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## Are Differences in Exposure to a Multicomponent School-Based Intervention Associated With Varying Dietary Outcomes in Adolescents?

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# Are Differences in Exposure to a Multicomponent School-Based Intervention Associated With Varying Dietary Outcomes in Adolescents?

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Multicomponent interventions are recommended for health behavior change among adolescents. However, it is difficult to disentangle the effects of multiple intervention components. This article reports outcomes associated with varying levels of exposure to a school-based nutrition intervention, Teens Eating for Energy and Nutrition at School (TEENS). Four incremental exposures were possible: (1) control group, (2) school environment interventions only, (3) classroom plus environment interventions, and (4) peer leaders plus classroom plus environment interventions. Patterns suggesting dose response were observed, with peer leaders reporting the largest increases in fruit, vegetable, and lower fat food consumption. Students exposed to classroom plus environment interventions also improved, whereas students exposed only to school environment interventions showed trends toward choosing lower fat foods and declining fruit intake and no change in vegetable intake. Control students' choices remained stable. Future studies may investigate mechanisms for peer leaders' changes, maximizing curriculum effectiveness, and improving environmental interventions.

Interventions to promote healthy adolescent behaviors are most likely to succeed when multiple intervention components, grounded in a theoretical framework, are used. A recent Institute of Medicine committee report concluded that effective health promotion interventions should combine multiple approaches to "address multiple levels of influence [on health and health behaviors] simultaneously" (p. 5)<sup>1</sup> and specifically recommended that interventions for adolescents should address multiple components of the social environment.<sup>1</sup> Eating is a complex behavior, shaped by social environmental factors such as social norms, family eating patterns, and availability of healthful foods in the environment, as well as individual factors such as taste preferences, nutrition knowledge, and functional meaning of foods.<sup>2,3</sup> By addressing these multiple domains of influence with multiple intervention components, programs designed to change eating patterns can

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increase the probability of successful outcomes. For example, results from school-based health promotion projects, such as the 5-a-Day Power Plus Program and the Child and Adolescent Trial for Cardiovascular Health (CATCH), suggest that a combination of classroom curricula addressing inter- and intrapersonal factors; parent involvement programs; and food service programs addressing availability and promotion of fruits, vegetables, and low fat foods can be effective in producing dietary change.<sup>4,6</sup>

By their nature, such multicomponent interventions present special challenges for evaluation. Differences in individual participants' exposure to intervention components may mask an overall intervention effect.<sup>7</sup> Improper implementation of one or more components may lead to what has been identified as Type III error, that is, incorrectly attributing null findings to an ineffective intervention rather than to process-related problems.<sup>8</sup> If an intervention effect is detected, it is desirable to determine whether all components truly contributed to the success or whether some might be dropped (or strengthened) to improve potency and cost-effectiveness.<sup>1,7,9,10</sup> A factorial design, in which individuals or groups are randomly assigned to treatment conditions representing each possible combination of intervention components, is ideally suited to testing the relative contribution of each component. However, such studies are large, require tremendous resource investments, and often are not feasible. Testing each proposed intervention component separately would ignore possible synergistic effects, be inefficient, and fail to address the multilevel determinants of most health behaviors. Therefore, creative strategies are needed to assess the effects of the different strategies used in multicomponent intervention trials<sup>9,11</sup> and possible dose response patterns corresponding to varying levels of intervention exposure.

In this article, we report the outcomes associated with different levels of exposure to 1 year of a multicomponent school-based intervention designed to promote healthful eating among young adolescents. The Teens Eating for Energy and Nutrition in Schools (TEENS) study is a school-based, group-randomized trial to evaluate school-environmental, classroom, and family interventions to increase fruit and vegetable intake and decrease the fat intake of low-income young adolescents to reduce their future risk of cancer. TEENS was implemented during a 2-year period with a cohort of students in middle and junior high schools. The study was conducted in 16 schools; half were randomly assigned to the intervention condition and half to a comparison condition.

The logistical arrangements for delivering multiple intervention components within the various scheduling rubrics used by schools were complex and resulted in students within schools having varied levels of exposure to the interventions.<sup>12</sup> All students in the intervention condition were exposed to the school environment interventions. However, in most schools, the classroom curriculum and family component were delivered in an elective course, meaning that not all students were exposed to those interventions. Furthermore, among those students who were exposed to the seventh-grade classroom curriculum, a subset was elected by their classmates to be peer leaders. They participated in a full-day training and helped lead interactive activities in all classroom sessions. As a result of these arrangements, students in the first intervention year of TEENS can be identified as belonging to one of four exposure groups (or "doses"): (1) control group: lowest exposure, (2) school environment interventions only, (3) classroom curriculum plus school environment interventions, and (4) peer leaders plus classroom curriculum plus school environment interventions: highest exposure.

The highest exposure group, the peer leaders, represented a novel component of TEENS. Peer leaders have been widely used to help deliver interventions directed at reducing risk behaviors among youth such as use of alcohol, tobacco and other drugs, vio-

lence, and risky sexual behavior.<sup>13-19</sup> However, to our knowledge, the use of peer leaders in nutrition education with young adolescents has not previously been evaluated. Our expectation was that using peer leaders would increase the effectiveness of the intervention as it has in many other studies.<sup>13-15,18</sup> In addition, there is evidence that students who serve as peer leaders or peer counselors tend to show the greatest benefit from the intervention, although this has been documented primarily with respect to alcohol, tobacco, and other drug use.<sup>16,19-21</sup> We believed that in TEENS as well, the intervention effect might be strongest among the peer leaders.

The purpose of this article is to examine the outcomes on students' eating patterns after exposure to the seventh-grade intervention and to assess whether different outcomes were associated with different levels of exposure (dose response). A secondary purpose is to test for dose response patterns in several psychosocial variables hypothesized to be mediators of the intervention.

## METHOD

### Study Design and Population

TEENS used a group-randomized trial design, with schools serving as the unit of both assignment and analysis. School districts in the metropolitan area of Minneapolis and St. Paul, Minnesota, with at least 20% of students approved for the free and reduced-price lunch program, were eligible to participate in the study. In addition, schools had to enroll at least 30 students in each of the seventh and eighth grades. Fourteen districts were eligible (33 schools), and 9 districts agreed to participate (20 schools). The main reasons cited for not participating were time constraints, personnel changes, and lack of interest in the school-environmental component of the intervention.

One school was chosen as a pilot school, and three others were later excluded due to scheduling difficulties that would have substantially limited the proportion of students exposed to the intervention. The remaining 16 schools were pair-matched based on the proportion of seventh graders expected to receive all school-based components of the intervention and the proportion of students receiving free or reduced-price meals.<sup>12</sup> Data for the matching variables were obtained from principals. For logistical purposes, matching of schools was done prior to baseline assessment, but neither the survey administrators nor school staff were aware of the pairings. Random assignment from within matched pairs to intervention or comparison conditions was done after all baseline measures were taken. Schools randomized to the comparison condition received intervention materials and training at the end of the 2-year intervention (fall 2000).

### Intervention

TEENS interventions were delivered across 2 years, to a cohort of seventh graders followed through their eighth-grade year. This article reports only on the effects of the seventh-grade intervention, because the four incremental exposure groups were unique to that year. The seventh-grade classroom intervention consisted of 10 curriculum sessions, informed by social cognitive theory and developed by using a systematic program-planning approach.<sup>2</sup> Peer leaders helped teachers deliver the classroom intervention by leading small-group activities and discussions. To elect the peer leaders, students were asked to write down names of three girls and three boys in their class whom they respected

and admired and believed could help teach the class. The peer leaders received a full-day training, giving them hands-on practice in leading the intervention activities and problem solving within small groups.

Each of the 10 behaviorally based curriculum sessions had some common themes that served as TEENS triggers. Sessions were started by playing an audiotape of "Foods for Dudes," a scripted call-in radio show in which students (teen actors) called in with nutrition-related questions that two corny hosts (adult actors) would answer. In addition, a low fat convenience snack was distributed for tasting during every session. Each session also had its own theme, such as "Smart Decisions," "Those Fantastic Fruits," and "A Variety of Veggies." In the fruit and vegetable sessions, peer leaders guided small groups through hands-on fruit and vegetable snack preparations and tasting. Two sessions featured peer-led "Station-to-Station Food Facts" in which students practiced looking for fat in popular foods like pizza, chips, and fast food. Several sessions included fruit, vegetable, and fat-related self-assessment and goal setting with progress checks, as well as practice in coming up with realistic options for making healthy food choices in a variety of social settings.<sup>2</sup>

In addition to classroom sessions, students receiving the curriculum also received three "Parent Packs," which contained activities and intervention-related messages and were mailed home to their parents or guardians. Each Parent Pack contained a short family assignment; a newsletter with a short lead article; tip sheets on how to eat more fruits, vegetables, and lower fat foods; an "Ask Eatie" advice column; and several quick and easy recipes. In addition, each mailing contained a book of 10 behavioral coupons with simple, specific behavioral messages such as "serve a fruit and vegetable with dinner tonight." Families got a \$10 gift certificate for returning 10 or more coupons indicating they had done the activity.<sup>2</sup>

Seventh graders in the intervention schools who did not receive the curriculum or family components were exposed only to the school environment intervention. This focused on promoting fruits and vegetables as part of the school lunch and promoting fruits, vegetables, and lower fat foods as healthy snacks available in school à la carte lines and vending machines. Intervention activities included taste testing of fruits, vegetables, and lower fat foods; increasing the availability of appealing fruits and vegetables on the lunch line; increasing the availability of good tasting lower fat snacks on the à la carte line (most items were taste tested first); displaying posters for à la carte lines and vending machines comparing fat and sugar in snack choices; displaying table tents and posters promoting fruits, vegetables, and lower fat foods; and holding prize raffles for students taking fruits and vegetables on the lunch line.<sup>2</sup> In practice, fruits and vegetables were generally more available on the lunch line, whereas lower fat snacks were more commonly added to the à la carte line, and thus the intervention activities were targeted accordingly. Regardless of whether they visited the lunch line or the à la carte line, all students in the lunchroom were exposed to the posters and table tents with TEENS messages.

In addition, six of the eight intervention schools formed a School Nutrition Advisory Council (SNAC) in the first year of the intervention. SNACs were made up of school staff, parents, and students with a goal of developing policy practices that would enhance the healthfulness of the school food environment. Examples of SNAC activities were developing policies to limit the use of candy, sweets, and nonnutritious foods as rewards for students and increasing the availability of fruits, vegetables, and lower fat foods at school social and extramural events.<sup>22</sup>

### Data Collection

Student surveys were conducted at baseline during fall 1998 and at the end of the seventh-grade intervention (spring 1999). All seventh graders were invited to complete the questionnaire. Parents or guardians received passive informed consent letters in advance of each survey, and students gave written assent at the time of each survey; these procedures were approved by the University of Minnesota Committee on the Use of Human Subjects in Research. Of the 4,050 seventh graders eligible for the fall 1998 baseline survey, 95 (2.3%) were missed due to absence from school on two survey attempts, 77 (1.9%) were excluded due to parental or student refusal, and 3,878 (95.8%) completed the survey. In spring 1999, 375 (9.7%) of the initial cohort were missed or excluded, and 3,503 (90.3%) completed the survey.

### Measures

Usual fruit and vegetable intake was measured using a modified version of the Behavioral Risk Factor Surveillance System (BRFSS) measure. This instrument included six items on the frequency of consuming fruit juices, fruit (excluding fruit juices), green salad, potatoes (excluding french fries, fried potatoes, and potato chips), carrots, and vegetables (excluding carrots, potatoes, and salad) 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. In a validation study with urban adolescents, this method yielded estimates with modest correlations to fruit and vegetable intake data from multiple 24-hour recalls (Spearman correlations .33-.43) and discriminated students who ate five or more servings of fruits and vegetables a day from those who ate less than five servings a day with moderate sensitivity (.48) and good specificity (.76).<sup>23</sup>

Usual food choices were assessed with a modified version of a scale previously tested with adolescents.<sup>24</sup> This scale presented students with nine pairs of foods and asked them to identify which they would choose to eat most of the time. One food item in each pair was considered a healthier choice based on its fat content; for example, one question asked whether the student would choose a plain baked potato or french fries most of the time. The individual items were coded so that higher scores reflected lower fat, healthier choices, and then summed to create a single scale. In a pilot administration, the test-retest Spearman correlation was .65.

Thirty-five items based on the Theory of Planned Behavior<sup>25</sup> were included to assess hypothesized psychosocial mediators of eating behavior change. Each item was presented in a five-category Likert-type scale format. The seven-item Outcome Expectations Scale included items such as “the foods I eat affect how strong I am” (Cronbach’s alpha = .79). The Valuation Scale included seven items corresponding to the Outcome Expectations Scale, such as “how strong I am is very important to me” (Cronbach’s alpha = .83). The six-item Barriers to Healthy Eating Scale included items such as “healthy foods cost too much money” (Cronbach’s alpha = .73). The Subjective Norms Scale included six items such as “people who care about me think that I should eat more fruits” (Cronbach’s alpha = .79). The Intentions Scale included five items such as “I intend to eat more vegetables during the next month” (Cronbach’s alpha = .71). The Assessment of Current Behavior Scale included four items such as “I think I eat enough fruit most days” (Cronbach’s alpha = .57).

Sociodemographic variables were also included. Age and gender were obtained from school records; all other sociodemographic measures were dummy-coded variables from the student survey. Race/ethnicity was categorized as African American, Asian or Pacific Islander, Hispanic/Latino, Multiracial, Native American, White, or Other (test-retest Spearman correlation = .86). Both the number of parents working full-time and the number of parents the student reported living with were categorized as zero, one, or two. Participation in the free or reduced-price lunch program was represented by a single indicator variable (yes/no). The highest level of education completed by a parent was coded using five categories ranging from 1 (*both parents completed high school or less*) to 5 (*both parents completed college or more*), with an additional category for other/unknown.

### Data Analysis

We fit separate models for four dependent variables: daily fruit servings, daily vegetable servings, daily fruit and vegetable servings, and the usual food choice score. The distributions of the fruit and vegetable variables were highly skewed, as is common in such count-type data, making the assumption of Gaussian distribution of the residual errors untenable. For these variables, we used repeated measures mixed-model Poisson regression, which assumes Poisson distribution of residual errors and is appropriate for count data.<sup>26</sup> The usual food choice score was distributed Gaussian, and repeated measures mixed-model analysis of variance was used with that dependent variable.

The main independent variable in all analyses was a categorical variable representing students' exposure to the TEENS intervention: 0 = no exposure (control school), 1 = school environment intervention only, 2 = curriculum plus school environment intervention, and 3 = peer leader plus curriculum plus school environment intervention. For each dependent variable, a crude model was first fit, specifying the exposure group variable as a fixed effect and school as a random effect. The demographic variables were then entered as a block, and individual variables that were not significant at the .05 level were eliminated.

We also fit an additional set of models to explore possible differences over time, by intervention exposure group, in the hypothesized psychosocial mediators of eating behavior change. Each psychosocial scale was treated as the dependent variable in a series of models, using the same procedures described above.

The use of mixed models was appropriate given the hierarchical structure of the data, with individual students nested in schools and schools nested within condition. Because observations from students in the same school tend to be positively correlated, an additional component of variance attributable to school is reflected in the data.<sup>27</sup> Repeated measures analysis was used to test whether at each different level of exposure to the TEENS intervention there was a nonzero slope for each dependent variable from baseline to the end of seventh grade. The Type III *F* test of a Time  $\times$  Exposure Group interaction term in each model was used to determine whether the slopes differed significantly across exposure groups ( $\alpha = .05$ ), and exposure group-specific *F* tests were used to determine whether each group's slope differed significantly from zero (i.e., changed from baseline to follow-up, when  $\alpha = .05$ ).

## RESULTS

### Sample Characteristics

Table 1 presents baseline characteristics of the sample, by intervention exposure group. Students from the control schools comprised half the sample ( $n = 1,755$ ); among the 1,748 students in the intervention schools, 845 students (48%) were exposed to the school environment intervention only, 677 (39%) were exposed to the classroom curriculum plus school environment intervention, and 226 (13%) were peer leaders (and also were exposed to the classroom and school environment interventions). There were slightly more boys than girls in each group except peer leaders, among whom slightly more were female. The overall sample was roughly two-thirds White (68.7%), with approximately 10.4% African Americans, 6.9% Asians or Pacific Islanders, 5.6% multi-racial, and 8.5% identifying one of the other racial/ethnic groups. Although the racial/ethnic distribution appears to differ across groups—for example, Asians or Pacific Islanders and Whites appear to be overrepresented, and African Americans appear to be underrepresented among peer leaders—these differences were not statistically significant. Similarly, differences across intervention exposure groups in parents' education level and full-time employment were not statistically significant. At baseline, the overall sample reported eating a mean ( $SD$ ) of 2.47 (2.14) servings of fruits and 2.01 (2.24) servings of vegetables per day, and the mean ( $SD$ ) usual food choice score was 5.77 (2.10), with a possible range of 0 to 9, with higher numbers signifying more healthful choices. These values did not significantly differ across groups.

### Fruit and Vegetable Consumption

Figure 1 presents the baseline follow-up slope in fruit and vegetable consumption for each of the intervention exposure groups. In this model, the Time  $\times$  Exposure Group interaction term was significant ( $F = 4.39$ ,  $df = 3, 14$ ,  $p = .023$ ). The slope among peer leaders was positive and significant ( $p = .012$ ); among students exposed to the curriculum plus school environment intervention, the slope was positive and borderline significant ( $p = .056$ ). Peer leaders reported nearly a full-serving increase in daily fruit and vegetable consumption, whereas students exposed to the curriculum plus school environment intervention reported almost a half-serving increase. The slope in combined daily servings of fruit and vegetables was not significantly different from zero in the students exposed only to the school environment intervention ( $p = .135$ ) or those in the control schools ( $p = .801$ ).

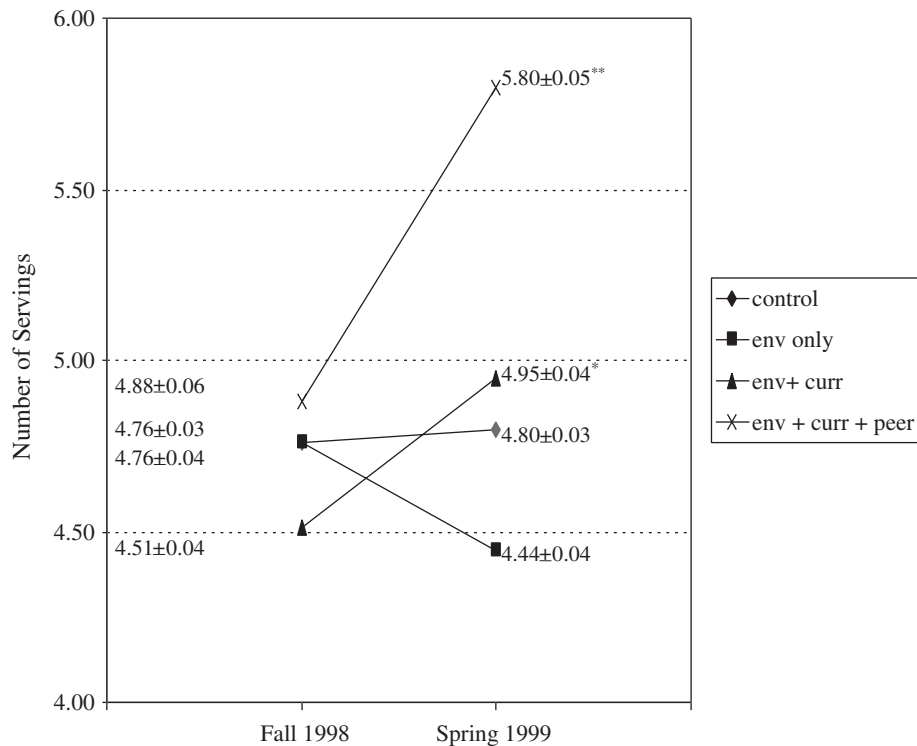
Results from the models predicting fruit consumption only and vegetable consumption only followed similar patterns. In the model predicting change in daily servings of fruit, the Time  $\times$  Exposure Group interaction term was significant ( $F = 5.05$ ,  $df = 3, 14$ ,  $p = .014$ ). There was a significant positive slope ( $p = .01$ ) among peer leaders, a borderline significant positive slope ( $p = .052$ ) among students exposed to the classroom curriculum plus school environment intervention, and a trend toward a significant negative slope ( $p = .087$ ) among students exposed to the school environment intervention only. The peer leaders reported nearly a half-serving increase in daily fruit consumption, whereas the students receiving the curriculum plus school environment intervention reported almost a quarter-serving increase, and those exposed only to the school environment intervention



Table 1. Baseline Demographic and Behavioral Characteristics of Final Sample, by Intervention Exposure Group

Variable	Peer Leaders + Curriculum + Environment ( <i>n</i> = 226)		Curriculum + Environment ( <i>n</i> = 677)		Environment ( <i>n</i> = 845)		Control ( <i>n</i> = 1,755)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Sex								
Male	105	46.5	343	50.7	426	50.4	900	51.3
Female	121	53.5	334	49.3	419	49.6	855	48.7
Race/ethnicity								
African American	13	5.8	58	8.6	86	10.2	206	11.7
Asian or Pacific Islander	21	9.3	50	7.4	104	12.3	65	3.7
Hispanic/Latino	4	1.8	16	2.4	34	4.0	38	2.2
Multiracial	13	5.8	34	5.0	43	5.1	107	6.1
Native American	2	0.9	17	2.5	11	1.3	26	1.5
White	164	72.6	474	70.1	525	62.1	1,241	70.8
Other	9	4.0	27	4.0	42	5.0	71	4.1
Parents' full-time employment								
Two parents	110	48.7	309	45.6	359	42.5	873	49.7
One parent	85	37.6	244	36.0	300	35.5	659	37.6
Neither parent	31	13.7	124	18.3	186	22.0	223	12.7
Parents' highest education								
Both high school or less	26	11.5	91	13.4	137	16.2	189	10.8
One high school or less	8	3.5	37	5.5	44	5.2	72	4.1
One trade school/some college	36	15.9	109	16.1	135	16.0	317	18.1
One college or more	44	19.5	131	19.4	139	16.5	366	20.9
Both college or more	61	27.0	127	18.8	113	13.4	450	25.6
Other/unknown	51	22.6	182	26.9	277	32.8	361	20.6

	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Usual daily servings of								
Fruits only	2.69	2.12	2.34	2.07	2.43	2.21	2.51	2.14
Vegetables only	2.15	2.05	1.92	2.06	2.01	2.40	2.03	2.25
Fruits and vegetables	4.84	3.65	4.26	3.57	4.43	4.02	4.54	3.86
Usual food choices (higher score = less fat)	5.97	2.22	5.76	2.09	5.56	2.03	5.84	2.12



**Figure 1.** Changes in self-reported past-year mean daily servings of fruits and vegetables, pre-post seventh-grade intervention, by exposure group.<sup>a</sup>

NOTE: env = environment; curr = curriculum.

a. Adjusted for baseline demographics: race and parents' education.

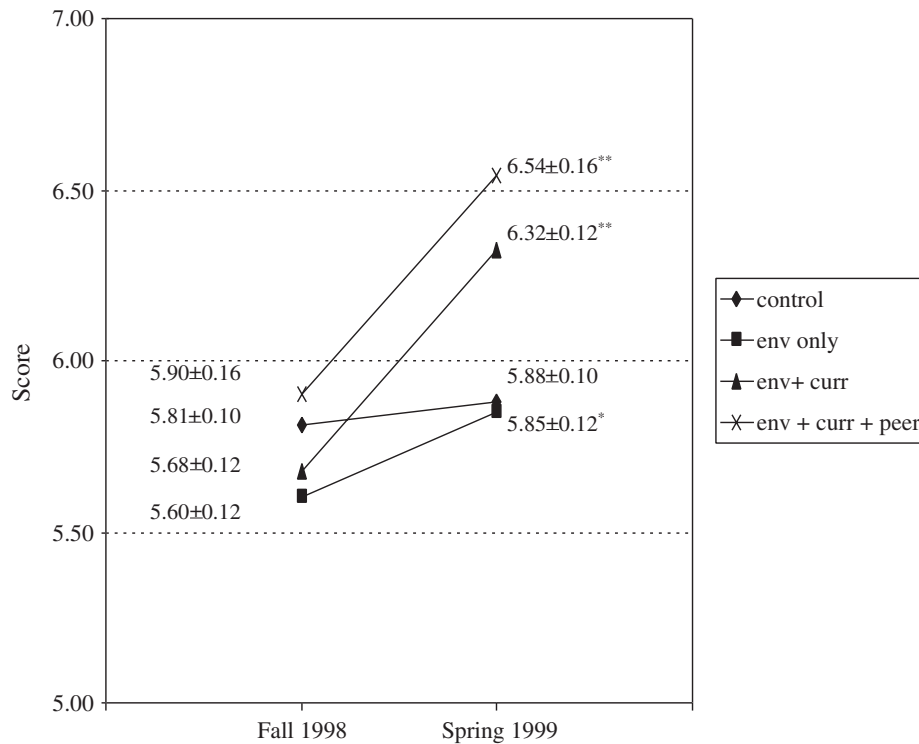
\* $p < .10$ . \*\* $p < .05$ .

reported a 0.19-serving decrease. Among students in the control schools, there was no change in daily fruit servings from baseline to end of seventh grade ( $p = .742$ ).

In the model predicting change in daily servings of vegetables, the Time  $\times$  Exposure Group interaction term showed a trend toward statistical significance ( $F = 1.03$ ,  $df = 3, 14$ ,  $p = .107$ ). Despite the  $p$  value exceeding the a priori alpha level of .05, we examined the group-level slopes for possible trends. Among peer leaders, there was a borderline significant positive slope ( $p = .059$ ), and among students exposed to the curriculum plus school environment intervention, there was a positive trend ( $p = .097$ ). The peer leaders reported eating 0.4 more daily servings of vegetables at follow-up than at baseline, and the students exposed to the curriculum plus school environment intervention reported almost a quarter-serving increase. There was no change in daily vegetable servings from baseline to end of seventh grade in students exposed only to the school environment interventions ( $p = .300$ ) or students in control schools ( $p = .895$ ).

### Usual Food Choices

Figure 2 presents the baseline follow-up slope for each of the intervention exposure groups in the usual food choice score, where higher scores indicate greater tendency to choose lower fat foods. The Time  $\times$  Exposure Group interaction term was significant ( $F =$



**Figure 2.** Changes in usual food choices score (higher score indicates lower fat consumption), pre-post seventh-grade intervention, by exposure group.<sup>a</sup>

NOTE: env = environment; curr = curriculum.

a. Adjusted for baseline demographics: sex, race, and parents' education.

\* $p < .10$ . \*\* $p < .01$ .

5.51,  $df = 3, 14$ ,  $p = .010$ ). There were significant positive slopes among peer leaders ( $p = .002$ ) and students exposed to the classroom curriculum plus school environment intervention ( $p < .001$ ) and a borderline significant positive slope among students exposed to the school environment intervention only ( $p = .058$ ). Among students in the control schools, there was no change in usual food choice score from baseline to end of seventh grade ( $p = .490$ ).

### Hypothesized Psychosocial Mediators

There were no between-group differences in baseline follow-up slopes for any of the six psychosocial scales modeled (Outcome Expectations, Valuation, Barriers to Healthy Eating, Subjective Norms, Intentions, Assessment of Current Behavior). Results from these models are not presented.

### DISCUSSION

These results suggest that differences in exposure to TEENS intervention components were associated with differences in the magnitude of eating pattern changes during the

course of seventh grade. The group that received the most intensive concentration of interventions, the peer leaders, consistently showed the greatest improvements in fruit and vegetable consumption and tendency to choose lower fat foods. Students who were exposed to TEENS classroom, family, and school environment interventions but were not peer leaders showed trends toward improvements in all the consumption variables, but the changes did not always reach statistical significance and were of smaller magnitude than those of the peer leaders. Students in the control schools showed remarkably stable consumption patterns from the beginning to the end of seventh grade. In contrast, among students who were exposed only to TEENS school environment interventions, there was a trend toward decreased fruit consumption and a nonsignificant decline in vegetable consumption. Among these same students, there was a trend in the desired direction on the usual food choices score, indicating an increased tendency to choose lower fat foods. The findings overall are suggestive of a possible dose response pattern in the intervention effects, but the response of the environment-only exposure group was unexpected and does not fit the usual dose response model.

Our data indicate that the peer leaders increased their fruit and vegetable consumption by nearly a full serving based on estimates using the modified BRFSS, compared with a half-serving increase among the other students exposed to all three intervention channels (classroom, family, and school environment). This is consistent with previous studies on other health behaviors that have reported better outcomes among peer leaders than the rest of the students receiving the intervention.<sup>16,19-21</sup> We can only speculate on how being a TEENS peer leader improved intervention outcomes relative to the other exposure groups. It is possible that the extra instructional time peer leaders received (6 hours of in-school training), with additional practice in behavioral skills such as food preparation, goal setting, and problem solving, may have increased their self-efficacy or ability to change their diet. Simply put, more time practicing and learning may have resulted in improved outcomes. In addition, the fact that the students were elected by their classmates may have made them feel good about themselves, giving them greater confidence and motivation to change their behavior and react positively to the content of the intervention.

It could also be that peer leaders changed their behavior to reduce cognitive dissonance or to “walk the talk.” Cognitive dissonance theory suggests that when a person’s behavior and cognitions are at odds, an aversive psychological state arises. This motivates the individual to shift either his or her behavior or his or her cognitions to return to a state of consonance.<sup>28</sup> Because the peer leaders were required, as part of their role, to personally deliver eating-related messages to small groups of their classmates, they may have felt some pressure (conscious or not) to make their behavior conform with those messages. It is also possible that peer leaders’ responses were more affected by social desirability than those in the other exposure groups. Knowing the “right answer” and feeling the responsibility as a peer leader may have affected their responses in the absence of actual eating behavior change.

With the change in behavior reported by the peer leaders, we would have expected to see some changes in the hypothesized mediating psychosocial constructs such as attitudes (e.g., outcome expectations and valuation) or intentions to eat more healthful foods, but no such differences were detected. Psychosocial factors have consistently been found to explain very small proportions of the variance in most measures of dietary intake,<sup>29</sup> suggesting that they may not be among the strongest determinants of eating behaviors or that our ability to assess psychosocial mediators in youth is weak. Given that peer leaders in an alcohol prevention intervention also showed positive outcomes without changes in

hypothesized mediating variables,<sup>16</sup> it may be worthwhile for future studies to investigate and identify mediators of behavior change among peer leaders. More research is needed to understand what or if psychosocial constructs mediate behavior change in adolescents.

Although not as striking as the peer leaders, the other students exposed to all three intervention channels also showed positive changes in eating patterns. On the basis of classroom observations, teacher interviews, and student evaluation forms, we determined that the classroom curriculum was feasible for most teachers, and feedback from teachers and students was generally favorable. It would be helpful to learn what additional changes might have yielded even stronger results among students in this group. One possibility would be to experiment with revising the curriculum so that all students have a turn at being peer leaders. However, it is not clear how often, or for how long, a student would need to be a peer leader to receive the increased benefits of that role. Training would also be more challenging. Teachers have expressed concern about how to conduct peer leader training with their existing resources. In-school peer leader training requires additional space and a trainer. Other possible drawbacks are that peer leaders who are appointed through rotation rather than election may not command their classmates' respect as leaders, and if the peer leaders' positive outcomes are somehow related to increased self-esteem due to being elected by classmates, then giving all students a turn to be peer leaders may not be successful.

The trend toward decreased fruit and vegetable intake among students exposed to the school environment interventions only was surprising and disturbing. Given the positive changes reported by students exposed to the combination of three intervention channels, social desirability bias may be a concern (i.e., students with greater exposure to the intervention messages may have overreported fruit and vegetable intake to please the survey staff); another interpretation may be that the environmental intervention was not strong enough. However, neither of these scenarios would explain why students in the environment-only exposure group reported apparent declines in fruit and vegetable intake, whereas students in the control schools, who received no environmental interventions, reported stable fruit and vegetable intake over time. A possible alternative explanation is that the effects of the environmental interventions varied depending on inclusion or exclusion from the classroom and/or family interventions. For example, perhaps students in intervention schools who did not receive the classroom curriculum felt isolated from the program or did not fully understand what TEENS was and had some negative reaction to the environmental intervention (which would not be an issue in control schools). Selection bias may also be a factor. Students in the environment-only exposure group attended schools in the intervention condition but did not enroll in the particular course in which TEENS was taught in their school; this group likely differed in some ways from students who did enroll in the TEENS course. In the control schools, on the other hand, selection bias by intervention dose was not an issue.

In contrast with the unexpected trend in fruit and vegetable intake, the students in the environment-only exposure group did show a trend toward positive change in usual food choices. This suggests some possible insight into the surprising findings in this group. As described earlier, there were some general TEENS promotions in the lunchroom, such as posters and table tents encouraging students to choose fruits, vegetables, and lower fat foods. But the point-of-sale promotions were focused on the primary locations of the different foods, so the meal pattern lunch (the "hot lunch" line) emphasized fruit and vegetable promotions, whereas the à la carte line emphasized lower fat snack promotions. If the students who did not enroll in the class in which TEENS was taught (usually Family and Consumer Science or Health) were also more likely, during the course of the year, to skip

the meal pattern lunch and purchase more snacks on the à la carte line, then they may have missed some of the added opportunities to consume fruits and vegetables but responded to the increased availability of lower fat à la carte items. Unfortunately, data to track students' meal pattern lunch and à la carte purchases are not available to explore this possibility further.

The findings reported here should be considered in light of several limitations. The main dependent variables, fruit and vegetable consumption and usual food choices, relied on self-report data. A validation study that assessed the modified BRFSS for estimating fruit and vegetable consumption suggested modest-to-moderate validity and reliability in a sample of urban high school students,<sup>23</sup> but we did not validate the measure in our population. The usual food choices score, which we used to assess tendency to choose lower fat foods, is useful for ranking respondents along a continuum, but we do not have data to show how changes in the absolute score correspond with changes in overall fat intake. The main independent variable, exposure group status, was obtained from process data recorded by the evaluation staff and was more reliable. However, there may have been heterogeneity of exposure within groups, for example, some students exposed to the classroom curriculum may have missed sessions due to absence, or some Parent Packs may not have been delivered due to changes in address. Although this does reflect the real-life situations in which the interventions would be disseminated, it may have limited our ability to detect between-group differences in dependent variable measures. In addition, although the results of the peer leader and classroom curriculum exposure groups showed positive changes during seventh grade, we do not know how long those changes will be maintained over time.

The potential for Type II error is also a consideration. For example, for the students exposed to all three intervention channels (but not peer leaders), the *p* values associated with the tests of slopes for fruit and vegetable consumption tended to be around .06. It is important to note that there may have been insufficient power to detect significant non-zero slopes within exposure groups. TEENS was designed as a group-randomized trial with two conditions, intervention and control, and the power analyses and sample size determination reflected that design. The analyses presented here are ancillary to the main study and were undertaken to take advantage of the unique exposure group arrangement created in implementing the seventh-grade interventions.

The logistics of delivering the seventh-grade TEENS interventions did not allow us to assess the separate contributions of the classroom curriculum and family component. Although families play a crucial role in adolescents' eating behaviors, family interventions also require additional resources, and little is known about the feasibility and effectiveness of eating-related family interventions with this age-group. The experience of TEENS suggests that such interventions are feasible; future studies are needed to assess the incremental benefits associated with family interventions in young adolescents to inform intervention development and resource allocation.

### **Implications for Research and Practice**

The results of this study suggest some possible recommendations for future interventions and research. The experience of the peer leaders, a group of students who at baseline were not different from their cohort in terms of important demographic, behavioral, or psychosocial characteristics, suggest that there is something about the process of being a peer leader that helps bring about positive dietary behavior change. Future studies should

explore this further, particularly because none of the proposed psychosocial mediators appeared to explain our findings. Of particular use would be studies focused on identifying both the mechanism for change and the ideal “dose,” that is, how much time in training and practice is needed for a student to receive the benefits of being a peer leader. Studies exploring the feasibility and effects of giving all students a turn to be peer leaders would also be useful.

For practitioners, our findings may have several applications. First, we demonstrated that it is possible to improve the dietary intakes of middle-school-age students. Many previous nutrition interventions have targeted primary-school-age youth,<sup>4,5</sup> and indeed working in middle schools introduces a number of new logistical and administrative challenges.<sup>12</sup> However, there is evidence that even children who had healthful eating patterns in elementary school adopt poorer eating patterns as they move into the middle and high school grades.<sup>30,31</sup> Thus, despite the challenges, it appears that there is a particular need for nutrition intervention for students in the middle grades, and with support, they are able to make healthy changes in their eating behavior. The overall positive dose response pattern in our results also reinforces the importance of multiple intervention components for complex behaviors such as eating. Our data were not generally supportive of environment-only interventions, although others have had success with environment-only interventions targeting vending machine purchases in high schools.<sup>32</sup> We also found that having a peer-led curriculum, in addition to the environmental interventions, resulted in positive changes for all the students who received the curriculum. Peer leaders have not been previously studied in nutrition interventions, and it appears from our findings that the use of peer leaders is feasible and helpful for nutrition education for young adolescents.

Finally, the findings concerning exposure to just the school environment raise several questions for future research. Although there is theoretical and empirical support for the importance of the environment in determining eating behaviors,<sup>33,34</sup> less is known about the types and doses of environmental interventions that are needed to create behavior change. For young adolescents, eating patterns and food availability in the home and other environments are probably important to learn about and address. Our results suggest that the school environment intervention alone did not help improve students' fruit and vegetable consumption, although it may have helped increase their tendency to choose lower fat foods. Additional studies are needed to determine whether environmental interventions alone (i.e., without classroom and/or family components) can effect positive change in eating behaviors; to investigate the requisite frequency, duration, and intensity of intervention needed; and to assess what types of changes (opportunities, promotions, policies) are needed to create effective environmental interventions.

## References

1. Smedley BD, Syme SL (eds.): *Promoting Health: Intervention Strategies From Social and Behavioral Research*. Washington, DC, National Academy Press, 2000.
2. Lytle LA, Perry CL: Applying research and theory in program planning: An example from a nutrition education intervention. *Health Promotion Practice* 2(1):68-80, 2001.
3. Perry CL, Story M, Lytle LA: Promoting healthy dietary behaviors with children and adolescents, in Weissberg RP, Gullotta TP, Adams GR, Hampden RL, Ryan BA (eds.): *Healthy Children 2010: Strategies to Enhance Social, Emotional and Physical Wellness*. Thousand Oaks, CA, Sage, 1997, pp. 214-249.



4. Luepker RV, Perry CL, McKinlay SM, Nader PR, Parcel GS, Stone EJ, Webber LS, Elder JP, Feldman HA, Johnson CC, et al: Outcomes of a field trial to improve children's dietary patterns and physical activity. The Child and Adolescent Trial for Cardiovascular Health. CATCH collaborative group. *JAMA* 275(10):768-776, 1996.
5. Perry CL, Bishop DB, Taylor G, Murray DM, Mays RW, Dudovitz BS: Changing fruit and vegetable consumption among children: The 5-a-Day Power Plus program in St. Paul, Minnesota. *Am J Public Health* 88(4):603-609, 1998.
6. Story M, Mays RW, Bishop DB, Perry CL, Taylor G, Smyth M, et al: 5-a-Day Power Plus: Process evaluation of a multicomponent elementary school program to increase fruit and vegetable consumption. *Health Educ Behav* 27(2):187-200, 2000.
7. Harachi TW, Abbott RD, Catalano RF, Haggerty KP, Fleming CB: Opening the black box: Using process evaluation measures to assess implementation and theory building. *Am J Community Psychol* 27(5):711-731, 1999.
8. Basch CE, Sliepecevic EM, Gold RS, Duncan D, Kolbe L: Avoiding Type III errors in health education program evaluations: A case study. *Health Educ Q* 12:315-331, 1985.
9. Israel BA, Cummings KM, Dignan MB, Heaney CA, Perales DP, Simons-Morton BG, et al: Evaluation of health education programs: Current assessment and future directions. *Health Educ Q* 22(3):364-389, 1995.
10. Valentine J, Gottlieb B, Keel S, Griffith J, Ruthazer R: Measuring the effectiveness of the Urban Youth Connection: The case for dose-response modeling to demonstrate the impact of an adolescent substance abuse prevention program. *J Prim Prev* 18(3):363-387, 1998.
11. Resnicow K, Royce J, Vaughan R, Orlandi MA, Smith M: Analysis of a multicomponent smoking cessation project: What worked and why. *Prev Med* 26:373-381, 1997.
12. Lytle LA, Gerlach SA, Weinstein AB: Conducting nutrition education research in junior high schools: Approaches and challenges. *J Nutr Educ* 33:49-54, 2001.
13. Black DR, Tobler NS, Sciacca JP: Peer helping/involvement: An efficacious way to meet the challenge of reducing alcohol, tobacco and other drug use among youth? *J Sch Health* 68(3):87-93, 1998.
14. Fors SW, Jarvis S: Evaluation of a peer-led drug abuse risk reduction project for runaway/homeless youth. *J Drug Educ* 25(4):321-333, 1995.
15. Klepp KI, Halper A, Perry CL: The efficacy of peer leaders in drug abuse prevention. *J Sch Health* 56(9):407-411, 1986.
16. Komro KA, Perry CL, Murray DM, Veblen-Mortenson S, Williams CL, Anstine PS: Peer-planned social activities for preventing alcohol use among young adolescents. *J Sch Health* 66(9):328-334, 1996.
17. Orpinas P, Parcel GS, McAlister A, Frankowski R: Violence prevention in middle schools: A pilot evaluation. *J Adolesc Health* 17:360-371, 1995.
18. Perry CL: Prevention of alcohol use and abuse in adolescence: Teacher vs peer-led intervention. *Crisis* 10(1):52-61, 1989.
19. Sawyer RG, Pinciaro P, Bedwell D: How peer education changed peer educators' self-esteem, personal development and sexual behavior. *J Am Coll Health* 45(5):211-217, 1997.
20. Abu-Rasain MHM, Williams DI: Peer counselling in Saudi Arabia. *J Adol* 22:493-502, 1999.
21. Tobler NS: Meta-analysis of 143 adolescent drug prevention programs: Quantitative outcome result of program participants compared to a control or comparison group. *J Drug Issues* 16(4):537-567, 1986.
22. Kubik MY, Lytle LA, Story M: A practical theory-based approach to establishing School Nutrition Advisory Councils. *J Am Diet Assoc* 101:223-228, 2001.
23. Field AE, Colditz GA, Fox MK, Byers T, Serdula M, Bosch RJ, Peterson KE: Comparison of 4 questionnaires for assessment of fruit and vegetable intake. *Am J Public Health* 88(8):1216-1218, 1998.
24. Edmundson E, Parcel GS, Feldman HA, Elder J, Perry CL, Johnson CC, et al: The effects of the child and adolescent trial for cardiovascular health upon psychosocial determinants of diet and physical activity behavior. *Prev Med* 25:442-454, 1996.

25. Godin G, Kok G: The Theory of Planned Behavior: A review of its applications to health-related behaviors. *Am J Health Promot* 11(2):87-98, 1996.
26. Allison PD: *Logistic Regression Using the SAS System: Theory and Applications*. Cary, NC, SAS Institute, 1999.
27. Murray DM: *Design and Analysis of Group-Randomized Trials*. New York, Oxford University Press, 1998.
28. Festinger L: *A Theory of Cognitive Dissonance*. Evanston, IL, Row Peterson, 1957.
29. Baranowski T, Cullen KW, Baranowski J: Psychosocial correlates of dietary intake: Advancing dietary intervention. *Annu Rev Nutr* 19:17-40, 1999.
30. Lytle LA, Seifert S, Greenstein J, McGovern P: How do children's eating patterns and food choices change over time? Results from a cohort study. *Am J Health Promotion* 14(4):222-228, 2000.
31. Kelder SH, Perry CL, Klepp KI, Lytle L: Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health* 84(7):1121-1126, 1994.
32. French SA, Jeffery RW, Story M, Breitlow KK, Baxter JS, Hannan P, Snyder MP: Pricing and promotion effects on low-fat vending snack purchases: The CHIPS study. *Am J Public Health* 91(1):112-117, 2001.
33. Perry CL, Baranowski T, Parcel GS: How individuals, environments and health behavior interact: Social Cognitive Theory, in Glanz K, Lewis FM, Rimer B (eds.): *Health Behavior and Health Education: Theory, Research and Practice* (2nd ed.). San Francisco, Jossey-Bass, 1996, pp. 246-279.
34. Crockett SJ, Sims LS: Environmental influences on children's eating. *J Nutr Educ* 27(5):235-249, 1995.