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A Food Service Intervention Improves Whole Grain Access at Lunch in Rural Elementary Schools

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Abstract

Background—Whole grain (WG) options are often limited in schools, which may impact rural, low-income students who rely on school meals for a substantial portion of their food intake. This study examined the changes in the availability and quantity of WG and refined grain foods offered in schools participating in the Creating Healthy, Active and Nurturing Growing-up Environments (CHANGE) study, a randomized, controlled intervention among rural communities (4 intervention and 4 control).

Methods—Foods were assessed using production records, recipes, and nutrition labels from breakfast and lunch over 1week during fall 2008 and spring 2009. Key informant interviews were conducted with school food service directors in the spring 2009.

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Results—The CHANGE intervention schools significantly increased the average percent of school days WGs were offered (p =.047) and the amount of WGs offered/food item (ounces) at lunch compared with control schools (p = .02). There was a significant decrease in the percent of students with access to refined grains at lunch compared with control schools (p =.049), although there were no significant differences in WG availability during breakfast.

Conclusions—The CHANGE schools improved WG availability, enabling student's WG consumption to be closer to national recommendations.

Keywords

school food service; whole grain

Whole grains (WGs) consist of intact, ground, cracked, or flaked kernels that include the germ, bran, and endosperm in the same proportions found naturally in unprocessed grains.[1,2] Whole grains have several health benefits because of their dietary fiber, phytochemicals, vitamins, and minerals.[3-10] Research suggests that replacement of refined grains with WGs is inversely associated with cardiovascular disease, type 2 diabetes, body mass index (BMI), and possibly cancer.[3-10]

The Dietary Guidelines for Americans, 2010, recommend that children aged 4 to 13 years consume 5 to 6 ounces of WG daily.[11] However, children usually consume significantly fewer servings of WG than is recommended, on an average only 0.3 to 0.5 ounces of WG daily.[12-15] Children who come from low-income families and/or live in rural populations often have the least access to healthier foods, including WG.[16,17] One study in rural South Carolina estimated there were 0.07 food stores per square mile and 74% were convenience stores, which tended to have fewer healthier options than supermarkets.[17,18] There is considerably less availability of food stores (and more availability of convenience stores) than what was found by another study examining urban environments; urban sites ranged in food stores per square mile from 1 (North Carolina) to 67 (New York) and the percentage of food outlets that were convenience stores ranged from 8% to 41%.[17,18]

This limited availability of WG may particularly impact children from low-income families, especially those who rely on school meals for as much as half of their daily energy intake.[19,20] Therefore, interventions in rural school districts may be particularly important because students in these areas may depend on school meals for access to WG.

However, until recently, there were no WG requirements for school meals, and schools typically serve refined grains, further limiting children's opportunities to consume WG food (beginning during the 2012-2013 school years, United States Department of Agriculture [USDA] standards for school meals will require half of grains to be WG).[21,22] Additionally, a recent publication found that WG intake was associated with healthier BMIs and weight status in the rural children.[23] Therefore, schools are an important venue to provide rural, low-income students with WG foods.

There have been a few previous studies that have focused on WG in schools. STOPP (STockholm Obesity Prevention Program) randomly assigned Swedish elementary schools

to healthier foods, which included the substitution of refined bread products with WG in the cafeteria during lunch.[24] After 4 years, they found no differences in self-reported WG bread intake between intervention and control students.[24] No information regarding successful implementation of WG in the cafeteria was reported.[24] A recent intervention among middle school students, the HEALTHY study, attempted to increase WG offerings in the cafeteria as part of a larger nutrition component to reduce the risk of developing type 2 diabetes.[25] However, they found that many of the WG products were too costly for the schools to introduce, and they did not find significant changes in grain consumption among students at intervention schools compared with students at control schools.[25,26] A pilot study by Burgess-Champoux et al[27] that focused exclusively on WG in a suburban elementary school was successful in both improving the availability of WG in school cafeterias and increasing the consumption of WG among the students at lunch compared with a control school. Last, Shape Up Somerville (SUS) was a community-based initiative in Massachusetts that focused on early elementary school-age children and included a cafeteria component to improve the foods served.[28] Whole grains were emphasized at both breakfast and lunch.[28] Shape Up Somerville was successful in implementing the healthier foods in school cafeterias to improve the nutrient profiles of foods provided, expanding WG consumption, and contributing to a reduction in the BMI z-scores of the students participating in the intervention compared with students at control schools.[28,29]

As a result of the SUS success, the Creating Healthy, Active, and Nurturing Growing-up Environments (CHANGE) study, a collaboration between Tufts University and Save the Children, adapted and tested the SUS model in a rural setting. The CHANGE study included multiple intervention components, including initiatives that focused on the school during the school day and after-school programs, the students' homes, and the communities in which the students lived. This study focuses on the school cafeteria component of the CHANGE study.

The aim of this analysis was to examine the change in availability and quantity of WG and refined grain foods offered to students during breakfast and lunch as part of the school meal programs comparing preintervention (fall 2008) with postintervention (spring 2009). It was hypothesized that school cafeterias participating in the CHANGE study would experience greater increases in the availability and quantity of WG at breakfast and lunch compared with control school cafeterias over 1 school year.

Methods

The CHANGE Study

The CHANGE study was a randomized, controlled field trial with 4 intervention and 4 control communities located in rural areas of California, Kentucky, Mississippi, and South Carolina designed to decrease BMI z-scores in children at high risk for obesity. Within a state, districts were randomly assigned to intervention or control status. Participants were students in grades 1 to 6 attending 1 of the 8 public elementary schools participating in the study. Each community had 1 elementary school. All 8 schools participated in the School Breakfast Program and National School Lunch Program and at least 85% of the students were eligible for free or reduced-price meals at both CHANGE intervention and control

schools. Table 1 summarizes the characteristics of the intervention and control schools participating in the CHANGE study.

The CHANGE study included a food service component, with the CHANGE research staff and school cafeteria staff working together in partnership. Details regarding the other study components have been previously published.[30] The food service directors at the intervention schools attended a 3-day training in Boston, MA, where they met the food service director who had collaborated with the SUS intervention and toured the Somerville, MA, food service operations. The food service directors also received training and materials to support the cafeteria changes encouraged by the CHANGE intervention.

The specific aims of the food service component were to offer at least 1 serving of WG daily, serve 5 different fruits and vegetables per week with a fresh option daily, provide a dark green or orange vegetable or fruit at least 3 times per week, offer beans or peas weekly, offer low-fat (1%) and non-fat milk daily, maximize use of USDA commodity foods, and maintain participation rates during lunch of at least 70%. Additionally, limitations on ice-cream sales and a healthier à la carte portfolio were encouraged. This analysis focuses on the goal to provide more WG. Outcomes were assessed using preintervention (fall 2008) and follow-up measures (spring 2009). All 8 schools signed contracts agreeing to participate in the study. Active informed consent was also obtained for all participating students and parents/guardians.

Data Collection Procedures

Production records for breakfast and lunch were collected from the participating schools for 1 randomly selected week in the fall (preintervention) and 1 week in the spring (postintervention). These records provided information on each specific food served, the quantity prepared for each food item, the quantity left over of each food item at the end of the meal, and the total number of students receiving a school breakfast and/or lunch each day. Cafeteria staff also provided recipes and vendor product labels for the foods served during the data collection days, which included ingredients, serving sizes, and weights of the foods. One week preimplementation and postimplementation was chosen because of the feasibility of receiving the production records, nutrition labels, and detailed recipe and ingredient information from the food service directors due to the large burden involved in compiling this information. A research assistant conducted 15- to 30-minute telephone interviews at the end of the study (spring 2009) with all 8 food service directors from each of the participating communities and asked 8 open-ended questions about changes made to the foods served over the past school year. Questions covered the following topics: policy, marketing and education, menu changes and food preparation, and staff training and equipment. Interviews were taped and transcribed for analysis.

Analysis of Production Records

A coding system was created that categorized menu items into food groups of interest. To ensure the accuracy of the coding, data were entered twice and checked for discrepancies. The codes were then reviewed by a second research assistant. Foods were coded as WGs if WGs were the primary ingredient or primary grain ingredient by weight, as defined by the

Healthier US School Challenge Whole Grains Resource.[31] Carbohydrates not meeting these criteria were coded as refined grains. When the weight of the food or the grain portion of the food, such as breading, was not available from the recipes or product labels, servings were converted to weight measurements based on the *USDA Food Buying Guide* for grains and breads.[32]

Outcome Measures

The primary goal of the cafeterias participating in the CHANGE study regarding WGs was to serve them daily. To estimate the frequency of access to WGs, the percentage of days that WGs were offered was calculated. The production records from breakfast and lunch were examined to determine if any WG was offered on a given day. The days with WG options were summed and divided by the total number of days examined for both time points in the fall and the spring. The frequency of access to refined grains was calculated using the same methods.

A secondary aim of the study was to determine the variety of grain options available to students daily. For WGs and refined grains separately, the number of different grain options offered to students daily was summed based on the production records. Different brands of cereal and types of sandwiches served on the same bread were counted as different options. For example, tuna sandwich on whole wheat bread and turkey sandwich on whole wheat bread were 2 separate choices. The same food item served on different days was also counted as distinct options.

The estimates of the availability of grains do not take into account the quantity of grains served as a percentage of the students attending the meal. Therefore, to calculate this, the total number of WG items offered was summed and divided by the number of students attending the meal each day and for breakfast and lunch separately. For example, 50 pancakes +150 muffins at breakfast/250 students attending breakfast =0.80 WG items per student, and therefore a maximum of 80% of the students would be able to select a WG during breakfast. This method was repeated for the refined grain options. The average ounces of the WG products served daily at breakfast and lunch were calculated and weighted to account for unequal quantities of WG products offered. The average ounces of refined grains served at breakfast and lunch daily were calculated using this method as well.

Last, the transcripts from the interviews with the food service directors in CHANGE schools were examined for references to WGs to determine if the WG message of the CHANGE intervention was being successfully conveyed. Interviews with the food service directors at control schools were also examined to see if more recent attention to WGs from the USDA, Institute of Medicine, food industry, and/or news was leading to awareness of WG.

Data Analyses

The primary study contrasts were the changes to the availability and quantity of WGs and refined grains offered to students in CHANGE and control schools at breakfast and lunch comparing production records in the fall (1 week) with the spring (1 week) during 1 school year. Analysis of variance accounting for clustering of observations within schools was used

to examine the changes in difference values (postintervention minus preintervention) between CHANGE and control schools, controlling for baseline levels (preintervention). Whole grains and refined grains were analyzed separately. The analyses were performed with SAS statistical software (version 9.1, 2003, SAS Institute, Cary, NC).

Results

Breakfast

Table 2 summarizes the availability and quantity of carbohydrate-based foods offered to students in CHANGE and control schools. The average percent of days that WGs were offered at breakfast increased from 35% at baseline to 45% at follow-up at both CHANGE and control schools. One CHANGE school achieved the goal of serving WGs daily at breakfast, and no control schools served WGs on 100% of the study days. There were no significant decreases in the percent of days that refined grains were offered at breakfast, and the schools served refined grains on average 90% of days postintervention at both CHANGE and control schools. The total number of unique WG food options at breakfast increased by 0.4 options per meal for breakfast at both CHANGE and control schools; from 1.6 options at baseline to 2.0 options at the end of the study in CHANGE schools, and in control schools from 0.4 options at baseline to 0.8 options at follow-up. There were also no statistically significant differences between CHANGE and control schools at baseline and the end of the study for the number of unique refined grain options at breakfast, for the average percent of WG or refined grain offerings per student, or the average number of ounces served per student for refined grain or WG. Both CHANGE and control schools increased the percent of students with access to WGs, and servings contained on average half an ounce of WGs. The main sources of WGs offered to students at breakfast were WG cereals. Other sources included WG pancakes, English muffins, toast, and oatmeal.

Lunch

The percent of days that WGs were available at lunch increased from 55% at baseline to 65% at follow-up in CHANGE schools, and in control schools from 20% at baseline to 25% at the end of the study ($p = .047$; Table 3). At follow-up, 1 CHANGE school served WGs every day during lunch, and no control schools served WGs daily. While there was an increase in the percent of days that refined grains were offered in the control schools and no difference in CHANGE schools from baseline to follow-up, this difference was not significant. The results suggested a trend toward greater increases in the mean number of WG options available to students in CHANGE schools, but differences between intervention and control schools were not significant. There were also no significant changes in the mean number of unique refined grain at CHANGE schools compared with control schools.

Both CHANGE schools and control schools experienced increases in the amount of WGs offered as a percentage of the students attending lunch; WG availability increased from 38.8% preintervention to 44.8% postintervention at CHANGE schools compared with 14.0% at baseline to 17.7% at follow-up in control schools ($p = .11$). There was a significant increase in the average daily amount of WG ounces available to students in CHANGE schools compared with control schools ($p = .02$). There was also a decrease in the amount of

refined grains offered as a percentage of the students (p =.0498). The decrease in ounces per refined grain item at lunch at CHANGE schools compared with the control schools postintervention was not significant. The major sources of WGs offered to students at lunch were WG sandwich breads, hamburger buns, and rolls. Other sources were WG crackers, pizza dough, breadsticks, and corn dogs because of their WG breading.

Food Service Director Interviews

At CHANGE schools, 3 of 4 food service directors mentioned their intention to increase WGs, whereas in control schools only 2 of 4 food service directors mentioned their intention to increase WGs. The interviews suggested an awareness of the importance of serving WG products, including prior to the start of the CHANGE intervention:

> We have been serving wheat bread now going on 2 years. So when we first started to serve it, we had a problem. They didn't want to eat it, wasn't anybody that wanted to eat it. 'We don't eat wheat bread. We don't want to change our bread.' But now everybody in the district is eating it. … We just are getting them wheat bread every day, so everybody's eating it, even some of the teachers that said they don't eat wheat bread. They never ate wheat bread, but now everybody's eating it because that's the only kind of bread we have…. We have wheat, you know, sliced bread and wheat hamburger buns. But this time, we're going to be trying to get them some wheat hot dog buns. (Food service director, intervention school)

Some of the food service directors also discussed the challenges of pursuing WG options:

> … we're trying to make sure we have more whole grains on the menu. It's just hard to get a lot of the products. Especially like on pasta products. They make it, but it doesn't come in bulk content, so it's been kind of hard for us. (Food service director, control school)

> Vendors are really good, and they're coming up—the vendors, I would like to say, are coming up with some better and better tasting healthier choice… . But then there's like poor taste quality, and kids don't like it. So it ends up being a fail—it falls on its face … it needs to taste good… . And you can't just give kids a whole wheat burrito. We've tried a lot of different ones. We have literally several different kinds of whole wheat burritos. Because we make a lot of our own, we make quesadillas, and some stuff that we make for even breakfast products. And it has to be tasty. You know, be nice quality. And some manufacturers have worked on that. So I'd like to say that that's going to help. (Food service director, intervention school)

While several of the food service directors discussed various staff training programs or new equipment for their cafeterias, this was primarily focused on other food categories, especially fruits and vegetables.

Discussion

The CHANGE study was an innovative, multi-component study that focused on children in rural America, a population that is often overlooked in school-based interventions. Because

children in rural areas may have limited access to WGs outside the school, the main carbohydrate-based goal of the CHANGE intervention was to serve WGs every day for schools. There were nonsignificant increases in the availability of WGs offered at breakfast from preintervention to postintervention at both CHANGE and control schools, with WGs available on almost half of the study days at follow-up. There was a significant increase in the percent of days that WGs were available at lunch in CHANGE schools compared with control schools. The CHANGE study was also successful at increasing the amount of ounces of WGs served to students in intervention schools and decreasing the percent of students with access to refined grain options. There was also a positive trend toward increasing the number of WG options offered to students daily, although the difference was not statistically significant. The majority of food service directors at CHANGE schools and half of the food service directors at control schools discussed their efforts to increase WG options to students during the food service interviews.

Overall, on the limited number of days that WGs were offered, there were typically enough WGs put out for only roughly a quarter to one third of the students to select a WG during breakfast at baseline in control and CHANGE schools, respectively. At lunch, control schools offered WGs on average only 1 day per week and typically offered enough WGs for only 14% of students to take a WG at baseline. Whole grains were offered on about half of the days in CHANGE schools at baseline, and enough WGs were offered for about 40% of the students to select WGs at lunch. Despite increases from baseline at both CHANGE and control school in the percent of days that WGs were offered and in the percent of students with access to a WG item, on an average the majority of students did not have access to WGs at breakfast or lunch postintervention. Additionally, the number of ounces of WGs in the items offered was often small. For example, even if a student at a control school selected a WG item at both breakfast and lunch postintervention, they received on average a total of 0.8 ounces of WG, which is less than one third of the USDA recommendation of at least 3 ounces for a child with an intake of 1800 calories per day.[33] However, CHANGE schools' increases in the percent of days that WGs were offered and in the ounces of WG per food item at lunch likely helped many students get closer to reaching the USDA goal. Students who selected a WG at breakfast and lunch received on average 1.6 ounces of WG or roughly half of the USDA recommendation. Because the study participants are low-income students who typically receive 2 meals per day or up to about half of their daily energy intake at school, it is likely that many of these students depend on schools to receive a substantial portion of WG.[19]

Despite the fact the majority of food service directors at CHANGE schools and half of the food service directors at control schools stated the intention to provide more WGs to students, this was not always reflected in the production records, and achievement of the CHANGE objectives varied between the sites. A variety of factors may explain the difficulties in achieving daily WG offerings in the schools. Recognizing WG products may be difficult and confusing.[34] Product labels that may suggest WG contents, such as “multigrain,” often have refined grains as the primary ingredient by weight. It is also possible that serving WG daily was not feasible because of the additional cost of many WG products compared with equivalent refined grain options, as was found in the HEALTHY study.[25] Because there were several cafeteria goals for the schools participating in the

CHANGE study, it is unclear if food service directors emphasized some of the goals more than others. It is possible that the success of a previous WG pilot study that increased the availability of WG was in part due to its emphasis on only 1 cafeteria change.[27]

Interestingly, the 2schools, 1 intervention and 1 control school, with food service directors who did not mention WGs during the interview both experienced increases in the availability of WG. While it is possible that the changes were deliberate and not mentioned during the interviews, it is also possible that some common foods have been reformulated to contain WGs and happened to be served more frequently during the week of follow-up. For example, some of the popular cereals marketed to children now contain WGs and were included in the cases of mixed cereal that the schools offered to the students. This could also partially explain the general increase of WG products in the control schools.

Limitations

The results are subject to some limitations. The analyses did not include data on WGs sold as competitive foods sold à la carte or from vending machines. This was due to the limited access to these foods in elementary schools, including the schools participating in the study. The study may have also been limited by the short, 1-year duration of the intervention program. Food service changes often occur slowly for various reasons, including that changes to food procurement bids are often required to purchase new foods. Previous school-based interventions, including the HEALTHY study and Pathways study, also found this to be an issue when making changes in the cafeteria.[26,35] Also, food service staff were not blind to the intervention status and knew about the production record collection activities; it is possible that they modified the foods served on data collection weeks. However, given how far in advance menus are developed and foods are ordered, planning was likely done prior to being informed about the study collection dates. This also contributes to the likelihood that the study days were representative of general WG availability in the schools, despite only 1 week of production records collection at baseline and at follow-up. Last, the number of servings actually taken by students could not be analyzed because of the large number of missing data in the production records. However, the study was strengthened by being well-designed, multifaceted intervention, the randomization of schools to intervention and control status, and the inclusion of 8 rural communities from geographically diverse areas throughout the United States. While randomization did not always result in similar preintervention values, these differences were accounted for in the analyses with an adjustment for baseline levels.

Conclusions

The CHANGE study used an innovative, multi-component intervention aimed at children in rural areas throughout the United States to encourage the consumption of healthier foods by increasing their availability. The CHANGE study was successful at increasing the percent of days that WGs were served at lunch and the ounces of WGs offered per food item to students. Overall, the results suggested a general positive trend in WG availability in school cafeterias, which may be in part due to national efforts to promote WGs and the food industry's reformulation of products to contain more WGs.

Implications for School Health

For schools to meet the new national guidelines to provide at least half of grains as WGs at meals cafeteria staff should receive additional training on identifying and preparing WG options, and the food industry should continue to increase the availability of palatable and affordable WG options to improve the feasibility of offering acceptable WG products to students. Future studies are required to examine the impact on the selection and consumption of WGs during the school day in other disadvantaged populations. Additional research is required to examine the costs associated with implementing more WGs in a rural school cafeteria setting, which may differ from urban or suburban settings where larger quantities of foods being purchased could be associated with lower food prices. Interventions, such as the CHANGE study, are important to help improve access to WGs among rural and low-income children, and the associated health benefits may be large. With repeated exposure to WGs, students may be more likely to select and consume WGs both during and outside the school day.

Human Subjects Approval Statement

The study was approved by the Tufts University Institutional Review Board.

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References

1. U.S. Food and Drug Administration (FDA). [Accessed October 19, 2010] The scoop on whole grains. Available at: http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm151902.htm#grains
2. American Association of Cereal Chemists (AACC) International. [Accessed October 19, 2010] Definition of whole grain. Available at: http://www.aaccnet.org/definitions/wholegrain.asp
3. Liu S, Stampfer MJ, Hu FB, et al. Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study. Am J Clin Nutr. 1999; 70(3):412–419. [PubMed: 10479204]
4. Mellen PB, Walsh TF, Herrington DM. Whole grain intake and cardiovascular disease: a meta-analysis. Nutr Metab Cardiovasc Dis. 2008; 18(4):283–290. [PubMed: 17449231]
5. de Munter JS, Hu FB, Spiegelman D, Franz M, van Dam RM. Whole grain, bran, and germ intake and risk of type 2 diabetes: a prospective cohort study and systematic review. PLoS Med. 2007; 4(8):e261. [PubMed: 17760498]
6. Jacobs DR Jr, Marquart L, Slavin J, Kushi LH. Whole-grain intake and cancer: an expanded review and meta-analysis. Nutr Cancer. 1998; 30(2):85–96. [PubMed: 9589426]
7. Schatzkin A, Mouw T, Park Y, et al. Dietary fiber and whole-grain consumption in relation to colorectal cancer in the NIH-AARP diet and health study. Am J Clin Nutr. 2007; 85(5):1353–1360. [PubMed: 17490973]
8. Liu S, Willett WC, Manson JE, Hu FB, Rosner B, Colditz G. Relation between changes in intakes of dietary fiber and grain products and changes in weight and development of obesity among middle-aged women. Am J Clin Nutr. 2003; 78(5):920–927. [PubMed: 14594777]
9. Steffen LM, Jacobs DR Jr, Murtaugh MA, et al. Whole grain intake is associated with lower body mass and greater insulin sensitivity among adolescents. AmJEpidemiol. 2003; 158(3):243–250.
10. Slavin J. Whole grains and human health. Nutr Res Rev. 2004; 17(1):99–110. [PubMed: 19079919]

11. United States Department of Agriculture. [Accessed June 1, 2012] MyPyramidgovchart: how many grain foods are needed daily?. Available at: http://www.choosemyplate.gov/food-groups/grains_amount_table.html
12. National Cancer Institute. [Accessed October 20, 2010] Usual dietary intakes: food intakes, US population, 2001-04. Available at: http://riskfactor.cancer.gov/diet/usualintakes/pop/grains_whl.html#f2
13. Harnack L, Walters SA, Jacobs DR Jr. Dietary intake and food sources of whole grains among US children and adolescents: data from the 1994-1996 Continuing Survey of Food Intakes by Individuals. J Am Diet Assoc. 2003; 103(8):1015–1019. [PubMed: 12891150]
14. Bachman JL, Reedy J, Subar AF, Krebs-Smith SM. Sources of food group intakes among the US population, 2001-2002. J Am Diet Assoc. 2008; 108(5):804–814. [PubMed: 18442504]
15. Affenito SG, Thompson D, Dorazio A, Albertson AM, Loew A, Holschuh NM. Ready-to-eat cereal consumption and the school breakfast program: relationship to nutrient intake and weight. J Sch Health. 2013; 83(1):28–35. [PubMed: 23253288]
16. Larson NI, Story MT, Nelson MC. Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med. 2009; 36(1):74–81. [PubMed: 18977112]
17. Liese AD, Weis KE, Pluto D, Smith E, Lawson A. Food store types, availability, and cost of foods in a rural environment. J Am Diet Assoc. 2007; 107(11):1916–1923. [PubMed: 17964311]
18. Moore LV, Diez Roux AV. Associations of neighborhood characteristics with the location and type of food stores. Am J Public Health. 2006; 96(2):325–331. [PubMed: 16380567]
19. Briefel RR, Crepinsek MK, Cabili C, Wilson A, Gleason PM. School food environments and practices affect dietary behaviors of US public school children. J Am Diet Assoc. 2009; 109(2 suppl):S91–S107. [PubMed: 19166677]
20. Briefel RR, Wilson A, Gleason PM. Consumption of low-nutrient, energy-dense foods and beverages at school, home, and other locations among school lunch participants and nonparticipants. J Am Diet Assoc. 2009; 109(2 suppl):S79–S90. [PubMed: 19166676]
21. Crepinsek MK, Gordon AR, McKinney PM, Condon EM, Wilson A. Meals offered and served in US public schools: do they meet nutrient standards? J Am Diet Assoc. 2009; 109(2 suppl):S31–S43. [PubMed: 19166671]
22. United States Department of Agriculture. Nutrition standards in the National School Lunch and School Breakfast Programs. Fed Regist. 2012; 77(17):4088–4167. [PubMed: 22359796]
23. Choumenkovitch SF, McKeown NM, Tovar A, et al. Whole grain consumption is inversely associated with BMI Z-score in rural school-aged children. Public Health Nutr. 2013; 16(2):212–218. [PubMed: 22894825]
24. Marcus C, Nyberg G, Nordenfelt A, Karpmyr M, Kowalski J, Ekelund U. A 4-year, cluster-randomized, controlled childhood obesity prevention study: STOPP. Int J Obes (Lond). 2009; 33(4):408–417. [PubMed: 19290010]
25. Gillis B, Mobley C, Stadler DD, et al. Rationale, design and methods of the HEALTHY study nutrition intervention component. Int J Obes (Lond). 2009; 33(suppl 4):S29–S36. [PubMed: 19623185]
26. Siega-Riz AM, El Ghormli L, Mobley C, et al. The effects of the HEALTHY study intervention on middle school student dietary intakes. Int J Behav Nutr Phys Act. 2011; 8:7. [PubMed: 21294869]
27. Burgess-Champoux TL, Chan HW, Rosen R, Marquart L, Reicks M. Healthy whole-grain choices for children and parents: a multi-component school-based pilot intervention. Public Health Nutr. 2008; 11(8):849–859. [PubMed: 18062842]
28. Economos CD, Hyatt RR, Goldberg JP, et al. A community intervention reduces BMI z-score in children: Shape Up Somerville first year results. Obesity (Silver Spring). 2007; 15(5):1325–1336. [PubMed: 17495210]
29. Goldberg JP, Collins JJ, Folta SC, et al. Retooling food service for early elementary school students in Somerville, Massachusetts: the Shape Up Somerville experience. Prev Chronic Dis. 2009; 6(3):A103. [PubMed: 19527575]
30. Tovar A, Chui K, Hyatt RR, et al. Healthy-lifestyle behaviors associated with overweight and obesity in US rural children. BMC Pediatr. 2012; 12(1):102. [PubMed: 22809332]

31. Healthier US School Challenge. [Accessed October 19, 2010] Whole grains resource. Available at: http://www.fns.usda.gov/TN/HealthierUS/wholegrainresource.pdf

32. United States Department of Agriculture. [Accessed October 19, 2010] Food buying guide for child nutrition programs: grains/breads. Available at: http://www.fns.usda.gov/TN/Resources/FBG_Section_3-GrainsBreads.pdf

33. United States Department of Agriculture. [Accessed October 19, 2010] Dietary Guidelines for Americans. 2010. Available at: http://www.cnpp.usda.gov/DietaryGuidelines.htm

34. Chu YL, Orsted M, Marquart L, Reicks M. School foodservice personnel's struggle with using labels to identify whole-grain foods. J Nutr Educ Behav. 2012; 44(1):76–84. [PubMed: 21943954]

35. Gittelsohn J, Davis SM, Steckler A, et al. Pathways: lessons learned and future directions for school-based interventions among American Indians. Prev Med. 2003; 37(6 Pt 2):S107–S112. [PubMed: 14636815]

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Table 1

Characteristics of Participating Schools by Site and Treatment Condition

					Students at Participating Schools				
Site	**Condition**	**Type of Food Service Delivery System**	**Number of Students**	**Female Participants (%)**	**Caucasian (%)**	**African American (%)**	**Hispanic (%)**	**Other (%)**	**Eligible for Free or Reduced-Price Meals (%)**
California	I	On-site	388	46	10	0	90	0	88
	C	On-site	281	47	9	0	91	0	89
Kentucky	I	On-site	297	47	100	0	0	0	72
	C	On-site	281	49	95	1	0	4	70
Mississippi	I	On-site	376	48	1	98	1	0	99
	C	On-site	279	51	0	99	1	0	99
South Carolina	I	On-site	489	47	12	85	2	1	90
	C	On-site	355	48	4	96	0	0	90

I, intervention school; C, control school.

Table 2

Carbohydrates Served at Breakfast in CHANGE Schools and Control Schools During Fall 2008 and Spring 2009*

	Intervention Schools			Control Schools			
	Pre	Post	Δ From Baseline†	Pre	Post	Δ From Baseline†	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-Value for Difference Between Intervention and Control Schools‡
Percent of days whole grains offered	35 (48.9)	45 (51.0)	10 (50. 0)	35 (48.9)	45 (51. 0)	10 (50.0)	ND§
Percent of days refined grains offered	90 (30. 8)	90 (30.8)	0 (30.8)	100 (0)	90 (30. 8)	−10 (21.7)	. 53
Number of whole grain options daily|	1.6 (2.4)	2.0 (2.7)	0.4 (2.6)	0.4 (0.6)	0.8 (1.3)	0.4 (1. 0)	. 85
Number of refined grain options daily|	1.7 (1.0)	1.5 (0.9)	−0.2 (1.0)	1.9 (1.1)	1.6 (1.2)	−0.3 (1.1)	. 86
Maximum percentage of students wi th access to a whole grain option¶	32. 7 (46.7)	33.7 (43.5)	1.0 (45.2)	25.8 (39. 4)	36. 5 (45.5)	10.7 (42.5)	. 86
Maximum percentage of students with access to a refined grain option¶	85. 9 (32.7)	86.4 (31.1)	0.5 (31.9)	100 (0)	86. 3 (31.6)	−13.7 (22.3)	. 46
Amount of whole grains offered per food item (ounces)#	0.4 (0.5)	0.5 (0.6)	0.1 (0.6)	0.4 (0.5)	0.5 (0.7)	0.1 (0. 6)	ND§
Amount of refined grains offered per food item (ounces)#	1.4 (0.8)	1.5 (0.9)	0.1 (0.8)	1.4 (0.6)	1.3 (0.8)	−0.1 (0.7)	. 55

*Based on 1 week pre and post for N = 4 intervention schools and N = 4 control schools; 20 days total per intervention and control group.

†Difference = post – pre.

‡Results based on analysis of variance accounting for clustering of observations within schools, calculated as the difference between pre and post in intervention schools vs. control schools, adjusting for baseline (preintervention) values.

§ND indicates no statistical difference.

|The number of unique options containing carbohydrates offered to students. This includes grain-based entrées, sides, and breaded products.

¶Calculated as: Number of food items offered/Number of students attending breakfast. For example, a value of 100% means that enough was offered so that all the students attending breakfast had an opportunity to take a carbohydrate-based food item.

#Valuesare weighted based on the quantity of each grain offered. The USDA recommends that a child or adolescent with an intake of 1800 calories per day should consume at least 3 ounces of whole grains per day.[11]

Table 3

Carbohydrates Served at Lunch in CHANGE Schools and Control Schools During Fall 2008 and Spring 2009*

	Intervention Schools			Control Schools			
	Pre	Post	Δ From Baseline†	Pre	Post	Δ From Baseline†	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-Value for Difference Between Intervention and Control Schools‡
Percent of days whole grains offered	55 (51.0)	65 (48.9)	10 (50)	20 (41. 0)	25 (44.4)	5 (42.8)	.047
Percent of days refined grains offered	90 (30.8)	90 (30.8)	0 (30.8)	95 (22.4)	100 (0)	5 (15.8)	.26
Number of whole grain options daily§	0.8 (0.8)	1.0 (1.1)	0.2 (0.9)	0.3 (0.6)	0.3 (0.6)	0.0 (0.6)	.06
Number of refined grain options daily§	1.7 (1.1)	1.8 (1.0)	0.1 (1.1)	2.0 (1.0)	2.0 (1.1)	0.0 (1.0)	.76
Maximum percentage of students wi th access to a whole grain option|	38.8 (41. 3)	44.8 (43.7)	6. 0 (42.5)	14.0 (32.0)	17.7 (33.5)	3.7 (32.8)	.11
Maximum percentage of students wi th access to a refined grain option|	79.4 (35. 7)	76.9 (38.2)	−2.5 (37.0)	94.9 (22.3)	100 (0)	5.1 (15.8)	.0498
Amount of whole grains offered per food item (ounces)¶	0.8 (0.8)	1.1 (0.9)	0.3 (0.9)	0.2 (0.4)	0.3 (0.6)	0.1 (0.5)	.02
Amount of refined grains offered per food item (ounces)¶	1.3 (0.8)	1.2 (0.6)	−0.1 (0.7)	1.3 (0.5)	1.5 (0.5)	0.2 (0.5)	.13

*Based on 1 week pre and post for N =4 intervention schools and N =4 control schools; 20 days total per intervention and control group.

†Difference = post – pre.

‡Results based on analysis of variance accounting for clustering of observations within schools, calculated as the difference between pre and post in intervention schools vs. control schools, adjusting for baseline (preintervention) values.

§The number of unique options containing carbohydrates offered to students. This includes grain-based entrées, sides, and breaded products.

|Calculated as: Number of food items offered/Number of students attending lunch. For example, a value of 100% means that enough was offered so that all the students attending lunch had an opportunity to take a carbohydrate-based food item.

¶Values are weighted based on the quantity of each grain offered. The USDA recommends that a child or adolescent with an intake of 1800 calories per day should consume at least 3 ounces of wholegrains per day.[11]