

Environmental Interventions for Eating and Physical Activity

A Randomized Controlled Trial in Middle Schools

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Background: Our objective was to evaluate the effects of environmental, policy, and social marketing interventions on physical activity and fat intake of middle school students on campus.

Design: Twenty-four middle schools were randomly assigned to intervention or control conditions. Baseline measures were collected in spring 1997, and interventions were conducted during the 1997–1998 and 1998–1999 school years.

Setting/participants: The schools had mean enrollments of 1109, with 44.5% nonwhite students.

Intervention: Over 2 years, physical activity interventions were designed to increase physical activity in physical education classes and throughout the school day. Nutrition interventions were designed to provide and market low-fat foods at all school food sources, including cafeteria breakfasts and lunches, a la carte sources, school stores, and bag lunches. School staff and students were engaged in policy change efforts, but there was no classroom health education.

Main outcome measures: Primary outcomes were measured by direct observation and existing records.

Results: Randomized regression models ($N=24$ schools) revealed a significant intervention effect for physical activity for the total group ($p<0.009$) and boys ($p<0.001$), but not girls ($p<0.40$). The intervention was not effective for total fat ($p<0.91$) or saturated fat ($p<0.79$). Survey data indicated that the interventions reduced reported body mass index for boys ($p<0.05$).

Conclusions: Environmental and policy interventions were effective in increasing physical activity at school among boys but not girls. The interventions were not effective in reducing fat intake at school. School environmental and policy interventions have the potential to improve health behavior of the student population, but barriers to full implementation need to be better understood and overcome. (Am J Prev Med 2003;24(3):209–217) © 2003 American Journal of Preventive Medicine

Introduction

Because most adolescents in the United States do not meet guidelines for fat and fruit and vegetable consumption¹ nor for physical activity,^{1,2} there is a need for effective interventions. Many such

interventions have been evaluated, and most have been delivered through schools.^{3–5} School health-promotion models and guidelines^{6–9} recommend multicomponent interventions that combine classroom, family, environmental, policy, and community approaches. In practice, programs consist primarily of classroom education, and there are few examples of comprehensive school health promotion.¹⁰

Environmental and policy interventions are the least studied component of school health promotion,^{11,12} but there are examples of effective environmental approaches. CATCH¹³ and Ellison et al.¹⁴ improved the nutritional quality of foods served at schools. Environmental and policy approaches to enrich physical education classes have increased students' physical activity in class and out of school.^{5,10,15,16} Because students consume 25% to 33% of their daily energy¹⁷ and accrue

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20% to 30% of daily physical activity at school,^{18,19} efforts to improve these behaviors on school campuses are needed and could have large cumulative effects.

The present study evaluated the effects of environmental and policy interventions on the eating habits and physical activity of students at school. The goals were to increase the availability of low-fat food choices and physical activity opportunities and to promote healthful choices. The study was conducted in middle schools, which have been neglected in school physical activity and nutrition intervention research.³⁻⁵

Methods

School Recruitment and Characteristics

Forty-eight public middle schools (grades 6 to 8) in San Diego County, California, were invited to participate in the study. The first 24 schools to indicate agreement were accepted, randomized, and included in the analyses. Mean enrollment across 24 schools was 1109 (standard deviation [SD]=356) students per school, of whom 49% (SD=2.4) were female, 44.5% (SD=20.2) were nonwhite, 39.5% (SD=22) received free or reduced school meals, and 36.4% (SD=22.7) were bused to school. On average, schools had two lunch periods per day (range=1 to 3), lasting 35.8 (SD=7.8) minutes.

Study Design

The Middle-School Physical Activity and Nutrition (M-SPAN) study was a randomized field trial, with the school as the unit of intervention and analysis. After baseline data collection, schools were randomly assigned within districts to intervention ($n=12$) or control conditions ($n=12$). There were no significant differences between conditions at baseline on school characteristics or outcome variables (all p 's >0.05). Baseline measures were collected in spring 1997, and interventions were conducted during the 1997-1998 and 1998-1999 school years.

Intervention Overview

The primary aims of the intervention were to (1) increase the total energy expenditure from physical activity by the student population at school and (2) decrease the grams of total and saturated dietary fat purchased at or brought to school by students. Although multiple dietary constituents need to be improved, the present study had one nutrition target because fat is linked to many health problems.¹ One target was sufficient to test the environmental approach, and resources did not allow for multiple nutrition targets. Intervention strategies were designed to change school policies and environments to provide more healthful food choices and more opportunities for physical activity at school. Because the study was designed to test environmental interventions, there was no classroom education.

Cohen et al.²⁰ proposed a structural, ecologic model of health behavior that can be used to classify M-SPAN interventions. This model built on broader ecologic models that posit health behaviors are influenced by personal, social/cultural, physical environmental, and policy variables.²¹ Cohen et al.²⁰ argued that because most interventions target individuals

only, specific ecologic models are needed to guide interventions. Thus, Cohen et al.²⁰ presented a pragmatic model that identified four factors that could be used as intermediate targets in behavior change interventions. The categories of structural and environmental influences on behavior were (1) availability of protective or harmful products and services; (2) physical structures or characteristics of products and services; (3) social structures and policies; and (4) media and cultural messages.

Physical Activity Interventions

Physical education (PE) was required daily in all grades, and one intervention component was designed to increase physical activity in PE classes through changing lesson context, lesson structure, and teacher behavior. Another intervention component was intended to increase physical activity on campus during leisure periods throughout the school day when students could make choices (i.e., before school, after lunch, and after school). Consistent with baseline findings,²² targeted environmental changes were to increase supervision, equipment, and organized activities. Strategies used in the physical activity interventions are summarized in Table 1, organized by the structural ecologic model.²⁰

Nutrition Interventions

The nutrition intervention was designed to provide and market low-fat foods at all school food sources.²³ Intervention strategies for each food source are summarized in Table 2. Middle school cafeterias offer government-reimbursable (Type A) lunches and breakfasts, along with unregulated a la carte foods.²⁴ Interventions with school food-service staff and managers were undertaken to provide more low-fat choices at these sources. An example of the food service strategy was to identify vendors who could provide schools with tasty, low-fat food items at competitive prices. About one third of students brought lunches from home,²⁵ so intervention strategies were developed to assist students in bringing lower-fat lunches. At baseline, 6 of 12 intervention schools had stores that sold mostly high-fat foods,²⁶ so this source was targeted for change. No schools had vending machines for students.

Creating and Supporting Policy Change

Health policy meetings. Key school personnel met with project staff to select and implement policy changes to create healthier school environments (described in Zive et al.²³). Participants included administrators (principals, food service directors); faculty (physical educators); staff (cafeteria managers, student body organization advisors); parents; and students. The project requested three, 90-minute meetings per school across 2 years, and 80% of planned meetings were held. Each intervention year, participants selected two to four policies to improve and formed action plans to achieve their goals. A manual guided the work of the groups. Example policies included "Serve 1% or skim milk only," "Close school stores at lunch time," "Provide supervision and transportation for student physical activity after school," and "Upgrade PE facilities and equipment." The schools' goals were printed on a poster-style newsletter distributed to staff at all intervention schools. Progress on goals was monitored in subsequent meetings.

Table 1. Summary of main components of the M-SPAN physical activity intervention categorized according to structural ecologic model of Cohen et al.²⁰

Availability of protective or harmful products and services	Physical structures or characteristics of products and services	Social structures and policies	Media and cultural messages
<p>Physical education Five 3-hour staff development sessions. Goals were to increase student PA time during class, improve teacher instructional skills, and create action plans for promoting. PA Provide new curriculum materials.</p>	<p>Physical education Project funds used for PE equipment.</p>	<p>Physical education On-site visits to assist and give feedback. Staff development improved teacher support and promotion of PA. PE staff gave class credit for out-of-PE activities. Poster-style newsletters highlighted changes made in each school's PE programs.</p>	<p>Physical education PE teachers promoted PA out of PE.</p>
<p>PA promotion throughout school day Goal was to promote PA before school, after lunch, and after school Volunteer PA providers recruited from community. Some volunteers received stipends or incentives. Made activity equipment available to students.</p>	<p>PA promotion throughout school day Project funds used to purchase PA equipment.</p>	<p>PA promotion throughout school day Policy group determined how project funds were used. Community providers recruited students to activity programs. PE staff supervised volunteer PA providers. Changed policies to make more activity areas accessible.</p>	<p>PA promotion throughout school day PA programs announced by flyers, school bulletins, parent newsletters, PTA meetings.</p>

M-SPAN, Middle-School Physical Activity and Nutrition study; PA, physical activity; PE, physical education.

Student health committees. Committees consisted of 9 to 12 students and were supervised by a faculty member and project staff. Members received T-shirts and training booklets describing how committees could support healthy policies and promote healthful choices. Student health committees were formed at 8 of the 12 intervention schools. The goal was to have a monthly activity, such as assisting with taste tests, announcing after-school activities, and creating posters promoting healthful lunch options.

Parental education. Parental education was delivered via existing school communication channels and was conceptualized as changing the information environment. Communications were made through school newsletters, posters, and a brochure at open houses and PTA meetings. Sixteen articles with strategies for improving students' dietary and physical activity habits at school were submitted to newsletter editors. Project staff made presentations to 11 of the 12 PTA boards.

School incentives. All 24 schools received an incentive to participate (\$1000 for PE equipment), and intervention schools received an additional \$500 for kitchen equipment and \$2000 for physical activity programs or equipment. Prior to receiving funds, intervention school staff submitted plans for how money would be used to provide a more healthful environment for students.

Measurements

The purpose of the outcome evaluation was to estimate the effect of the policy and environmental changes on the eating and physical activity behaviors of the whole population at

school. Measures were based on direct observation or existing records. Surveys were used to assess secondary outcomes.

Measures were collected by an extensively trained and regularly supervised staff. Data quality was monitored by assessing inter-observer agreement on observational measures. Observations of physical activity and bag lunches were made on randomly selected days at each school: 3 days at baseline and 2 days during each intervention semester.

The validated SOFIT (System for Observing Fitness Instruction Time) method^{27,28} was used to evaluate student physical activity in a random sample of PE classes. The SOPLAY (System for Observing Play and Leisure Activity of Youth) method²⁹ was developed for the present study to assess the number and activity level of students during leisure times. For SOPLAY observations, all locations used for physical activity at school were identified, and observers collected data in all locations before school, after lunch, and after school on randomly selected days.

The menu documentation measure of Type A lunches and breakfasts, the a la carte assessment, and the school store assessment required record keeping by school personnel. Due to resource limitations, only foods with >1 gram of total fat per serving were monitored. Most nutrition measures were collected during the same randomly selected 5-day period at each school during baseline, intervention Year 1, and intervention Year 2. School staff received forms, training, and compensation for completing reports. Labels of all packaged foods were collected for nutrient information. Recipes were collected and analyzed with the Nutrition Data Systems software,³⁰ and total and saturated fat were used in analyses.

Table 2. Summary of main components of the M-SPAN nutrition intervention categorized according to structural ecologic model of Cohen et al.²⁰

Availability of protective or harmful products and services	Physical structures or characteristics of products and services	Social structures and policies	Media and cultural messages
<p>Changes in school food service 11 hours of training for CNS staff. Goals were to reduce fat content of breakfast, lunch, and a la carte foods through changes in purchasing, preparation, and serving practices. CNS created plans to reduce fat content and introduce low-fat foods.</p>	<p>Changes in school food service CNS staff chose goals from list of 29, which included recipe modification and ingredient substitution. Entire low-fat meals were packaged together Salad bars were adopted.</p>	<p>Changes in school food service On-site visits for goal setting and monitoring progress. Policy group adopted and implemented nutrition policies. Poster-style newsletters highlighted CNS changes at each school. Monthly action alerts sent to CNS staff, school administrators, and PTA recommending a goal for the month. Healthy lunch contests provided raffle tickets to students observed to have that day's category of low-fat food.</p>	<p>Changes in school food service Signs promoted low-fat foods to students. CNS servers were encouraged to recommend low-fat choices to students.</p>
<p>Food vendors Vendors of low/fat items identified for breakfast, lunch, and a la carte. Vendors donated food for CNS staff sampling and student taste/testing. Taste/testing of new items, with feedback to CNS. CNS staff encouraged to add new foods to menus and recipes.</p>	<p>Food vendors Lower-fat items from vendors substituted in recipes.</p>	<p>Food vendors Vendor fairs were hosted, so CNS directors could sample products and meet vendors.</p>	<p>Food vendors Vendors donated marketing materials.</p>
<p>Bag lunch Goal was for parents and students to substitute low-fat for high-fat items brought from home (i.e., change the food environment).</p>	<p>Bag lunch</p>	<p>Bag lunch Healthy lunch contests provided raffle tickets to students observed to have that day's category of low-fat food.</p>	<p>Bag lunch Ideas for low-fat bag lunch items printed in schools' parent newsletters.</p>
<p>Student stores Goals were to substitute low-fat for high-fat items. Educational packet developed for store managers and other school staff. Hours of operation were reduced.</p>	<p>Student stores</p>	<p>Student stores Policy group set goals to improve healthfulness of foods offered at student stores. Site visits to stores with feedback on healthfulness of food offerings.</p>	<p>Student stores Low-fat foods promoted with signs.</p>

CNS, child nutrition services; M-SPAN, Middle-School Physical Activity and Nutrition study; PA, physical activity; PE, physical education.

Table 3 summarizes measurement methods and provides citations for papers describing each method. Reliability data in Table 3 cover the entire study.

Computation of Outcome Variables

Two primary outcome variables were created to summarize the physical activity and dietary fat that the “average child” had during a typical day at school. The conceptual approach was to sample all student physical activity occurring through-

out the school day and to measure all sources of dietary fat so aggregate variables could be computed to estimate kilocalories of moderate to vigorous physical activity expenditure and grams of dietary fat per child per day at each school.

To create the primary outcome variable for physical activity at school, assessors systematically observed physical activity occurring at different times and places (PE classes, before school, during lunch, and after school on school grounds). Computed estimates of kilocalorie expenditure were summed

Table 3. Summary of measures used to assess primary outcomes

Measure, target behavior, references	Procedures and psychometrics	Schedule of measurement	Summary variable
Physical activity			
System for Observing Fitness Instruction Time, to assess PE classes ^{25,26}	Observation of randomly selected students during PE classes. Codes for lying down, sitting, standing, walking, very active transformed to energy expenditure. Interobserver agreement on categories=83%.	Baseline: 3 randomly selected days per school. Intervention: 2 randomly selected days at each school per semester. 1947 classes observed.	Mean kilocalories expended in class=kcal/student/day
System for Observing Play and Leisure Activities for Youth, to assess out-of-PE activities ²⁷	Observation of all activity areas before school, during lunch, and after school. All students coded as sedentary, walking, very active. Codes transformed to energy expenditure. Interobserver agreement on energy expenditure, $R = 0.99$.	Baseline: 3 randomly selected days per school. Intervention: 2 randomly selected days at each school per semester. Total of 5046 observations.	Total kcal observed divided by school attendance=kcal/student/day
Nutrition			
Type A breakfast and lunch ^{13,22,28}	Menu documentation, conducted by food service staff after training. Followed up with cook interviews. Recipes, product labels, and sales data collected. Recipes entered into NDS program.	1 randomly selected week each measurement period per school (Breakfast available in 11 schools).	Total fat and saturated fat grams sold through Type A breakfast and lunch
A la carte foods ^{22,28}	Menu documentation conducted by food service staff after training. Followed up with cook interviews. Food labels and sales data collected. Data entered into NDS program.	1 randomly selected week each measurement period per school. (A la carte foods in 23 schools).	Total fat and saturated fat grams sold through a la carte
Bag lunches ^{23,28}	Trained observers recorded food and serving size of all bag lunch contents. Percentage of students bringing bag lunches estimated from student surveys.	Baseline: 3 randomly selected days per school. Intervention: 2 randomly selected days at each school per semester. 18 lunches per day.	Total fat and saturated fat grams brought in bag lunches
Student stores ^{24,28}	All food labels collected by school staff or M-SPAN staff. Sales recorded for each item.	1 randomly selected week per school at each measurement period. (Stores available in 13 schools).	Total fat and saturated fat grams sold by student stores

M-SPAN, Middle-School Physical Activity and Nutrition study; NDS, Nutrition Data System; PE, physical education.

to create total energy expenditure from moderate to vigorous physical activity occurring at a given school on an average day. This aggregate measure was adjusted by student attendance to provide the school-level primary-outcome measure for physical activity at school (kcal/child/day/school expended in moderate to vigorous physical activity).

For the nutrition primary outcome measure, total and saturated dietary fat from all sources purchased at school (Type A breakfasts or lunches, a la carte, school stores) or brought from home on an average day was summed for each school. To adjust for school size and to provide the school-level primary outcome measure for nutrition (dietary fat grams/child/day/school), total dietary fat aggregated across sources was divided by the number of students in attendance. (Detailed descriptions of the computation of primary outcome variables are available at www.drjamesallis.sdsu.edu.)

Secondary Outcomes from Student and Parent Surveys

Surveys were distributed to separate random samples at baseline (spring 1997) and 2 years later (spring 1999). Students and parents/guardians completed surveys at home. A total of 1678 student-parent pairs participated at baseline (response rate=72%) and 1434 pairs at post-intervention (response rate=60%). There were similar numbers of students from each grade. Non-Hispanic Caucasian students (51%) and males (43%) were underrepresented in survey samples, compared to the student population (57% non-Hispanic Caucasians and 51% male).

On a list of 32 physical activities, students reported number of days of participation and average duration per day outside of PE for the past 7 days. Intensity values for each physical

activity³¹ were multiplied by minutes to yield a weighted moderate to vigorous physical activity (MVPA) score. Students reported participation in nine sedentary behaviors (e.g., studying, computer/Internet use) for the past 7 days, and sedentary hours per day were calculated.

From a list of 31 common high-fat foods and beverages, students reported what they had consumed the previous day,³² yielding a fatty foods tally. Avoidance of fat in family food preparation was reported by parents using a modified version of the saturated fat/cholesterol avoidance scale.³³ Students reported their weight and height to calculate body mass index (BMI; kg/M²). (The survey is available at www.drjamesallis.sdsu.edu.)

Seven-day test-retest reliability of the survey was evaluated with 100 middle school students and their parents. Intra-class correlations (ICCs) were adequate for the student fatty foods score (0.74); sedentary behavior (0.92); reported height (0.90) and weight (0.76) (BMI, ICC=0.64); and parent fat avoidance (0.68). The Pearson correlation for parent and child reports of child's BMI at baseline was strong, $r=0.96$. The ICC for student MVPA score was 0.47 (N=88, with outliers deleted) and probably was reduced by the memory demands of the 7-day recall task.

Analysis Methods

Randomized regression models using PROC MIXED in SAS were used to examine change in school-level outcomes by condition. For physical activity, analyses were conducted overall and for boys and girls separately. Time points were baseline, intervention Year 1, and intervention Year 2. There were 24 schools and 72 observations available for analyses (no missing data). For physical activity, the covariance structures that maximized Akaike's information criteria (AIC) were compound symmetry for the overall and boys' models and autoregressive for girls. For nutrition, the covariance structures that maximized AIC were autoregressive for total fat and compound symmetry for saturated fat. Randomized regression models were used to examine changes in survey-based secondary outcomes by condition. Survey data were aggregated at the school level.

Effect sizes (d) were calculated by subtracting the change in control schools from the change in intervention schools and dividing by the pooled SD of change. Change was examined from baseline to intervention Year 2. Effect sizes were interpreted as small (0.20), medium (0.50), and large (0.80).³⁴

Results

Physical Activity at School

The time by condition interaction for the total population was significant ($F[1,46]=7.53$, $p<0.009$) with a large effect size ($d=0.93$). Intervention schools increased physical activity over time at a greater rate than control schools. Gender-specific secondary analyses revealed the time by condition interaction was significant for boys ($F[1,46]=12.16$, $p=0.00$), with a large effect size of $d=1.10$. The interaction was not significant for girls ($F[1,46]=0.73$, $p=0.396$), and the effect size was

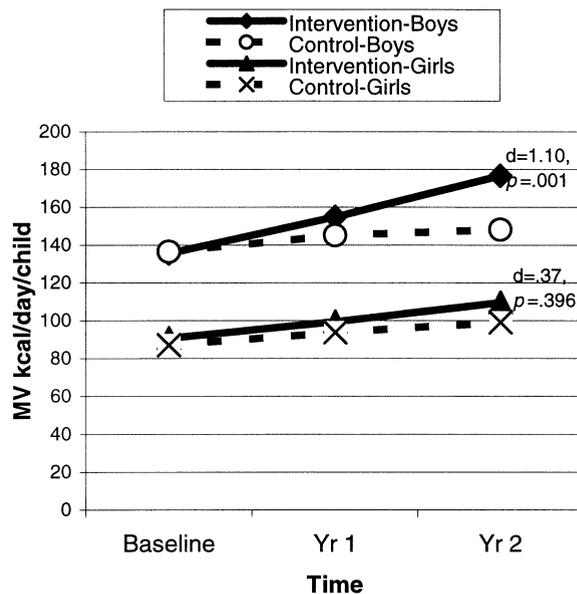


Figure 1. Physical activity results: observed physical activity by condition for boys and girls. $n=12$ intervention and 12 control schools.

MV, moderate to vigorous.

small ($d=0.37$). The gender-specific results on kcal/day/child are shown in Figure 1.

Figure 2 shows changes in physical activity from baseline to intervention Year 2 and illustrates the contribution of PE and out-of-PE activities for girls, boys, and the total group. Boys in intervention schools increased about equally in physical activity in PE and out of PE, but girls in intervention schools increased their activity mainly through PE.

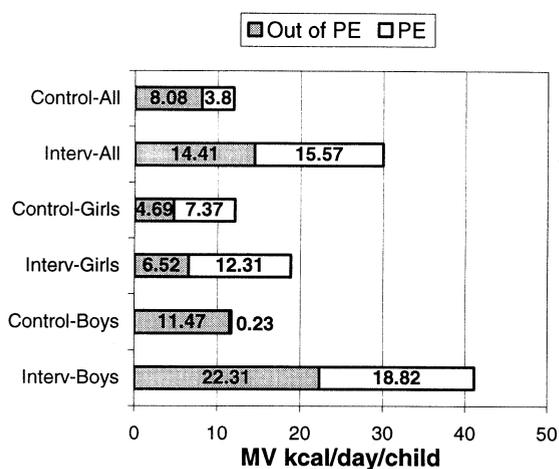


Figure 2. Contribution to overall physical activity results by physical-education and out-of-physical-education intervention components. Change scores from baseline to Year 2 of intervention (Interv) are presented.

Interv, intervention; MV, moderate to vigorous physical activity; PE, physical education.

Table 4. Student/parent survey time \times condition interactions for boys and girls

Variable	Assessment	Intervention group	Control group	Time \times condition	d
Boys					
Body mass index (kg/m ²)	Baseline	20.12 (0.98)	19.68 (0.63)		
	Intervention Yr 2	19.84 (0.61)	20.04 (0.85)	$F=4.60, p=0.044$	0.83
Moderate to vigorous physical activity score	Baseline	130 (48)	122 (31)		
	Intervention Yr 2	115 (25)	104 (19)	$F=0.04, p=0.839$	0.09
Sedentary hrs/day/student	Baseline	4.65 (0.78)	4.68 (0.86)		
	Intervention Yr 2	4.42 (0.75)	3.87 (0.71)	$F=0.16, p=0.693$	0.17
Student fatty foods	Baseline	8.2 (0.91)	8.8 (0.68)		
	Intervention Yr 2	8.9 (0.92)	9.7 (1.19)	$F=0.10, p=0.761$	-0.13
Parent fat avoidance	Baseline	5.1 (0.47)	5.1 (0.44)		
	Intervention Yr 2	5.1 (0.45)	5.1 (0.25)	$F=0.004, p=0.948$	-0.03
Girls					
Body mass index (kg/m ²)	Baseline	19.76 (0.77)	19.52 (0.89)		
	Intervention Yr 2	19.88 (1.16)	19.73 (1.16)	$F=0.09, p=0.771$	-0.12
Moderate to vigorous physical activity score	Baseline	90 (20)	96 (28)		
	Intervention Yr 2	93 (18)	91 (17)	$F=0.37, p=0.548$	0.25
Sedentary hrs/day/student	Baseline	4.58 (0.74)	4.68 (.86)		
	Intervention Yr 2	4.64 (0.69)	4.61 (0.85)	$F=0.14, p=0.709$	0.11
Student fatty foods	Baseline	7.7 (0.92)	7.9 (0.97)		
	Intervention Yr 2	8.0 (0.92)	8.2 (0.70)	$F=0.006, p=0.937$	-0.03
Parent fat avoidance	Baseline	5.2 (0.36)	5.2 (0.39)		
	Intervention Yr 2	5.1 (0.38)	5.0 (0.33)	$F=1.12, p=0.301$	0.43

Fat Intake at School

The time by condition interaction term was not statistically significant for total ($F[1,46]=0.01, p=0.903$) or saturated ($F[1,46]=0.08, p=0.781$) fat, indicating no differences in change over time by condition in fat measures at the school level. Effect sizes indicated a near null effect for total ($d=0.03$) and saturated ($d=0.13$) fat. It was not possible to conduct gender-specific analyses for fat intake, because most data were derived from sales records.

Secondary Outcomes

Survey data revealed that the intervention did not have a significant impact on reported physical activity or participation in sedentary behaviors. Similarly, there was no intervention effect on fatty foods consumed or parental fat avoidance. There was a significant reduction in BMI among intervention boys, compared to control boys, but there was no effect for girls (Table 4).

Discussion

The environmental and policy interventions implemented in middle schools were effective in increasing students' physical activity at school but were not effective in reducing total and saturated dietary fat purchased at, or brought to, school. The physical-activity effect was significant only for boys. There was no evidence that the school-environment interventions improved health behaviors outside of school, nor was there evidence that students compensated for changes at school by decreasing physical activity or increasing

consumption of fatty foods outside of school. The lack of changes outside of school was not surprising, as these environments were not targeted by the interventions. The significant intervention effect on boys' BMI suggests that boys may have increased their physical activity enough to produce physiologic effects. Thus, the M-SPAN environmental and policy interventions appear to have had important effects on physical activity and weight control for boys.

Reasons for the lack of effect on girls' physical activity are not clear. Challenges in promoting physical activity among girls were anticipated because girls are less active than boys.^{1,2} Thus, the PE intervention focused on including all students in physical activities and improving PE instruction for all students. The out-of-PE intervention was staffed mainly by female volunteers who offered many activities believed to be attractive to girls, but this approach was insufficient. Additional study is needed to tailor activity offerings, instructional methods, and promotional strategies to middle school girls.

Present findings of positive outcomes for boys contrasted with Planet Health results. Gortmaker et al.³⁵ reported a 2-year physical activity and nutrition intervention in grades 6 and 7 that produced significant decreases in obesity prevalence for girls but not for boys. Perhaps enhanced physical activity opportunities in M-SPAN were a sufficient intervention for boys, but girls needed the combination of opportunities, promotion, and education offered by Planet Health.

Environmental approaches to school health promotion are rarely evaluated, so it is important to consider factors that led to the mixed results. The structural

ecologic model²⁰ can be applied by considering how well the four components were implemented for the multiple intervention targets. Changing “availability” of products and services was the first component. Availability of PE was not altered because it was already required daily. The intervention, however, improved the quality of the PE classes in intervention schools, while little change occurred in control PE classes (Figure 2). Interventions to increase the availability of activity programs throughout the school day appeared to be successful in some, but not all, schools for several reasons, including inability to recruit volunteers in some locations.

Project goals included increasing availability of low-fat foods at all food sources on campus. Although some new food items were introduced, particularly in reimbursable lunches and a la carte sources, the extent of the change may have been too limited and too variable to be detectable. There were powerful financial barriers within schools to efforts to reduce availability of popular high-fat food items.

The second structural change approach was to alter characteristics of products and services. The quality of PE classes was improved, affecting all students on a daily basis. Training of school food-service staff targeted modifications in recipes and food preparation that would reduce fat in dishes, but it appears that the guidelines were insufficiently implemented. Changing food preparation was complicated by a central kitchen system in some districts that eliminated local school control of ingredients and preparation.

Cohen et al.’s²⁰ third approach was to change social structures and policies. There were examples of successful policy change, such as introducing salad bars, removing high-fat foods from school stores, allowing students to use activity areas after school, and hiring aides to lead activity programs. The effectiveness of policy change committees varied widely, and project support for the groups was probably inadequate to yield meaningful policy changes in most schools.

Perhaps the single largest policy barrier was the requirement for school food services to be financially self-supporting. This policy created financial incentives to serve products students already preferred, particularly processed foods advertised heavily in the mass media. Schools took a financial risk when introducing new products, especially perishable fruits, and they were unable to conduct marketing activities of sufficient intensity to build demand for low-fat products.

The social context of PE was changed through staff development, and school food-service training sessions emphasized prompting the choice of low-fat foods. Physical activity providers were encouraged to recruit students personally to activity programs, but many were reluctant to do so.

The fourth structural component was the application of media to promote use of healthful products and

services. Multiple communication media were used, including posters, parent newsletters, and public address announcements. In the context of popular mass media marketing of unhealthful foods and sedentary recreation, project media were inadequate to make a large impact. As an example of limitations, sometimes there was no appropriate place for, or policies prohibited use of, point-of-purchase signs to encourage selection of low-fat foods.

The significant intervention effect on boys’ BMI was consistent with boys’ increased energy expenditure at school and suggests that school environment interventions have some promise for contributing to solutions to the youth obesity epidemic. Confidence in the findings was limited by the self-report nature of the BMI variable and the fact that BMI was not measured on a cohort. However, the quality of self-reported BMI was supported by a study of middle school students that found adequate 1- to 2-week reliability (ICC=0.82; $n=250$) and validity compared to measured BMI (ICC=0.88; $n=62$).³⁶

Environmental and policy interventions produced substantial effect sizes for some outcomes. Effect sizes were large for boys’ physical activity ($d=1.10$) and boys’ BMI ($d=0.83$). However, the effect size for girls’ physical activity was small ($d=0.37$) and for total fat was negligible ($d=0.03$). Results suggest the promise of environmental interventions but indicate the need for continued study to improve implementation of environmental and policy changes.

Priorities for future research include (1) improving school physical-activity interventions for girls; (2) documenting barriers to school food environment changes; and (3) assessing multilevel school–health promotion interventions.³⁷ The M-SPAN study showed that school environmental and policy interventions can be effective by themselves, but subsequent studies need to develop methods of overcoming barriers to implementing policy and environmental changes.

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