SNAC meetings per year per school	2.3 (6/8 schools had SNACs)		4.6 (7/8 schools had SNACs)	
Mean number of participants per meeting per SNAC year	8.2		6.8	

NOTE: SNAC = School Nutrition Advisory Councils.

leaders in seventh grade may have been crucial to the success of TEENS in the 1st year. Those who had been peer leaders in seventh grade had been more affected by the intervention at the end of seventh grade. We did not, however, plan for peer leaders in eighth grade, fearing that the burden of training peer leaders for 2 years of a nutrition education curriculum would limit the sustainability and diffusion of TEENS.

Another possibility is that the loss of effects in the eighth grade may be attributed to the poor response to TEENS group projects that were the final four lessons of the eighth-grade curriculum. These group projects were included in an attempt to satisfy state-mandated Family and Consumer Science curriculum requirements for group work and demonstration of analytic skills. In addition, prior experience in a curriculum-based intervention for alcohol use prevention had shown group projects to be successful.[36] Similar to these prior efforts, students were assigned to groups for preparing a TEENS nutrition project with clear and explicit directions on what was to be included and resource materials provided. The project culminated in an in-class presentation of the group projects. However, observation of these presentations revealed that students, for the most part, appeared to have done very little work on the projects and that teachers had not supervised or monitored the groups' progress on the projects and gave almost no feedback, and sometimes, inaccurate feedback, on the in-class presentations. Process data suggest that less than 40% of students indicated that they liked the group projects. Unfortunately, this was the TEENS curricular experience most proximal to the final data collection time point.

Our process data suggest that incomplete implementation of the intervention, particularly the classroom curriculum and engaging families in intervention activities, may help explain the outcomes. However, our process data do not reveal why implementation was incomplete. Despite poor fidelity to the planned classroom lessons, across the 2 years, 84% of teachers told us that they believed that the TEENS program was valuable to their students, 76% said they enjoyed teaching the TEENS curriculum, 68% said their students seemed to enjoy the TEENS curriculum, 64% said they planned on teaching TEENS again the next school year, and 64% said it was culturally appropriate. As for challenges to teaching TEENS, 20% said that it took too much time to teach, and 24% said that if they were to teach it again, they would need to make a lot of changes.

As for families, only about 30% of families participated in the family activities. Other school-based research has shown difficulty in getting families involved and demonstrating the effectiveness of family components on student-level health outcomes.[18,37,38] However, when large percentages of parents participate, outcomes have been noted.[39]

Changing the larger school environment is also challenging. À la carte sales and sales of fruits and vegetables were also assessed as secondary outcomes for the TEENS research. These analyses suggest that the TEENS school-level intervention did not affect the selection of fruits and vegetables as part of the meal pattern lunch but did affect the availability of lower fat snack options à la carte.[40]

Implementation of health curricula in a middle school setting is difficult to optimize for several reasons. Placement of the curriculum in classes that students may not be required to take for a full year creates challenges in ensuring that all students will be exposed to the entire curriculum. In addition, teachers may not view nutrition as seriously as they do other health-related issues, such as alcohol and drug use prevention, reducing fidelity to the intervention activities. Although difficult to document from our process data, teachers' ability or interest in teaching a behaviorally based nutrition curriculum, even with a full day of training and support from research staff interventionists, was quite limited. Other nutrition-based research using a curriculum component suggests that fidelity to, and the effectiveness of, such interventions are greatly enhanced when delivered by staff specifically trained to deliver the classes rather than by the regular classroom teacher.[21] Also, homework is often not expected in classes where nutrition education is placed, limiting the ability to have students practice behavioral skills outside of class as homework or involving parents in homework. Classes that are considered more central, academic, and yearlong, such as social studies or science, may be a better placement for middle school health education curricula.

Implications for Research and Practice

The TEENS intervention was based on the state-of-the-science understanding of health behavior change, included formative assessment to guide the development of the intervention, and was developed by a very experienced creative staff.[23] TEENS was one of the first multicomponent school-based studies focusing on nutritional outcomes conducted in middle schools. Planet Health[41] attempted to affect nutrition and television viewing in an obesity-prevention trial in middle schools and was successful in increasing girls' consumption of fruits and vegetables by 0.2 servings but had no effect on boys' intakes.

TEENS was designed with an eye toward dissemination and institutionalization. The implementers of the intervention were regular classroom teachers and school food ser-

vice staff. The structure of the curriculum was built around schools' existing health education, and training manuals were developed that gave clear and precise information about what should occur and provided materials that could be easily reproduced. After the end of the TEENS research study, the TEENS seventh-grade curriculum was turned over to a publisher for larger dissemination and has recently been placed on a Web site (www.epi.umn/cyhp/r_teens2.html) for wide dissemination. Still, several aspects of TEENS make dissemination and institutionalization difficult, including no system for training teachers to implement health promotion curricula, low priority of health education vis-à-vis the emphasis at state and national levels on academic achievement and school accountability, lack of funds for providing curricular materials, and challenges in positively influencing the wider school environment.[42]

Trying to effect dietary change in an adolescent population is very challenging. Not only are their dietary patterns in great flux and their choices increased, but their questioning of authority and need for autonomy likely affect how young teens respond to efforts to improve their dietary patterns.[43] In addition, adult support for improving the diets of adolescents may not be strong. Other health issues that adolescents face, including smoking initiation, substance use, and sexual activity, may seem like more important issues for adults (both families and school staff) to focus on as they try to influence young teens' behavior.[44] However, with the current epidemic of childhood obesity, greater emphasis on nutrition and physical activity in schools may be forthcoming.

It is our hope that the disappointing results from TEENS do not signal that multicomponent, school-based interventions for middle school students are not worth conducting. Rather, we hope that our results give some suggestions for future research directions. It may be prudent for future research to move back toward more controlled efficacy trials, examining what intervention strategies, implemented in the optimal conditions, are most effective in achieving behavior change in young adolescents. For example, delivering the curriculum or other components of the intervention by research staff, or other trained staff, might improve the fidelity and the completeness of the intervention, permitting a better test of intervention strategies. Once successful strategies are identified, then studies evaluating the research in "real-world" intervention trials can be developed and tested. The use and effectiveness of peer leaders in middle school nutrition interventions should continue to be examined, and mechanisms for training peer leaders should be explored. Future research should also consider doing continued formative research during the intervention trial, particularly with middle school–age students who are undergoing a great deal of change. Teacher training needs to be very comprehensive for behaviorally based nutrition curricula. Not only do teachers need more training on implementing behaviorally based educational strategies, but many also need more education on the basics of nutrition science so that they can feel more confident in teaching nutrition and appropriately lead classroom discussions. Lack of attention to the scope and sequence of health education and teachers who are inadequately trained to teach health promotion topics are additional environmental barriers to healthful dietary patterns for students.

More work on positively influencing the school and community food environments is greatly needed. Research and applied work to improve adolescents' eating behaviors will continue to be significantly challenged by the environments wherein our youths learn behavioral responses. In schools where à la carte offerings are ever-increasing, soft-drink companies offer pouring rights as financial incentives to school administrators, and junk food is used as rewards and incentives, trying to influence youths to make a healthful

choice will be extremely difficult.[30,45,46] Similar challenges exist in the community at large as food becomes ever more ubiquitous, portion sizes increase, and eating more is aggressively promoted by the food industry.[46] Finally, in future trials, we suggest collecting process information from students and staff that tap their opinions of all of the components of the intervention. We may have learned important information if we had asked students their opinion of the complete package of TEENS activities in their school, and that may have better guided our efforts during the 2 years of intervention.

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