Nutrition

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Impact of a School-Based Interdisciplinary Intervention on Diet and Physical Activity Among Urban Primary School Children

Eat Well and Keep Moving

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Abstract

Objective To evaluate the impact of a school-based interdisciplinary health behavior intervention on diet and physical activity among children in grades 4 and 5.

Design A quasiexperimental field trial with 6 intervention and 8 matched control schools. Outcomes were assessed longitudinally using preintervention (fall 1995) and follow-up (spring 1997) student survey food frequency and activity measures and follow-up 24-hour recall measures of diet and activity. Change was also assessed using yearly repeated cross-sectional surveys of all grade 5 students from 1995 through 1997.

Participants Longitudinal data were collected from 479 students initially in grade 4 in Baltimore, Md, public schools; 91% were African American. Repeated 24-hour recall measures in 1997 were collected for a random subsample of 336 students. Cross-sectional survey data were collected from all grade 5 students in 1995, 1996, and 1997 (n=2103).

Intervention The Eat Well and Keep Moving Program was taught by classroom teachers over 2 years in math, science, language arts, and social studies classes. Materials provided links to school food services and families and provided training and wellness programs for teachers and other staff members. Intervention materials focused on decreasing consumption of foods high in total and saturated fat and increasing fruit and vegetable intake, as well

Main Outcome Measures Dietary intake and physical activity measured via repeated 24-hour recall were primary end points, with additional food frequency and activity measures.

Results The 24-hour recall measures indicated that, after controlling for baseline covariates, the percentages of total energy from fat and saturated fat were reduced among students in intervention compared with control schools (–1.4%; 95% confidence interval [CI], –2.8 to –0.04; *P*=.04 and –0.60%; 95% CI, –1.2 to –0.01; *P*=.05). There was an increase in fruit and vegetable intake (0.36 servings/4184 kJ; 95% CI, 0.10-0.62; *P*=.01), in vitamin C intake (8.8 mg/4184 kJ; 95% CI, 2.0-16; *P*=.01), and in fiber consumption (0.7 g/4184 kJ; 95% CI, 0.0-1.4; *P*=.05). Television viewing was marginally reduced (–0.55 h/d; 95% CI, –1.04 to 0.04; *P*=.06). Analysis of longitudinal and repeated cross-sectional food frequency data indicated similar significant decreases in the percentages of total energy from fat and saturated fat.

Conclusion Evaluation of the Eat Well and Keep Moving Program indicates effectiveness in improving dietary intake of students and reducing television viewing.

DIETARY HABITS and physical activity levels of children are risk factors for subsequent morbidity and mortality in adolescence and adulthood, including increased risks for cardiovascular disease, obesity, and diabetes mellitus.[1-3] Reduced intake of dietary fat, increased intake of fruits and vegetables, and increased physical activity are behaviors that have been targeted for population-based interventions among both children and adults to reduce disease risk.[4-6]

Data on nutrition and physical activity of children in the United States indicate that improvement is warranted. Although estimates of average total energy intake of youth aged 1 to 19 years shows little change from past decades, the average diet of children exceeds recommendations for fat, saturated fat, and sodium intake.[7] More than 80% of children consume more than the recommended amount of total fat and saturated fat.[8] Only an estimated 1% of the population aged 2 to 19 years meets all federal recommendations for a healthy diet.[9] There are limited data concerning physical activity among children and adolescents, but available studies indicate an increasingly sedentary population.[3] Childhood obesity is rapidly increasing[10,11]; one identifiable cause is excess television viewing.[12,13]

School-based programs among elementary school students represent an important channel for behavioral change because of the near universal enrollment of children in school[14] and the potential to affect behaviors of children that track into adolescence and adulthood.[15] Of particular concern is the nutritional status of urban minority populations, including substantial numbers of underserved children and youth who are at risk for obesity, elevated serum lipid levels, and dietary consumption patterns that do not meet Dietary Guidelines for Americans.[8] African American adults experience excess mortality because of cardiovascular disease, stroke, and diabetes mellitus.[4] Promoting healthy diet and activity patterns among African American children in the United States can potentially contribute to lowering excess adult mortality.

The Eat Well and Keep Moving Program is a school-based program designed to improve diet and physical activity levels in children that was implemented among students in grades 4 and 5 in 6 primary schools in Baltimore, Md. The project was developed via formative research from fall 1993 through fall 1995. Matched control schools were selected at baseline, and data were collected before and after implementation of the classroom-based

The present analysis focuses on evidence for impact of the classroom-based interdisciplinary intervention on dietary intake and physical activity of children, contrasting change in the intervention vs control participants.

Methods

Design

The Eat Well and Keep Moving classroom-based intervention materials were implemented in 6 public elementary schools in Baltimore beginning in late fall 1995. Eight matched control schools were selected prior to implementation. The plan was to provide intervention materials and training to the control schools at the end of the intervention and evaluation period. The study is quasiexperimental because schools were not randomly assigned to intervention or control condition.[16] Randomization was not possible because of the interests of the initial participating schools in rapidly receiving intervention materials (control schools received materials later). There were 2 additional control schools; 1 was added to provide baseline data on students who later attended a middle school (in another intervention project), and a potential intervention school (which also included a middle school) was dropped before the intervention began.

Intervention and control schools were well matched in average school enrollment, percentage of students receiving free/reduced-cost lunches, percentage of students who were African American, and reading and math achievement scores (letter, L. F. Howe, director, Department of Research and Evaluation, Department of Education, Baltimore, 1993). The median household income of the ZIP code areas where the schools are located averaged $22,708 among intervention schools and $22,651 among control schools according to 1990 US Census data. This median was lower than that for all households in the United States ($33,952).[17] The nutrition content of the school lunch offerings in intervention and control schools, as indicated on lunch menus, was similar in the percentage of energy from fat, percentage of energy from saturated fat, and offerings of fruits and vegetables per day.

The classroom-based interdisciplinary interventions were implemented when students were in grades 4 and 5. All students at the intervention schools in grade 4 in 1995-1996 and grade 5 in 1996-1997 were exposed to the intervention. Children who completed both grades 4 and 5 in an intervention school received 2 school years of intervention. Control schools received the usual health education materials and none of the Eat Well and Keep Moving materials.

Outcome impact was estimated based on longitudinal analyses of individuals in intervention and control schools (1995 and 1997), as well as analysis of repeated cross-sectional surveys of all grade 5 students in intervention and control schools (1995, 1996, and 1997). Students in the longitudinal sample in 1997 were also in the 1997 cross-sectional sample. Because cross-sectional surveys included both students evaluated in the longitudinal sample and those not evaluated (eg, students new to school), analyses of change using these data provide another estimate of impact.

Subject selection

The same procedures were followed each year in collecting data from students. Informed consent forms were sent home with students to parents or guardians, who had the option to sign and return a form if they did not want their child to participate in data collection. The study was approved by the Committee on Human Subjects at the

Longitudinal survey data were collected from eligible students in grade 4 in fall 1995 and from students in grade 5 in spring 1997. A stratified random subsample of 336 students in grade 5 (stratified by intervention status, school, and sex) completed the repeated 24-hour recall interviews in spring 1997, following the intervention. Students with baseline survey data in 1995 and 24-hour recall data in 1997 make up the primary longitudinal cohort for estimation of intervention impact on dietary intake and physical activity (n=336). In addition, students with complete baseline and follow-up survey data make up a larger cohort for estimation of impact of the intervention on dietary intake and physical activity using food frequency and activity survey measures. A smaller sample of 24-hour recall data was collected to minimize costs.

Repeated cross-sectional survey data were collected for all grade 5 students in fall 1995, fall 1996, and spring 1997 (n=2103).

Eat well and keep moving intervention

Theoretical Framework

The Eat Well and Keep Moving Program was developed assuming the importance of both individual and school-level change theories, as described in a related article (L.W.Y.C., S.L.G., G.A.C., et al, unpublished data, 1995-1997). The classroom-based intervention materials were developed to provide a low-cost and sustainable intervention that could improve the diet and physical activity of students. We assumed that well-implemented and sustainable programs must fit with goals and financial constraints of schools and the perspectives of school system administrators, principals, teachers, parents, students, and other community members. A key strategy employed in the Eat Well and Keep Moving Program was to integrate the intervention into existing school structures and curricula via an interdisciplinary approach using classroom teachers. Materials were developed that fit into math, science, language arts, and social studies classes and provided links to the school food service and physical education activities.

To ensure that materials fit well with the school system and population, we employed a social marketing approach, which emphasizes multiple channels of communication and intensive formative research,[18] including focus group interviews with students and interviews with principals, system administrators, lead teachers, and classroom teachers.

The intervention focused on 4 behavioral changes: decreasing consumption of foods high in total and saturated fat, increasing consumption of fruits and vegetables to 5 a day or more, reducing television viewing to less than 2 hours per day,[19] and increasing moderate and vigorous physical activity.

We developed classroom-based materials grounded in social cognitive theory; prior school-based interventions based on social cognitive theory have shown modest effectiveness.[20-22] These materials help enhance cognitive and behavioral skills by enabling students to make changes in their own behavior, develop skills that strengthen perceived competence in employing new behaviors effectively, and provide support for these behaviors.[23] While the primary outcome was behavioral change, we also focused on the intermediate goal of increasing student knowledge of healthy diet and activity choices.

Intervention components also relied on recent research in behavioral choice theory that suggests that altering access to one set of behaviors can influence substitute behaviors, even if substitute behaviors are never directly

enhanced by decreasing access to sedentary activities, such as television viewing, and increasing access to vigorous activity,[26] with similar findings for eating behavior.[25]

Classroom-Based Interventions

Interventions were delivered by classroom teachers, integrating units into math, science, language arts, and social studies classes, including links to the school food service, physical education, teacher and other staff member wellness programs, families, and classroom-based campaigns. Details can be found elsewhere (L.W.Y.C., S.L.G., G.A.C, et al, unpublished data, 1995-1997). The lessons were designed to be taught as part of the regular math, science, language arts and social studies curriculum and fit the Maryland state educational standards. Units were implemented during each of 2 school years and consisted of 13 lessons each for grades 4 and 5. In 1997, there were also 5 physical education lessons that focused on nutrition issues, using a "Safe Workout" format. These lessons took place in physical education classes for those schools with physical education (4 of 6 schools). In addition, 3 of the classroom lessons had a physical education theme involving students in movement. Each lesson was designed for use by a classroom teacher during a 50-minute period. Eighteen Eat Well cards were developed to link classrooms and food services, and teachers used the cards to introduce a students to wide variety of different foods, particularly fruits and vegetables. The cards took only a few minutes of class time and were designed to be used on days that school lunch selections included the foods.

To increase opportunities for students to try the recommended behaviors and build links with families and community, Eat Well and Keep Moving Program activities included campaigns that focused on promoting fruits and vegetables ("Get 3-at-School & 5-a-Day"), limiting television viewing time ("MyTV Unplugged"), and increasing walking ("Walking Clubs"). These campaigns were classroom-based, but because they included activities at home, they involved family members. Project activities and information were listed in existing school newspapers that were sent to parents. A coalition was developed, linking parent liaisons at schools with representatives of organizations that provide free or low-cost nutrition and physical activity programs to parents, including the Cooperative Extension Service, Share Our Strength, and the American Cancer Society. Classroom teachers attended 1 day of teacher training and 2 staff wellness meetings each year. Teacher training included hands-on practice using the lessons as well as other wellness topics. Additional materials included Eat Well and Keep Moving Program banners and cups for the "Get 3-at-School & 5-a-Day" contest.

Outcome Measures

Primary End Points—Dietary Intake and Physical Activity. Measures of dietary intake and physical activity in spring 1997 were collected using both repeated 24-hour recalls and a student food and activity survey (FAS). In prior years (1995 and 1996), measures of dietary intake and activity were based on the FAS. The FAS was used at baseline to save resources (the FAS is much less expensive). Because subsequent research has indicated lower validity of the FAS in this age group,[27] we added 24-hour recalls at follow-up to enhance the validity of the study findings. Primary end points included the percentage of total energy from fat, the percentage of total energy from saturated fat, fruit and vegetable servings per day, and the micronutrients concentrated in fruits and vegetables, including vitamin C, folate, and carotene.

Dietary Intake—24-Hour Recalls. Two 24-hour dietary recalls were administered to students by interviewers who had completed a 3-day training session and at least 15 practice interviews before being certified for fieldwork. Recall records were reviewed by project nutritionists before analysis of food and nutrient data. The 20- to 30-

developed in 1996 by the University of Texas Houston Health Sciences Center and the US Department of Agriculture. The dietary software includes standardized prompts and appropriate probes and visuals for food recognition and quantification. Nutrients were calculated using data from the US Department of Agriculture National Nutrient Data Bank, Riversdale, Md. Interviews were scheduled throughout the school week, thus providing recalls for Sunday through Thursday. The two 24-hour recalls were conducted at approximately 2-week intervals in spring 1997. The 24-hour recall method has been shown to be reliable and valid in children as young as grade 3.[28]

Physical Activity—24-Hour Recalls. Recalls of physical activity in the past 24 hours were obtained immediately following the dietary interviews using methods described in detail elsewhere.[29] Students described all physical activity in the preceding 24 hours. Each reported activity was classified as sleep, stand, sit and watch TV, sit and watch videos or play games, walk, or other activity (with activity described and metabolic equivalents [METs] assigned).[30] Time spent in each category was recorded to the nearest minute. Analysis was focused on the variables quantifying the number of hours per day during which movement is vigorous (≥6.0 METs) and hours per day watching television or videos and playing computer games.

Food and Activity Survey. Self-reported measures of dietary intake, television viewing, and physical activity as well as other sociodemographic and behavioral variables were obtained via an optically scannable student FAS. Students completed the FAS in class under the supervision of teachers who participated in 1-hour training sessions prior to the administration of each test. Questions were read aloud by teachers in class.

Youth Food Frequency. Primary dietary outcomes were also assessed using a youth food frequency questionnaire that has been adapted and validated for use in ethnically and socioeconomically diverse populations.[29,31,32] One limitation of this measure is that lower validity estimates have been found for students in grades 4 and 5 compared with those in grades 6 and 7 and adults.[27]

To calculate fruit and vegetable intake, we excluded french-fried potatoes to be consistent with National Cancer Institute nutrition education guidelines.[33] We energy-adjusted micronutrient measures by dividing by total energy intake to produce nutrient density estimates.[34] We excluded observations with extreme values (individuals reporting a total energy intake of less than 2092 kJ/d, or extremely high estimates of other nutrient parameters [top 1%]). These exclusions reduced the longitudinal sample with FAS data by 7%, to 479 students.

We estimated the relationship between dietary intake measures based on the youth food frequency questionnaire and repeated 24-hour recalls in 1997, and we calculated deattenuated[35] correlations for total daily energy intake (r=0.46), the percentage of energy from fat (r=0.35), the percentage of energy from saturated fat (r=0.43), fruit and vegetable servings per day (r=0.29), and carotene (r=0.24), folate (r=0.28), and vitamin C (r=0.30) intake. These estimates are similar to those found in an earlier validation study of students in grades 4 and 5 in Baltimore.[27]

Television and Video. Hours spent watching television and and video/computer games in 1996 and 1997 were assessed with an 11-item measure; television and video use in 1995 was measured using a 4-item scale.[36] We estimated the relationship between the 11-item measure and repeated 24-hour recalls in 1997 and calculated a deattenuated[35] correlation for hours of television viewing per day (r=0.27).

month. The YAQ was adapted from a validated measure for adults.[37,38] Among a multiethnic sample of adolescents, a YAQ activity score of vigorous activity was correlated with mean times engaging in vigorous activity for at least 20 minutes (r=0.63; A. E. Field, G.A.C., M.K.F., and K.E.P., unpublished data, Boston, Mass, 1996). We estimated the relationship between the YAQ and repeated 24-hour recalls in 1997 and calculated a deattenuated[35] correlation for hours of strenuous activity (≥6.0 METs) per day (r=0.42).

Other Variables.*Dietary and Physical Activity Knowledge.* Scales measured students' knowledge of healthy food and activity choices, using prior items[22] as well as new questions focused on fruit and vegetable consumption and television viewing, with both exhibiting good internal consistency[39] (r=0.79 and r=0.78, respectively).

Sociodemographic Variables. Ethnic categorizations were based on student responses to a question asking them to mark all that apply: "How do you describe yourself? White, Black, Hispanic, Asian or Pacific Islander, American Indian or Alaskan Native, Other." Students who checked *black* were classified as African American.

Program Implementation. Classroom interventions were monitored via surveys of teachers after classroom lessons were implemented, a method that has been validated with classroom observations.[40] In fall 1995, 71% of teachers in the intervention schools returned evaluation forms; in spring 1996, 81% returned evaluations.

Statistical analysis

All analyses were conducted using an intention-to-treat protocol that analyzed participants in their baseline condition (intervention or matched control school), without regard to the number of intervention sessions attended.[41] The intervention materials were generally provided in classes within schools and included homework that involved other household members.

Analyses of primary outcomes in the 1995-1997 longitudinal sample account for clustering of observations within schools by using SUDAAN software (SPSS Inc, Chicago, Ill), with schools nested within condition.[42] Clustering of observations within schools does not bias estimates of coefficients and odds ratios but can affect P values and confidence intervals (CIs). In regression models, the dependent variable was the subject's response at follow-up, with the baseline value as a covariate. Other covariates included intervention (vs control) and other variables associated with diet and activity, including sex, African American ethnicity, and baseline total energy intake.

We also tested whether the addition of other potentially important covariates to the regressions altered results, including baseline dietary and activity knowledge, having been held back in school, mobility, number of adults in the household, frequency of sit-down dinners, whether both parents live with the child, number of children living at home, and how often the mother and father exercised; the results were unchanged.

A recent school-based intervention that focused on fruit and vegetable consumption also used 24-hour recall data.[43] Schools were the unit of intervention, and outcome analyses were conducted using mixed-model regression procedures, with schools included as a random effect nested within condition, employing SAS PROC MIXED software.[44,45] We reestimated the final regressions using this approach; the results were unchanged.

Analysis of primary outcomes in the repeated cross-sectional surveys focused on change in mean values in intervention vs control school students in grade 5 at each occasion, controlling for clustering using SUDAAN software. In these analyses of covariance, the dependent variable was the outcome measure in grade 5 (measured

postintervention (1997) compared with change in control schools. Any subject with at least one grade 5 measure was used in the analysis, including subjects in the longitudinal sample.

For analysis of 24-hour recall data, the mean intakes of nutrients and fruits and vegetables across the two 24-hour recalls were computed for each individual. We energy-adjusted daily nutrient and fruit and vegetable measures by dividing by total energy intake, so nutrients are expressed per 4184 kJ. In estimating intervention impact, we also included total energy intake at baseline as a covariate in regressions.[34]

Results

Longitudinal sample

Participation and Follow-up

Survey data were collected at baseline in fall 1995, prior to the initiation of interventions, from 785 students in grade 4 (response rate, 90%). Excluded were students on school lists who were transferred at baseline or who were in special education classes. The response rate was 91% for control and 90% for intervention schools. Major reasons for nonparticipation were absence from school (61% of all nonparticipants) and parent refusal (15%).

Surveys were administered 2 school years later in spring 1997 following intervention implementation. Response rates to the survey among students in grade 5 were 88% (control) and 89% (intervention). Follow-up survey data were obtained for 66% of the baseline sample, including 66% of both the intervention and control subjects. When subjects were excluded because of extreme dietary measures, the overall response rate with complete predata and postdata was 61% (60% of intervention and 61% of control schools). A comparison of cohort subjects with complete data in both 1995 and 1997 and those who were not followed up indicated some differences among groups (**Table 1**). There was a higher rate of not being in the same school in the preceding year in the longitudinal cohort vs students lost to follow-up (90% and 88% of the intervention and control subjects, respectively, in the cohort vs 79% and 80% of those lost to follow-up), a higher percentage of female students, and differences in dietary knowledge and practices. Among subjects in the longitudinal cohort (n=479), intervention and control subjects were very similar on baseline variables (**Table 1**). The 24-hour recall random subsample subjects were also similar in the intervention and control conditions and similar to the overall longitudinal cohort.

Table 1.

Baseline Characteristics of a Longitudinal Cohort Sample of Fourth Grade Students in Fall 1995, With Complete Data, Random Subsample Data, and Data for Subjects Not Followed Up in Spring 1997 at Intervention (I) and Control (C) Schools*

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Baseline Characteristics of a Longitudinal Cohort Sample of Fourth Grade Students in Fall 1995, With Complete Data, Random Subsample Data, and Data for Subjects Not Followed Up in Spring 1997 at Intervention (I) and Control (C) Schools*

Survey data collected from teachers indicated that, on average, 22 (71%) of the possible total of 31 nutrition and physical activity lessons were completed during the intervention. Teachers and students liked the lessons, with 95% of responding teachers rating the lessons "effective" and 65% of students reporting that they "liked" the lessons. Participation in promotions included 73% of students in the "MyTV Unplugged" program, 80% in the "Get 3-at-School & 5-a-Day" program, and 57% in the walking program. Three quarters of the Eat Well and Keep Moving cards were used by teachers during the second intervention year, and 97% said they would use the cards again.

Analysis of student knowledge concerning healthy diet and activity choices indicated that, after controlling for baseline measures, dietary knowledge was increased in students in intervention schools relative to controls (1.4 scale points; 95% CI, 0.1-2.6; *P*=.05), with a similar impact on knowledge of healthy activities (0.7 scale points; 95% CI, 0.2-1.2; *P*=.02). This change in knowledge scales represents a moderate effect size (SD, 0.4-0.3).[46]

Impact on Dietary Intake and Physical Activity

Analysis of repeated 24-hour recall data in spring 1997 indicated that, after controlling for baseline measures, the percentage of total energy from fat was reduced in students in the intervention schools relative to control schools (–1.4%; 95% CI, –2.8 to –0.04; *P*=.04) (**Table 2**). Similarly, the percentage of total energy from saturated fat was reduced (–0.60%; 95% CI, –1.2 to –0.01; *P*=.05). There was an increase in consumption of fruits and vegetables (0.36 servings per 4184 kJ; 95% CI, 0.10-0.62; *P*=.01). This difference in fruit and vegetable consumption is equivalent to an increase of 0.73 servings per day given a mean total energy intake of 8473 kJ.

Table 2.

Estimated Differences in Daily Dietary Intake Based on Repeated 24-Hour Recalls at Follow-up for Children in Intervention (n = 173) vs Control (n = 163) Schools, Controlling for Baseline Measures*

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Estimated Differences in Daily Dietary Intake Based on Repeated 24-Hour Recalls at Follow-up for Children in Intervention (n = 173) vs Control (n = 163) Schools, Controlling for Baseline Measures*

The 24-hour recall data also indicated an increase in vitamin C intake (8.8 mg per 4184 kJ; 95% CI, 2.1-15.5; *P*=.01). There was a suggestion that hours per day of television and video viewing were reduced, but the difference was not statistically significant (–0.55 h/d; 95% CI, –1.1 to 0.04; *P*=.06). There was no evidence for a difference in vigorous physical activity.

In addition to these primary end points, the 24-hour recall data indicated an increase in fiber consumption (0.70 g per 4184 kJ; 95% CI, 0.0-1.4; *P*=.05) and no change in total energy, vitamin A, calcium, iron, zinc, or sodium intake.

We also used the food frequency measures of dietary intake at baseline and follow-up to estimate intervention impact (**Table 3**). These analyses also indicated reductions in the percentage of total energy from fat (–1.1%; 95%

from saturated fat (−0.43%; 95% CI, −0.84% to 0.05%; *P*=.08), and no increases in vitamin A intake (298 carotene RE per 4184 kJ; 95% CI, −40 to 635; *P*=.08).

Table 3.

Estimated Differences in Daily Dietary Intake Based on Food Frequency Measures and Physical Activity Based on Activity Survey for Children in Intervention vs Control Schools After Controlling for Baseline Measures of Intake*

Go to Figure in Article

Estimated Differences in Daily Dietary Intake Based on Food Frequency Measures and Physical Activity Based on Activity Survey for Children in Intervention vs Control Schools After Controlling for Baseline Measures of Intake*

Repeated cross-sectional surveys

Participation

Response rates to the cross-sectional surveys of grade 5 students in 1995, 1996, and 1997 were 90%, 90%, and 88% of eligible students, respectively, with similar rates for intervention and control schools. Descriptive data on the repeated cross-sectional surveys indicate that the grade 5 samples were similar throughout the 3-year period (data not shown).

Impact on Diet and Physical Activity

Analysis of the repeated cross-sectional surveys (**Table 4**) indicates that there were reductions in the percentage of total energy from fat (−1.1%; 95% CI, −2.0% to −0.15%; *P*=.02) and from saturated fat (−0.49%; 95% CI, −0.94% to −0.04%; *P*=.04) but no statistically significant evidence for a reduction in television viewing (−0.76 h/d; 95% CI, −1.6 to 0.10; *P*=.09). These results indicate that evidence of impact was found among all children surveyed, including those who were not evaluated longitudinally and those who had only been in the schools a short period.

Table 4.

Estimated Differences in Mean Daily Dietary Intake and Mean Physical Activity for Children in Intervention vs Control Schools From Analysis of Repeated Cross-sectional Surveys*

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Estimated Differences in Mean Daily Dietary Intake and Mean Physical Activity for Children in Intervention vs Control Schools From Analysis of Repeated Cross-sectional Surveys*

Comment

Analysis of the repeated 24-hour recall measures indicates that the Eat Well and Keep Moving Program improved dietary intake, with marginal evidence (P=.06) for reducing television viewing time. Reductions were found in the percentage of total energy from fat and saturated fat, and there was evidence for an increase in fruit and vegetable servings and vitamin C and dietary fiber intake.

We also examined evidence for change based on self-administered student surveys of diet and activity, both longitudinally and via repeated cross-sectional samples. These analyses confirmed the reduction in the percentage of energy from total and saturated fat in intervention students. Evidence for change in fruit and vegetable consumption, micronutrients, and television viewing was statistically insignificant using the survey measures, although the sign of the coefficient estimates (positive or negative) was in all cases consistent with the repeated 24-hour recall results.

These changes were in response to implementation of an interdisciplinary classroom-based program with substantial potential for replicability and sustainability because regular classroom teachers integrated the material into math, science, language arts, and social studies classes. The lack of an observed effect of the intervention on increasing vigorous activity may be caused by a number of factors. Both the intervention and control schools had very minimal physical education programs as well as very limited after school programs. In addition, it is likely that safety concerns and lack of community facilities also constrained the impact of the program. In addition, the limited physical education classes meant that one effective approach to increasing physical activity in school, making physical education more active,[22] could not be included in the intervention.

This quasiexperimental study had several limitations. Because students were not randomized to intervention and control conditions, there is the possibility that the intervention and control schools differed in ways that may or may not be measurable. Baseline data indicate, however, that participants in the intervention and control schools were comparable on measured variables. Adjusting for these and other potentially confounding covariates did little to alter the differences observed after the intervention in spring 1997. However, given the nonrandom assignment, we must acknowledge that the observed results could still reflect unmeasured baseline differences, although we have no evidence that this was the case.

Another measurement concern is the limited validity of measures of dietary intake and physical activity based on student reports. We cannot dismiss the possibility that students in intervention schools may have biased their recalls of dietary intake and physical activity as a consequence of the intervention, although we have no evidence to support this hypothesis. However, students did not know on which days 24-hour recalls would be administered, and research has shown that this approach minimizes bias.[47] The imperfect validity of these measures also indicates potential underadjustment for baseline differences between intervention and control schools. In particular, the baseline measures of diet and activity were based on student self-reported food frequency and activity measures, which show only modest correlations with repeated 24-hour recall measures in validation studies. We have focused our discussion of results more on the 24-hour recall measures, because these are currently accepted as the standard in this age group.

These results need to be placed in the context of other school-based studies. Some studies have indicated that interventions can successfully improve the content of school lunches (eg, reduced saturated fat[22] or reduced salt in school menu items)[48] or increase active class time in physical education,[22,49] so that children, without making

and control schools, this evaluation provides evidence for the impact of this health behavior intervention independent of food service offerings. The increases in fruit and vegetable consumption found in this intervention program are similar to those found in a recent, much more comprehensive program in Minnesota that included extensive changes in the food service, working with local food suppliers, and extensive outreach to parents.[43]

The changes observed in the dietary and television variables were modest, and children in the sample still consumed a greater percentage of total energy from fat (34%) and saturated fat (12%) than recommended (30% and 10%, respectively). Similarly, the repeated 24-hour recall evidence of an increase in fruits and vegetable consumption of 0.72 servings per day is also modest, with the average participant still consuming 3.6 servings per day, well below the goal of at least 5 a day (assuming a total daily energy intake of 8368 kJ). The estimated reduction in television viewing of 0.55 hours per day is substantial, but youth participants were still reporting 3.5 hours of television per day, more than the recommended maximum of 2 hours per day.[19] While the changes associated with the Eat Well and Keep Moving Program were modest, these changes may translate into substantial changes at the population level because of changes in the distribution of risk in the population.[50]

Finally, it should be noted that, based on this initial evidence for successful implementation of the Eat Well and Keep Moving Program, Baltimore public school superintendent Walter Amprey in January 1997 recommended that the Eat Well and Keep Moving Program be offered to all elementary schools in the system. As of June 1998, teachers from an additional 50 schools in Baltimore had been trained. These results indicate the feasibility of this interdisciplinary approach in integrating nutrition and physical activity health promotion topics within core subject classes. With an increasing emphasis in urban schools on student performance in core subject areas, experience with the Eat Well and Keep Moving Program in an urban school system indicates the viability of this approach to effectively teaching nutrition and physical activity and motivating primary school students for positive behavioral change.

Conclusions

The Eat Well and Keep Moving Program was effective in improving the dietary intake of students and reducing television viewing. The materials were well liked by teachers and students and fit within existing classroom curricula.

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For information about the intervention materials, visit our Web site: http://www.childhealth.harvard.com.

Editor's Note: The subtitle of this study might bring hope to those who "eat on the run." WRONG! Read the study.
—Catherine D. DeAngelis, MD

Reprints: Steven L. Gortmaker, PhD, Eat Well and Keep Moving, Harvard Center for Children's Health, Harvard School of Public Health, 677 Huntington Ave, Boston, MA 02115.

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