Reducing Elementary School Children's Risks for Chronic Diseases through School Lunch Modifications, Nutrition Education, and Physical Activity Interventions

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ABSTRACT Many behaviors, such as physical inactivity or a poor diet, that put adults at risk for chronic diseases are established in childhood. This manuscript describes the outcomes of a comprehensive school health project, the Kansas LEAN School Intervention Project. The Kansas LEAN School Intervention Project in Salina and Dighton had four components, three of which were school based: (a) modified school lunches, (b) enhanced nutrition education, and (c) increased opportunities for physical activity. The fourth component, actions taken by a community partnership, is described elsewhere. Data from two case studies were used to address three primary evaluation questions: (a) did changes in the school lunch menu reduce the fat content yet maintain calories in meals served? (b) did nutrition knowledge, skills, and attitudes of students improve? and (c) did students' physical fitness improve? The findings suggest that the project was successful in reducing the fat content in school lunches in both communities from baseline levels of approximately 38% calories from fat to the target goal of 30% calories from fat during the 1993–94 school year. The schools also maintained adequate calories for students in this age group. Students' knowledge, skills, and behaviors related to nutrition as well as their physical fitness improved in both Kansas communities. The strengths and limitations of this strategy of making healthy choices easy choices through school-based intervention are discussed.

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Work was conducted in the Kansas communities of Salina and Dighton in conjunction with Unified School Districts 305 and 482.

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INTRODUCTION

Heart disease is the leading cause of death in the United States.[1] Poor diets and physical inactivity, which are risk factors for cardiovascular diseases, are established early in life.[2–4] Research suggests that approximately 50% of children have at least one modifiable risk factor for coronary heart disease by age 12.[5] Schools are an important channel for prevention programs. Approximately 60% of school children in the U.S. participate in school lunch programs and these students receive more than one-third of the Recommended Dietary Allowances for food energy and key nutrients at school.[6] Schools also have the capacity to disseminate nutrition education and promote physical activity, reaching large numbers of children.

Several school- and community-based health initiatives have successfully reduced risk factors for chronic diseases among youth. These have used a variety of strategies, including modifying school lunches,[7–10] increasing physical activity,[9–12] providing nutrition education,[13–15] and implementing mass media campaigns.[14,16,17] Few studies, however, have examined the impact of multiple components of a school intervention within the context of a community partnership to reduce risks for chronic diseases.

This paper describes the evaluation of three components of a comprehensive school health intervention designed to change the environment to affect health-related behavior and outcome by (1) modifying school lunches, (2) enhancing nutrition education, and (3) increasing opportunities for physical activity. Community changes introduced by establishing a community partnership to support the changes are described elsewhere.[18] First, we describe the context and collaborators of the project. Second, we describe the major components of the Kansas LEAN School Intervention Project. Third, we describe the measurement system and results for the key evaluation questions. Last, we discuss the challenges and opportunities of designing and evaluating comprehensive school interventions.

METHODS

Kansas LEAN,[19] a program of the Kansas Department of Health and Environment, Bureau of Chronic Disease and Health Promotion and the Kansas Health Foundation, designed and facilitated the implementation of the Kansas LEAN School Intervention Project. The Kansas Health Foundation provided funding over 2 years to design and pilot test the project. The Kansas LEAN Director, a registered dietitian, provided project oversight and direction. Two registered dietitians worked on site for approximately 20 to 30 hours per week assisting foodservice staff, classroom teachers, and physical education (PE) teachers in conducting nutritional analysis of menus, modifying menus, implementing enhanced nutrition education in classrooms, and enhancing fitness activities. The Work Group on Health Promotion and Community Development at the University of Kansas (KU Work Group) provided technical assistance and evaluated the project.

Communities and schools. The communities of Salina and Dighton, and their respective school districts, agreed to implement the program. The two communities were selected to represent two different-sized communities and school districts in Kansas. Salina (population 42,300) is relatively urban with over 6000 students and 15 schools in the district. Cooks prepared school meals for the district in four centralized kitchens. By contrast, Dighton (population 1400) is a rural, geographically isolated community with an economy based on farming and ranching. The school district served 400 students and meals were prepared at one central kitchen. In Salina, all 4th graders in one elementary school (N = 74) received the intervention; 4th-grade students (N = 62) in two other schools in Salina served as a comparison group. In Dighton, all 5th graders (N = 34) participated in the intervention. Since there was only one elementary school in Dighton, a comparison group of 5th graders was not available. PE teachers in both schools, 4th-grade teachers in Salina, and 5th-grade teachers in Dighton agreed to participate in designing and implementing the project.

School-based components. Table 1 outlines the three school-based components implemented by each community. The implementation of each component varied between the two communities and is briefly described below.

Table 1. School-based components and elements of the Kansas LEAN School Intervention Project to reduce children's risks for chronic diseases.

Components	*Elements*
Modify school lunch	(a) Recording nutritional content of menu items (e.g., measuring or weighing and recording ingredients) (b) Determining nutritional content of products (e.g., requesting dietary information from food vendors) (c) Receiving feedback (before and after modifications) on the percent calories from fat and calories in menu items and menu combinations (d) Modifying food preparation techniques (e.g., rinsing cooked ground beef in hot water before serving) (e) Modifying recipe ingredients (e.g., substituting nonfat yogurt for mayonnaise in salads, dips, dressings, and tartar sauce) (f) Modifying products ordered from vendors (e.g., lower fat fish sticks) (g) Changing menu combinations to reduce percent calories from fat in overall weekly menus (h) Locating or assisting vendors to develop new products (e.g., developing products with a higher percentage of wheat flour)
Provide nutrition education	(a) Assisting teachers and administrators to integrate the American Cancer Society's Changing the Course (CTC) into health units or core subjects (e.g., math, English) (b) Providing training for teachers on nutrition and using CTC (CTC included individual worksheets, food tasting, small-group activities, field trips, and class discussion) (c) Arranging for coordinators, community volunteers, or foodservice employees to serve as role models and provide general assistance (d) Facilitating field trips and special activities (e.g., supermarket tours, lunch at McDonald's) (e) Providing incentives for teachers to implement the curriculum (e.g., $100 for classroom materials)
Increase physical activity	(a) Installing physical fitness stations in each classroom, which consisted of individual workbooks (e.g., readings on fitness, songs about nutrition) and optional physical fitness activities (e.g., stretching, sitting, and reaching) (b) Initiating a noncompetitive incentive system based on students' personal goals (e.g., students earned class parties for using the fitness stations) (c) Training of PE teachers in how to increase the amount of time students engaged in cardiovascular fitness activities (d) Providing lesson plans for PE teachers with enhanced variety and intensity of physical activity (e.g., games, music, and dance)

School lunch. Changing school lunches to reduce dietary fat while maintaining both adequate calories and food acceptability was one of the primary goals of this project. The director of Kansas LEAN and two on-site coordinators provided training, technical assistance, and direct support to foodservice professionals in the school districts. Coordinators used workshops, one-on-one training, coaching, and modeling to train foodservice workers. The training was informal and collaborative, and changes were made gradually as foodservice staff became comfortable with new food preparation techniques and products. Foodservice staff made many recommendations that were incorporated into routine kitchen practices. To maintain acceptability of the new foods served, potential food products and recipes were evaluated with food tasting panels consisting of students, parents, foodservice staff, and teachers.

The foodservice programs in Salina and Dighton differed in size, location, and experience of foodservice professionals. Assistance provided to the two programs differed to respond to the unique challenges and opportunities in each community. For example, training in Dighton focused on food preparation techniques to lower fat because nearly all menu items were prepared from scratch. By contrast, food served in the Salina district was purchased frozen from vendors, prepared in central kitchens, and delivered to school cafeterias. Accordingly, training in Salina focused on ordering from vendors and locating or assisting vendors in the development of new products.

Nutrition education. Project coordinators collaborated with elementary school teachers and school administrators to implement the American Cancer Society's (ACS) nutrition education program, *Changing the Course* (CTC).[20] The goals of the curriculum were for students to eat a variety of fruits and vegetables, more high-fiber foods, and fewer higher fat foods. The curriculum focused on teaching healthy food choices, rather than labeling foods as "good" or "bad." The curriculum was behaviorally oriented and activity based. The ACS provided teachers with the CTC Upper Elementary curriculum and teachers' handbooks.

Physical activity. Each community enhanced opportunities for physical activity by installing classroom fitness stations and modifying PE classes to increase the proportion of time spent on cardiovascular fitness activities.

Evaluating the school-based components of the partnerships. Evaluators and project staff designed the evaluation system to examine outcomes of the project and to facilitate continuous improvement of the project's efforts. There were several key evaluation questions of interest to the staff and leadership of the community partnerships. Questions related to the school components included (a) did changes in the school lunch menu reduce the fat content and calories in foods served? (b) did nutrition knowledge, skills, and attitudes of students improve? and (c) did the physical fitness of students improve? To address these key questions, the evaluation system used three measurement instruments: (a) menu analysis, (b) a review of foodservice records, and (c) student surveys on nutrition and fitness. In addition, evaluators used a measure of community change[21] to track implementation of innovations in nutrition education, school lunch, and PE; community change data are reported elsewhere.[18] The measures, methods for data collection, feedback systems, and statistical analysis are described in the sections below.

Menu analysis. School foodservice menus were analyzed using Nutritionist IV,[22] a computerized menu analysis program that used an extensive database of nutrients for specified foods. Menus were analyzed in several stages: (1) local foodservice employees recorded foods included in each recipe by weighing or measuring quantities, (2) the dietitian entering the data contacted local foodservice employees to clarify quantity or ingredient information, as necessary, (3) foods for each recipe were entered into Nutritionist IV, (4) printouts of the nutrients for each recipe and menu combinations were sent back to foodservice employees, (5) foodservice employees modified the menus to reduce dietary fat and maintain calories, and (6) steps 1 and 5 were repeated until percent of calories from fat and total fat were within target. Prepared products were entered into the database using manufacturers' nutritional analysis data. A registered dietitian conducted an analysis of recipes and menus for all menu combinations during baseline (3 months in Dighton and 5 months in Salina) and after menu changes (7 months in Dighton and 8 months in Salina).

Review of foodservice records. Archival records were reviewed, including school attendance, meals served in the lunch program, food costs, and personnel expenses. Where possible, data from the records were used to calculate the cost and percentage of students participating in the school lunch program.

Student surveys. Surveys were used to assess students' knowledge, skills, and attitudes related to nutrition and students' physical fitness. Surveys were administered to students before and after the intervention was implemented. Paper and pencil assessments developed to accompany the CTC Lower (66-item) and Upper Elementary (53-item) curricula were used to assess the effectiveness of the nutrition education curriculum in Salina (Lower) and Dighton (Upper). Teachers administered the assessments, which took about 45 minutes to complete, during school hours. The assessment included items related to knowledge (e.g., "It is a good idea to eat a variety of foods each day"), skills (e.g., "Identify high-fat foods"), and attitudes (e.g., "All people like the same foods"). A formative evaluation of the CTC curriculum[23] reported that the test items were written at age-appropriate levels and that teachers were highly satisfied with the curriculum. Researchers who conducted this evaluation also used a review of experts to establish that the assessment had high content validity and calculated Cronbach's alpha reliability

coefficients, which were .79 and .92 on the upper and lower upper elementary assessment, respectively.[20]

The Amateur Athletic Union (AAU) physical fitness assessment[24] was used to assess the impact of increased opportunities for physical activity on students' fitness. Project staff and a fitness expert trained the PE teachers to administer the assessment, a behavioral observation designed to measure students' strength, muscular endurance, circulorespiratory endurance, and flexibility. Students demonstrated their fitness in five required events (such as pull-ups and endurance runs) and six to seven optional events (such as long jumps and sprints). Students' performance levels were categorized based on age and national AAU fitness standards.[24] Attainment and Outstanding levels from the AAU corresponded to the 45th and 80th percentiles of sample scores.

Feedback. The intervention model called for regular reports on all key measures, including (a) menu analyses; (b) students' nutrition knowledge, skills, and attitudes; and (c) students' fitness. Regular feedback on menu revisions was delayed until late in the project because of the amount of training involved in getting the menu reporting and data entry systems in place. Students' levels of nutrition knowledge, skills, and attitudes as well as fitness were graphed and fed back to project staff after assessments were administered.

Design and statistical analysis. An interrupted time-series analysis[25] was used to analyze data on nutritional content of menus over time in Dighton and Salina. Individual level data on students' knowledge of nutrition and levels of physical fitness were assessed using pretest–post-test group designs[25] with a comparison school in Salina and replications of findings in Dighton. Statistical tests, performed using SPSS for Windows,[26] were used to conduct statistical analysis of individual level data. A two-tailed dependent t-test[27] was used to examine the differences before and after the intervention was implemented for (a) nutrition knowledge in Dighton and (b) a fitness indicator in Salina. Effect sizes were analyzed using the d statistic.[28] The McNemar Change Test[29] was used to test differences in fitness scores in Dighton. An f ratio[28] was used to analyze differences in nutrition knowledge between students who received the intervention and those who did not. An R^2 proportion was used to measure the strength of association between the variables.

RESULTS

This section describes the findings organized under several key evaluation questions about the school-based components of the partnerships.

Did changes in the school lunch menu reduce the fat content and maintain calories in foods served? After the intervention was implemented, the fat content of school lunches was reduced to target levels while maintaining or increasing total calories in both sites. Figure 1 shows daily averages of calories and percent calories from fat in the school lunch menus served during the 1993–94 school year and percent calories from fat during baseline for the project in Dighton. Baseline levels of percent calories from fat were calculated using menu data from the first 3 months of the grant period (October–December 1992). Mean percent calories from fat fell from baseline levels of 40% to the target level of 30% during the 1993–94 school year. After menu modifications, total calories ranged from 767 kcal to 830 kcal, which is above the target level of 750 kcal.

Figure 2 shows trends in average daily caloric and fat content of the Salina school lunch program. Mean percent calories from fat decreased from baseline levels of 38% to the target level of 30% after menus were modified. Mean calories per month increased from baseline levels of 738 kcal to 821 kcal in the second year of the project.

Reviews of foodservice records showed that participation in the school lunch program remained relatively constant in the two communities as the menus changed. The accounting system in Salina did not separate expenses in a way that allowed researchers to calculate the cost per meal. Data on the cost of the lunch program were available for Dighton and showed that the cost increased less than 5%. This may be due to economic inflation and an increased number of portions consumed by each student (e.g., more students going back for "seconds"), and not to higher costs of lower fat menus.

Did nutrition knowledge, skills, and attitudes of students improve? The percentage of youth who answered the nutrition knowledge, skills, and attitude questions correctly or favorably increased significantly from pretest to post-test in Dighton. In Salina, intervention students' scores were significantly higher when compared to students who did not receive the curriculum in Salina. In Dighton, intervention students' performance on the Upper Elementary Assessment increased from pretest (71%) to post-test (84%), and the increase was maintained at a 1-year follow-up (83%). Changes from pretest to post-test were statistically significant

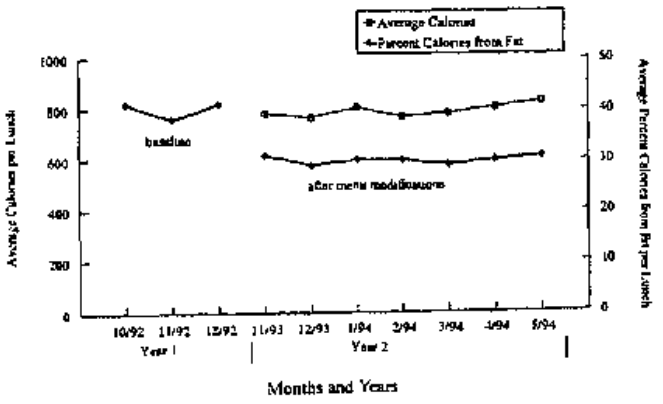

Figure 1. Trends in fat and calorie content in school lunches for Dighton

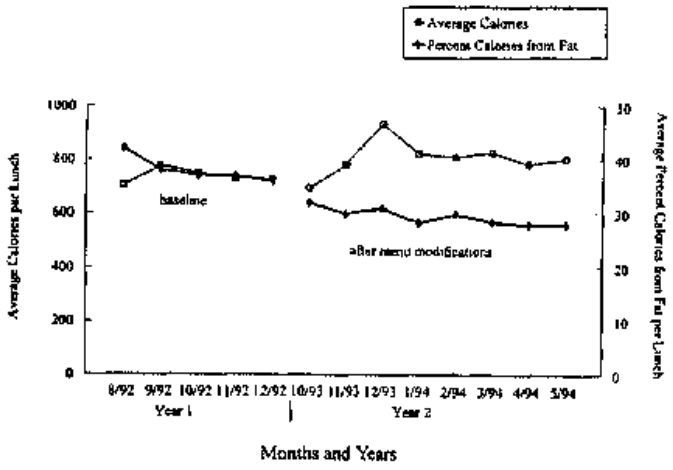

Figure 2. Trends in fat and calorie content in school lunches for Salina.

($t[33] = -6.64, p < .0001$) with a very large effect size (d statistic = 6.9). These findings were replicated with 5th graders receiving the same curriculum in the following year; their knowledge increased from pretest (68%) to post-test (83%). In addition, the lower performance scores (66%) of 5th graders (who had not received the curriculum) at the end of the previous year suggested that the findings were due to the curriculum rather than maturation.

Fourth-grade students who received nutrition education in Salina scored higher at post-test on the Lower Elementary Assessment (82%) than students who did not receive the enhanced nutrition education (74% and 72%). Difference between these scores is statistically significant ($F[2,133] = 20.179, p < .0001$) with a large proportion of variability due to differences between groups ($R^2 = .2328$).

Did youth physical fitness improve? Analysis of the fitness data suggests that fitness levels of the intervention students increased from pretest to post-test and, in Salina, intervention students were more fit than similar students who did not participate in the project. The percentage of Dighton students experiencing the intervention who performed at or above the AAU Fitness Attainment level increased from pretest (18%) to post-test (29%). These differences, however, were not statistically significant ($p = .29$). The small number of intervention students may not have provided enough power to detect any potential statistical significance.

The AAU Fitness Assessment was modified slightly in Salina. In the "Endurance Run" event, students ran 1 mile rather than the standard 3/4 of a mile. Overall performance awards, therefore, could not be determined for students in Salina. The endurance run event was selected for analysis because it is a measure of circulorespiratory endurance and is the event that is most closely linked to reduced risks for cardiovascular diseases. In Salina, compared to same-grade students in comparison schools, intervention students showed a larger reduction in the amount of time taken to complete the mile run from pretest to post-test. Girls in the intervention group reduced their average time by 1.21 minutes while girls in the comparison group reduced their average time by only 0.32 minutes. Boys in the intervention group reduced their average time by 1.76 minutes while boys in the comparison group reduced their average time by 0.64 minutes. The differences between comparison and intervention students' performance changes from pretest to post-test were statistically significant for both girls ($t[48] = 2.60, p = .012$) and boys ($t[59] = 2.19, p = .033$).

DISCUSSION

This manuscript describes two case studies of the school-based components of the Kansas LEAN School Health Project. The results suggest that the projects in Salina and Dighton facilitated important changes in the school to reduce youth risks for chronic diseases. Each community facilitated changes of the school lunch menus, including adopting new food products, revising recipes, and developing new menus. These changes resulted in reduced fat and maintained calories in school lunch menus without negatively influencing costs or participation. Further, nutrition knowledge, skills, and attitudes as well as physical fitness improved among participating students in both schools.

There were several challenges to evaluating the school-based components of these partnerships. First, without randomized control groups, conclusions about the strength of the intervention's effects are limited. Other events, such as the national interest in diet and exercise, could have contributed to the effects. However, attempts were made to control for such confounding variables, such as using comparison schools in Salina and comparison groups in Dighton, for the nutrition education and fitness assessments. No data from control or comparison groups were available for changes in the school lunches. Although comparison groups would have helped rule out other possible explanations of the observed effects, establishing a control group was not seen as feasible given the complexity of conducting nutrient analysis.

Second, a strength of the AAU Physical Fitness Assessment is the reliance on direct observation of students' fitness rather than self-reports. However, one drawback is that students may not consistently perform to the best of their ability and single assessments may not accurately assess their fitness. The assessment is time consuming, prohibiting multiple administration in this community demonstration.

Third, this study assessed changes in students' knowledge, skills, and behavior related to nutrition using assessments developed and tested by other researchers. Since the assessments were not pilot tested locally, our understanding of the findings may be limited. In addition, to maintain consistency across multiple testing of the intervention students in Salina, the Lower Elementary assessment was used to assess 4th graders, who were beyond the recommended age range for this assessment.

Fourth, the accuracy of the nutritional analysis was not systematically verified by laboratory studies. Further, the measurement system was intentionally reactive: documenting the fat content of foods served was intended to draw attention to the foods' nutritional content and prompt kitchen staff to modify menus. In addition, as a result of multiple computer-related problems, summarized nutrition information was not available to project staff until after the project was completed; foodservice staff made menu and recipe revisions without complete and ongoing information on the fat content of menus. Overall, however, nutrient analysis data collected over a 2-year period strongly suggest that the project successfully met its goals for revisions in school lunches. Finally, data on the actual consumption of school lunches are not available. Plate waste studies were attempted but abandoned due to large variability in consumption and a lack of staff time and resources to conduct frequent plate waste studies. However, taste testing and sampling were conducted with students and foodservice staff to help assess the palatability and the likelihood of consumption of the school lunches.

Despite these limitations, the findings from this multiple case study contribute substantially to our understanding of nutrition education, physical activity opportunities, and changes in foods served during school lunch to reduce children's risks for chronic diseases. The data suggest that the major components of the intervention were implemented, and positive changes in nutrition knowledge and physical fitness were found among participants. Further, increasing opportunities for healthier school lunches increases the likelihood that children might consume fewer calories from fat when in school.

Future research is warranted to extend understanding about and improve methods for reducing children's risks for chronic diseases. First, future research should attempt to identify comparison communities. Second, future research should attempt multiple assessments of physical fitness and food consumption. The Kansas LEAN School Intervention Project is being replicated in six communities in Kansas. These applications of the school and community components should help to extend our understanding of the strengths and challenges of such interventions that have the mission of reducing risks for chronic diseases among children.

The overarching strategy of the Kansas LEAN School Intervention Project is to change the environmental context for children's health-related behaviors. By modifying school lunches, the opportunities for selecting (and potentially eating) lower fat foods is enhanced. By enhancing students' knowledge and skills through behaviorally based nutrition education, selections of healthy food choices may be improved. By increasing opportunities for school-linked physical activity, children are more likely to engage in those behaviors associated with fitness. Rather than blame children (or their parents or teachers) for engaging in health risks, this approach demonstrates how environmental changes may improve health behavior. In so doing, it illustrates a fundamental tenant of public health: make healthy choices easy choices.

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