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The CHANGE study: A healthy-lifestyles intervention to improve rural children's diet quality

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Abstract

Background—Despite the high rates of overweight and obesity among rural children, there have been limited interventions reported to improve the diet quality of rural, low-income children in the United States.

Objective—To evaluate student's diet quality at baseline and after implementing the CHANGE (Creating Healthy, Active and Nurturing Growing-up Environments) study, a two-year (2007-2009) randomized, controlled, community- and school-based intervention to prevent unhealthy weight gain among rural school-aged children.

Design—School and community-based group randomized controlled design.

Participants/setting—Data were collected in eight rural communities in California, Kentucky, Mississippi, and South Carolina (one elementary school per community). Children in grades 1-6 participated in the study (n= 432; mean age = 8.65 years \pm 1.6 years). Students' diets were

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assessed at baseline (spring or early fall 2008) and post-intervention (spring 2009) using the Block Food Screener for ages 2–17 years.

Statistical Analyses—Mixed-model analysis of variance was used to examine the effect of the CHANGE study intervention on students' diets. Results were adjusted for corresponding baseline dietary values, sex, age, grade, race/ethnicity, and state, with school included as a random effect nested within condition.

Results—At the end of one year, students enrolled in the CHANGE study intervention schools consumed significantly more vegetables (0.08 cups/1000 kcal per day; $p=0.03$) and combined fruits and vegetables (0.22 cups/1000 kcal per day; $P<0.05$) compared to students in control schools. Students in the intervention schools also showed a reduction in the average daily dietary glycemic index ($GI=-1.22$; $P<0.05$) and a trend toward more fruit consumption (0.15 cups/1000 kcal per day; $P=0.07$). There were no significant differences in students' consumption of whole grains, legumes, dairy, potatoes/potato products, saturated fat, added sugars, or dietary fiber consumption.

Conclusions—The CHANGE study enhanced some aspects of rural students' dietary intake. Implementing similar interventions in rural America may be promising to support vegetable consumption.

Keywords

Children; Rural; Diet; Vulnerable populations; Healthy lifestyle behaviors

In the United States, children typically have inadequate intakes of fruits, vegetables, and whole grains, and have excessive intakes of added sugars and solid fats, which runs counter to the Dietary Guidelines for Americans' recommendations (1-4). In addition to providing important nutrients, consuming a healthy diet reduces the risk of overweight and diabetes (5-9). Childhood is an important time to establish healthy eating behaviors, which can impact diet and the risk of chronic diseases in adulthood (10-13).

Interventions have focused on schools to improve the diets of students and/or reduce the risk of overweight and obesity of children, but the available evidence shows mixed success. The Coordinated Approach to Child Health (CATCH) study¹, an intervention that included classroom, physical education, cafeteria, and family components to improve several aspects of urban elementary children's diets, found significant reductions in saturated fat consumption among the intervention group at the end of two years (14). The Teens Eating for Energy and Nutrition at Schools (TEENS) study in Minnesota, which had school and family components to increase fruit and vegetable consumption and reduce fat intake among adolescents in a metropolitan area, did not report significant changes at the end of two years (15). A smaller, cafeteria-based study in Boston found that students selected and consumed healthier foods, particularly whole grains and vegetables, when the palatability was enhanced by engaging a professional chef (16). The Shape Up Somerville (SUS) study in the greater Boston area implemented a multi-faceted intervention before-, during-, and after school, including a significant school food component, as well as in the homes and in the larger community in an urban setting. SUS documented a reduction in the BMI z-scores of the students exposed to the intervention compared with students in matched-control schools at the end of two years (17,18).

However, interventions targeting low-income, rural areas have been limited despite children in these areas having a disproportionately higher risk for overweight and obesity and less healthy dietary habits compared with their peers in urban and suburban settings (19-21).

¹Formerly the Child and Adolescent Trial for Cardiovascular Health (CATCH)

Those in rural America typically experience greater health disparities compared with those in urban areas, including increased risk of diabetes and coronary heart disease as adults (22). Therefore, effective interventions that improve the diets and overall health of rural children are needed.

To address this lack of attention to a vulnerable population, the Creating Healthy, Active and Nurturing Growing-up Environments (CHANGE) Study was designed with three primary objectives: to improve the diets, physical activity levels, and weight status of rural children based on the successful model developed by SUS (17). The objective of this analysis was to examine changes in fruit, vegetable, legume, whole grain, and low-fat dairy consumption among rural elementary students who were exposed to the CHANGE study intervention compared with students in control schools. Secondary aims were to examine changes in energy from saturated fats, added sugars, fiber, white potatoes/potato products, and glycemic index (GI) among CHANGE and control children. GI, which is a system for classifying carbohydrate-based foods used to examine carbohydrate quality, has been inversely associated with obesity, diabetes, and cardiovascular disease (23).

It was hypothesized that students exposed to the CHANGE study would improve their diet quality compared to the control students because of the healthier food environments.

METHODS

Study Design

The CHANGE study was a two-year randomized, controlled community- and school-based healthy lifestyles intervention designed to improve rural elementary school children's diets, increase their physical activity levels to meet the one hour or more of moderate-to-vigorous activity recommended, limit their screen time to two hours or less per day, and decrease their BMI z-scores. Eight communities in rural areas of California, Kentucky, Mississippi, and South Carolina participated in the study from 2007-2009. Each state had two participating communities that were randomly assigned to intervention or control status. Each community consisted of an entire school district. Each school district had only one elementary school, and all eight elementary schools participated in the study as either control or intervention schools. Formative research was conducted to adapt the successful SUS model to a rural setting, which resulted in focusing on certain systems within the community. This research helped to determine that schools would be the most effective setting, and thus the primary focus, to leverage change (in addition to smaller, secondary, initiatives throughout the school district). Additional study details have been previously published (24,25).

Description of the Intervention

There were multiple components to improve the diets and overall health of the students enrolled in CHANGE communities. These changes began mid-fall after baseline data collection and were maintained for the rest of the school year. Students were primarily exposed to the intervention while at school through daily access to a food service component and to an educational curriculum on average every week. The research staff collaborated with and provided professional development training for the school cafeteria staff to serve healthier school breakfasts and lunches. Food service directors participated in a multi-day training, including a tour of Somerville's school food operation. The cafeteria changes included: offering whole grains daily; providing five different fruit and vegetable options weekly (with a fresh fruit or vegetable option daily, and a dark green or orange vegetable or fruit at least three times per week); providing beans or peas weekly; supplying low-fat (1 percent) and non-fat milk daily; limiting icecream sales; and encouraging a healthier a la

carte portfolio. Students were also exposed to the “*Shape Up*: during- and after-school curricula,” the Eat Well Keep Moving curricula (both curricula were based on the social-cognitive theory), and the 5-2-1 messages (i.e. at least 5 servings of fruits and vegetables/day; no more than 2 hours of television or other screen time/day; and at least 1 hour of physical activity/day) (26). Additionally, the CHANGE study also included parent and community outreach components throughout the school district to promote the healthy lifestyle changes encouraged during and after the school day. The study protocol was approved by the Institutional Review Board at Tufts University.

Participants

Students in grades 1 to 6 who attended a public elementary school in a CHANGE or control community were eligible to participate in this study. A total of 1302 children initially agreed to participate and parental informed consent was obtained. Of these children, 1230 (94%) completed at least one survey with dietary information. Students were excluded if they did not complete a dietary assessment both pre- and post-implementation (n=640 excluded [49%]) or reported consuming an implausible quantity of food (>5000 kcal/day or < 500 kcal/day; n= 158 excluded [12%]) (27). These exclusions left a total of 432 students (33%) for the analyses. At baseline, the average age of participants was roughly 8.6 years and slightly over half were female (Table 1). The participants came from families with high household poverty levels; in all of the participating communities, at least 85 percent of the students were eligible for free or reduced price meals, a proxy measure for poverty and low socio-economic status. About 85-95% of the participants were non-white.

Outcome Measures

Student’s diets were assessed using the 2007 Block Food Screener for ages 2-17 years (28). This food screener is self-administered with adult assistance and obtains consumption information from the past 24-hours for forty-one commonly consumed foods and beverages and their portion sizes. The foods and beverages included on the list are based on the foods most commonly consumed by children determined by data from two cycles of the National Health and Nutrition Examination Survey (NHANES 2001–2002 and 2003–2004). The food screener estimates the consumption of food groups, including fruits, vegetables (excluding potatoes), potatoes/potato products, whole grains, dairy, and legumes. It also estimates saturated fats, fiber, added sugars, and the overall GI of the foods consumed. The Block Food Screener has been used previously in several studies with children who need assistance with recalls (29-31). Additional information about the Block Food Screener’s consumption calculations has also been published previously (25).

Students enrolled in the CHANGE study completed the food screener with the assistance of a trained data collector, either one-on-one (children in grades 1-3) or in small groups (children in grades 4-6). Students completed these surveys at baseline in the spring and/or early fall of 2008 and then again post-implementation in the spring of 2009. For students who had two baseline measures (both spring and fall 2008), the spring 2008 value was used. Differences between the two baseline measurements were non-significant. Parents/primary caregivers provided additional information on their child’s age, sex, race/ethnicity, grade, and demographics on a family survey, adapted from the SUS study (17).

Statistical Analysis

Analyses were conducted using mixed-model analysis of variance (ANOVA) using SAS PROC MIXED, with schools included as a random effect nested within condition. Food categories were energy adjusted by dividing by total energy intake and expressed per 1000 kcal, and saturated fat was calculated as a percentage of energy intake. To estimate change in consumption, the post-implementation value of the dependent variable was regressed on

the condition, adjusting for the pre-implementation value of the dependent variable, sex, race/ethnicity, grade, and age. The primary analyses were changes in daily consumption of fruits, vegetables, whole grains, legumes, and dairy intake. Similar to other studies, fruits and vegetables were also examined combined (15,32,33). The secondary analyses measured changes in students' consumption of potato/potato products, added sugars, fiber, percent of energy from saturated fats, and GI. Statistical analyses were conducted using the SAS statistical software (version 9.2, 2008, SAS Institute, Cary, NC).

RESULTS

At baseline, students in CHANGE and control schools consumed similar amounts fruits, vegetables, whole grains, dairy, potatoes/potato products, saturated fats, and sugars, and had a diet with a similar GI (Table 2). Student in CHANGE schools consumed significantly more legumes at baseline compared with students in control schools. Students ate on average roughly 1 cup of fruit, 0.50 cup of vegetables, 0.40 ounces of whole grains, negligible amounts of legumes, and 1 cup of dairy per day per 1000 kcals. Students also consumed about 0.20 cups of potatoes/potato products, 7 teaspoons of added sugar, and 8 grams of fiber per 1000 kcals. Saturated fat intake represented roughly 7% of their total energy intake, and students' intakes had an overall GI of about 50.

Significant intervention effects were seen for servings of vegetables and combined servings of fruits and vegetables per 1000 kcal (Table 3). At the end of the intervention, students exposed to the CHANGE intervention consumed 0.08 cups of vegetables per 1000 kcal more per day than students in control schools ($P<0.05$). Students attending CHANGE schools also consumed 0.22 cups of combined fruits and vegetables per 1000 kcal more at the end of the intervention compared with students enrolled at control schools ($P<0.05$). There were no significant differences between the intervention and control schools in fruit, legume, whole grain, or dairy consumption, although the results were suggestive of a trend toward more fruit consumption (0.15cups/1000 kcal per day; $P=0.07$). There were no significant differences in consumption by sex or grade level.

In the secondary analysis, it was found that the GI of the diets of students in CHANGE schools was significantly lower than the GI of students in control schools post-intervention (-1.22 ; $P<0.05$). However, there were no significant differences in the consumption of potatoes/potato products, added sugars, fiber, or saturated fats.

DISCUSSION

The outcomes of the CHANGE study provide evidence that a multi-component intervention targeting low-income children living in rural communities in America can improve their diet quality. Overall, students consumed significantly more vegetables and combined fruits and vegetables after exposure to the CHANGE study intervention compared with students in control schools and communities. For a typical child consuming a 2000 calorie diet, this translates to more than an additional cup of vegetables per week, and an additional 3 cups of fruits and vegetables combined per week. There were no significant differences in their whole grain, legume, or dairy consumption, but there was a trend toward more fruit consumption. While there were also no differences when examining potatoes/potato products, added sugars, fiber, or saturated fats, the analysis revealed a significant reduction in the GI of students in the CHANGE study schools compared with students in the control schools, which could have important implications for obesity prevention in this at-risk population. While there has been criticisms of using GI in the literature, overall this has been found to be a valid measure of carbohydrate quality (34).

Vegetable consumption can be particularly difficult to modify in children, and those in rural America tend to have limited access to and consumption of fruits and vegetables (35). Previous studies attempting to impact fruit and vegetable intake, including the 5-A-Day Power Plus Program and TEENS study, have found improving vegetable consumption to be a challenge (33,36). Additionally, a recent systematic review and meta-analysis of school-based interventions to improve fruit and vegetable consumption concluded that overall, interventions were successful at increasing fruit, but not vegetable consumption (37). This meta-analysis also found the average impact of the interventions to be an increase in 0.25 portions of fruits and vegetables per day when fruit juice was not included, which was similar to the increases seen in the CHANGE study.

Because these other studies included similar components, such as classroom and parent involvement and cafeteria changes, it is possible that the changes seen were due to differences in the content of the school nutrition curriculum provided, the multi-day training of the food service directors, or the additional exposure through the before and after school activities that the CHANGE study provided.

This study was subject to a number of limitations. Many students who agreed to participate in the study failed to complete a second food survey at the end of the intervention. Because loss to follow up was anticipated in this lower income, transient population, students were over-recruited at baseline and they were given multiple opportunities to fill out a food screener. Additionally, local coordinators worked with the schools and the students to assist with the study, including administering the food screener.

No differences were seen in whole grain consumption, but it is possible that students were unaware of their whole grain consumption. Many common foods, including breakfast cereals or white whole wheat bread may appear to be refined but actually contain whole grains. Students at CHANGE schools had significantly increased access to whole grain foods at lunch (primarily whole wheat bread, rolls, and hamburger buns, but also crackers, pizza dough, corn dogs, and breadsticks) compared with students at control schools, but it is possible that students consuming the school meals did not recognize these foods as whole grains (38). Therefore whole grain consumption may have been underreported.

While the results of the study may not be generalizable to other population, this model has already been successfully implemented in an urban setting. Therefore, this type of intervention is promising as a way to improve the diet quality in diverse populations.

CONCLUSIONS

Improving the diets of children is important given the high prevalence of overweight and obesity, and overconsumption of nutrient-poor foods that are high in solid fats and added sugars. The CHANGE study used an innovative, multi-component community based intervention in rural America to improve the diets of children. The intervention took place in an area that is understudied despite the disproportionately higher rates of obesity and poorer dietary habits. The CHANGE study improved some aspects of rural children's dietary intakes, providing further evidence that the community based model for interventions can be successful in a rural environment. Efforts to promote change within the school setting have the potential to reach a substantial number of children through systemic changes. More research is needed to examine how to improve other aspects of the children's' diets using this community-based model and to understand students' awareness of whole grain consumption.

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Table 1
Baseline characteristics of elementary students participating in the CHANGE study in intervention and control schools

	Intervention (n=251)	Control (n=181)
	Mean (SD)	Mean (SD)
Age, years	8.6 (1.5)	8.7 (1.7)
	%	%
Sex		
Male	47%	41%
Female	53%	59%
Grade		
1	16%	17%
2	22%	22%
3	16%	16%
4	26%	20%
5	18%	21%
6	2%	3%
Ethnicity		
White	15%	3%
Black	40%	44%
Hispanic	38%	51%
Other	6%	2%

Table 2

Baseline Dietary Measures from the Block Kids Yesterday Food Screener

Primary Outcomes	Intervention Mean (SD)	Control Mean (SD)
Fruits (cups) per 1000 kcal	1.15 (0.88)	1.18 (0.84)
Vegetables [excl. potatoes] (cups) per 1000 kcal	0.55 (0.36)	0.50 (0.33)
Fruits and vegetables combined (cups) per 1000 kcal	2.13 (1.53)	2.00 (1.73)
Whole grains (oz) per 1000 kcal	0.39 (0.34)	0.38 (0.32)
Legumes (cups) per 1000 kcal	0.06 (0.11)	0.04 (0.08)*
Dairy (cups) per 1000 kcal	1.16 (0.58)	1.20 (0.58)
Secondary Outcomes		
Potatoes (cups) per 1000 kcal	0.22 (0.19)	0.23 (0.20)
Energy from saturated fat (%)	7.39 (4.74)	7.22 (3.98)
Added sugars (tsp) per 1000 kcal	6.8 (3.5)	7.4 (3.7)
Fiber (g) per 1000 kcal	8.5 (2.8)	8.1 (2.7)
Glycemic index	49.9 (4.6)	51.0 (4.4)

* Significantly different from intervention by *t*-test

Table 3

Estimated difference in dietary intakes based on the Block Kids Yesterday Food Screener at follow-up

PRIMARY	Intervention* Mean (SE)	Control* Mean (SE)	Adjusted Difference† (SE)	P-value
Fruits (cups) per 1000 kcal	1.05 (0.07)	0.90 (0.08)	0.15 (0.08)	0.07
Vegetables [excl. potatoes] (cups) per 1000 kcal	0.56 (0.04)	0.47 (0.05)	0.08 (0.04)	0.03
Fruits and vegetables combined (cups) per 1000 kcal	1.57 (0.12)	1.35 (0.13)	0.22 (0.09)	0.01
Whole grains (oz) per 1000 kcal	0.38 (0.04)	0.38 (0.05)	0.003 (0.04)	0.94
Legumes (cups) per 1000 kcal	0.05 (0.01)	0.04 (0.01)	0.006 (0.01)	0.56
Dairy (cups) per 1000 kcal	1.14 (0.10)	1.12 (0.11)	0.02 (0.06)	0.72
SECONDARY				
Potatoes (cups) per 1000 kcal	0.22 (0.01)	0.21 (0.02)	0.006 (0.02)	0.75
Energy from saturated fat (%)	8.65 (0.92)	8.98 (0.97)	-0.34 (0.46)	0.46
Added sugars (tsp) per 1000 kcal	7.23 (0.33)	7.12 (0.41)	0.11 (0.41)	0.79
Fiber (g) per 1000 kcal	8.12 (0.33)	7.73 (0.39)	0.39 (0.28)	0.16
Glycemic Index	49.5 (0.62)	50.6 (0.70)	-1.13 (0.50)	0.03

* Calculated using least-squares means regression, adjusted for the baseline value of the dependent variable (based on the food screener), sex, race/ethnicity, grade, and age.

† Adjusted difference represents the difference in values between the intervention group and the control group after adjustment for the baseline value of the dependent variable (based on the food screener), sex, race/ethnicity, grade, and age. Regression estimates were calculated using SAS Proc Mixed to account for clustering of observations within schools.