PEER-REVIEWED ARTICLE

Making an IMPACT:
Effect of a School-Based Pilot Intervention

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Abstract

Background: *Poor nutrition and inactivity are widespread and contribute to the epidemic problem of childhood obesity. This study examined the effectiveness of a school-based pilot program to improve nutrition and activity in elementary (ES) and high school (HS) students.*

Methods: *The Improving Meals and Physical Activity in Children and Teens (IMPACT) school-based curriculum used a train-the-trainer model to improve activity and nutrition. Nine students were recruited from one rural North Carolina high school and trained in the IMPACT curriculum and leadership skills. Four 4th grade classes at a neighboring elementary school were randomized to receive the IMPACT curriculum delivered by the HS students over 12 weeks (two classrooms, 38 students) versus the standard curriculum (two classrooms, 37 students). Pre- and post-intervention surveys were used to assess program effectiveness.*

Results: *ES students in the intervention classes reported increased fruit and vegetable intake (+0.85 servings/day compared with controls; $p<0.05$) and improved knowledge of the food group in which to eat the most servings ($p<0.01$). ES students who participated in the IMPACT curriculum also reported increased intake of calcium-rich foods and grains, though these results were not statistically significant. Similar though nonsignificant improvements in diet behaviors were reported by the HS students who assisted in delivering the 4th grade curriculum.*

Limitations: *Study limitations include small sample size, risk of cross-contamination, and short program duration.*

Conclusions: *ES students who participated in the IMPACT curriculum reported improved dietary behaviors and knowledge. School-based curricula such as IMPACT may help improve nutrition among ES students.*

Keywords: *nutrition; fitness; school health instruction*

North Carolina faces a childhood obesity epidemic; over 40% of 5-18 year olds are overweight (>85th percentile to <95th percentile of gender-specific BMI for age) or obese (≥95th percentile of gender-specific BMI for age).[1] These children are at increased risk of social marginalization, type 2 diabetes, cardiovascular disease, and other morbidities[2] which often persist into adolescence and adulthood.[3] The increasing prevalence of childhood overweight is likely due to both worsening nutrition habits and decreased physical activity. In 2007, only 15% of North Carolina's high school students reported eating at least five daily servings of fruits and vegetables in the past seven days[5] while three-fourths said they eat fast food at least once per week.[6] Less than half of North Carolina's middle and high school students engage in at least 60 minutes of physical activity five or more days per week.[5]

Schools are an important venue for promoting nutrition and physical activity among children, who are a "captive audience" for approximately 180 days each year. School-based obesity prevention interventions have led to improved health behaviors including decreased television viewing, decreased soft drink consumption, improved body mass index (BMI), and improved nutrition and physical activity behaviors.[7,8] Despite promising results from these programs, few schools provide nutrition education or daily physical activity opportunities.[9] Rigorous academic standards and budget constraints limit the amount of time allocated to physical activity and nutrition education. Previous elementary school interventions have demonstrated increased physical activity but have required additional time and resources.[10,11] We were interested in developing a nutrition and physical activity intervention that could be incorporated into

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the traditional school day and ultimately be sustained by the school system.

We drew upon Social Cognitive Theory,[12] recognizing the reciprocal influence of the school environment on diet and activity behaviors. Within the school environment, we theorized that students could acquire new knowledge and skills to change diet and activity behaviors. Further, we hypothesized that peer modeling of desired behaviors could motivate students' behavior change. Previous health education programs have reported that peer-led interventions produce comparable or better results than adult-led programs.[13]

In designing the IMPACT school-based pilot intervention, we used peer modeling to influence the behavior of three groups of learners: medical students, high school (HS) students, and elementary school (ES) students. The project was a collaborative partnership between a university medical center and a rural school district and included medical students as health educators. To reinforce learning, we employed a train-the-trainer model. In the first phase, medical students, including study authors Muth and Chatterjee, trained HS students as health educators; in the second phase, medical students and HS students implemented the IMPACT diet and activity curriculum in an elementary school. Although previous programs have used HS students as health educators for their peers,[14,15] to the authors' knowledge such programs have not involved elementary school students. The objective of this pilot study was to evaluate the IMPACT program's effect on HS and ES participants' knowledge, attitudes, and behavior regarding nutrition and physical activity.

METHODS

Subjects

The IMPACT curriculum was implemented in a rural North Carolina high school and elementary school that were selected based on location, close proximity to each other, and support of school leadership. Nine HS students were selected from a health occupations class based on their interest and application to assist in educating ES students about nutrition and physical activity. The HS students and their parents signed informed consent forms before participating. Teachers provided approval for HS students to miss three classes during the semester to assist with implementing the ES curriculum. Study authors Muth and Chatterjee recruited eight additional medical student volunteers with an interest in nutrition, physical fitness, and pediatrics. These 10 medical student leaders were interested in providing community service and outreach to local public schools. They received a short training on anthropometry and attended a 15-hour teen training on the IMPACT curriculum led by two of the study authors—a registered dietitian (Muth) and a former high school teacher (Chatterjee).

In the participating elementary school, 4th grade classrooms were randomized to two intervention (38 students) and two control classrooms (37 students). The intervention curriculum was implemented by HS students and two medical students who were supervised by each class's usual ES teacher. Each student signed an assent form and each student's parent/guardian signed an informed consent to participate in the intervention or serve as a control. The study was approved by the Biomedical Research Institutional Review Board at the University of North Carolina School of Medicine.

Instruments

The primary outcome for both HS and ES students was change in self-reported nutrition and physical activity knowledge, attitudes, and behaviors. The authors assessed this pre- and post-intervention using a validated age-appropriate Texas School Physical Activity and Nutrition (SPAN) questionnaire.[16] HS students completed this written questionnaire independently at enrollment. Under the supervision of their teacher, ES students completed an age-appropriate version of the written questionnaire which included pictures of sample foods and serving sizes. Students self-reported demographic information including sex, ethnic background, and birth date, which were used to calculate exact age in months at enrollment. The questionnaire included the following *nutrition behaviors*: self-reported number of servings in the past 24 hours of milk, cheese, yogurt, whole wheat bread, rice/pasta, white bread, cereal, vegetables, fruits, fruit juice, sweetened drinks, soft drinks, fries/chips, and sweets. For these items, students were given closed-ended response options (0, 1, 2, or 3 or more servings in the past 24 hours). Since the authors were interested in examining effects of the intervention on specific nutrient groups (calcium-containing foods, grains, and fruits and vegetables), scores were calculated for each of these nutrient groups by summing the appropriate individual items. For example, calcium scores for each student were calculated by summing the number of daily servings of milk, cheese, and yogurt.

Students also self-reported the following *physical activity behaviors* on the questionnaire: number of hours of TV, computer, and video games in last 24 hours and number of days per week of moderate physical activity (defined as at least 30 minutes of exercise that did not increase heart rate or cause hard breathing) and vigorous physical activity (defined as at least 20 minutes of activity that increased heart rate or caused hard breathing). To examine overall sedentary activity, number of daily hours of TV, computer, and video game time were summed. Days per week of moderate and vigorous physical activity were summed to evaluate overall physical activity.

Questionnaire items also assessed students' *diet knowledge* (i.e. which food group the most and fewest servings should come from and how many servings of fruits and vegetables are recommended daily). For these items multiple response options were provided and responses were tallied as correct only if they selected the single most appropriate answer. The authors compared the proportion of students who answered these questions correctly pre- and post-intervention. *Diet/activity attitudes* were assessed through two items: belief that diet can affect risk of heart disease or cancer (yes/no) and belief that overweight affects health (yes/no). The authors compared the proportion of students who endorsed these beliefs pre- and post-intervention.

As a secondary outcome, the program's effect on participants' weight as measured by BMI percentile-for-age before and after

intervention was assessed. BMI percentile (age and sex specific) was calculated for each student using directly measured weight and height. Trained research assistants weighed HS and ES students to the nearest 0.01 kg using a beam balance scale (Detecto) pre- and post-intervention. Height was measured to the nearest 1 mm using a rigid upright portable stadiometer (Seca 214). Students removed shoes and heavy clothing prior to the height and weight measurements. BMI and BMI percentile for age were calculated using a program available from the Centers for Disease Control and Prevention (CDC).[17]

Procedure

The IMPACT curriculum was developed by the investigators and is available by request. Table 1 outlines the curriculum content. The lessons consisted of approximately 20 minutes of physical activities and 40 minutes of a nutrition lesson developed to fit within the North Carolina academic competency goals in math, science, reading, social studies, language arts, and/or healthful living for the 4th grade. Students also had weekly homework assignments that required parent or guardian participation for each lesson. Most nutrition lessons were

Table 1.
IMPACT Curriculum Content

Lesson	Objectives	Physical Activity
MyPyramid for Kids	State the purpose of IMPACT Describe the food groups of MyPyramid	"Dance Domino Effect" (students create dance moves to music)
More MyPyramid for Kids	Assign foods to food groups Use math to create a healthy menu	"Healthy Eating Rhyme" (students make up rhyme and dance)
Reading the Nutrition Label	Learn to read the nutrition label Recognize foods with Winner's Circle logo (the logo recognizes foods that meet certain nutrition criteria)	"VERB Charades" (students draw cards with various physical activities that they must act out)
Eating Healthy Eating Out	Choose healthy fast food alternatives Use math to evaluate nutrition value of meal	"Follow the Fitness Leader" (with music playing, each student leads the class in some form of physical activity for one minute each)
Fill Up on Fruits and Veggies	Describe the benefits of eating produce Evaluate current fruit and vegetable intake	"Rock, Paper, Scissors Tag" (modified version of tag)
Grow Tall and Strong	Evaluate nutrition content of dairy products Select healthy calcium-rich foods	"Memory Lane" (teacher calls out activities and students compete together as partners)
SMART Health Goals	Develop specific, measurable, attainable, relevant, and time-bound (SMART) nutrition and physical activity goals	"Keep the Beach Ball Up"
Food and Activity from Around the World	Learn about food customs of other countries Classify cultural foods using MyPyramid	"Hopscotch Without Borders" (variations of hopscotch from around the world)
Commercial Galore	Identify various food advertising strategies Recognize lack of nutrition in most heavily promoted foods Create a bar graph of strategies used on TV	"Travel the Tarheel State/California Dreamin" (students are "transported" to various locations throughout North Carolina and California where they act out activities they would do there.)
Lifelong Health	List benefits of a healthy, active lifestyle Identify ways to be even healthier	"Triangle Tag" (variation of tag)
Healthy Me Scrapbook 1 & 2	Demonstrate how students have made healthier choices since beginning the IMPACT program by taking photographs of themselves being healthy and organizing the photographs on a "Healthy Me" posterboard	"Jewel Thieves" (variation of tag) "Invent-a-Game" (students are given 20 pieces of sports equipment and given the task to invent a game in small groups)

adapted from preexisting curricula such as MyPyramid for Kids[18] while many physical activities were adapted from CDC's VERB materials.[19]

The IMPACT pilot school-based intervention consists of two parts: a 15-hour extracurricular HS student training and a 12-week classroom-based 4th grade curriculum. Study authors Muth and Chatterjee as well as medical students conducted the HS training over three school holidays in the fall of 2005. The trainings consisted of four components: (1) at least 30 minutes of physical activities; (2) a HS-specific nutrition/activity lesson adapted from the California LEAN project;[20] (3) practice teaching sessions; and (4) classroom management and public speaking development exercises. As an incentive, each HS student received a free membership to a local athletic club for the duration of the seven-month intervention.

From January-April 2006, the ES portion of the IMPACT curriculum was implemented. Trained HS students, medical students, and the regular ES teachers delivered the IMPACT lessons to the two 4th grade intervention classrooms for one hour per week over the course of 12 weeks. Study authors Muth and Chatterjee were present at each of the lessons and participated in the lesson instruction. Control classrooms received the usual health education materials and none of the IMPACT materials.

Data Analysis

Questionnaires and height/weight data were entered manually into a Microsoft Excel database and exported to Stata 8.0 for analysis. For HS students, the authors examined baseline characteristics and then compared pre- and post-intervention dietary behaviors, physical activity behaviors, dietary knowledge, and diet/activity attitudes using t-tests and tests of equality of proportions for each variable as appropriate.

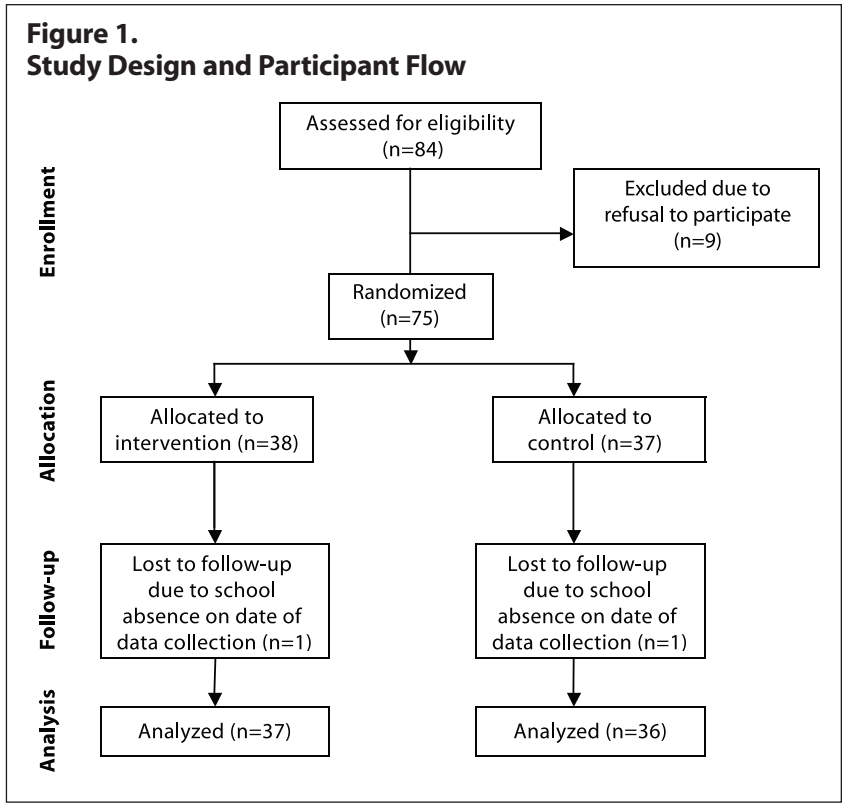
For ES students, baseline characteristics in the intervention and control groups were compared using t-tests and chi-square tests as appropriate for continuous and categorical variables. Distributions of the outcome variables of interest were examined for skew; for normally distributed outcome variables, only means are presented. The authors hypothesized that the intervention might affect multiple dependent variables (dietary behaviors, physical activity behaviors, dietary knowledge, and attitudes). The analysis therefore included estimation of a separate regression equation for each individual dependent variable of interest. Separate linear regression equations were used to estimate the pre-post intervention change in each dependent variable. Group (intervention or control) was the independent variable in each regression. Since the authors' hypothesis was that age, sex, and BMI percentile could affect each dependent variable, these were included as covariates in all regressions, as was the pre-intervention (baseline) value of each dependent variable. The authors expected that secular changes in the control group could affect dependent variables during the time period under study. Therefore, changes in the intervention group compared with the control group were examined; the relative pre-post intervention differences after adjustment for covariates are reported. All ES students were analyzed according to an intention-to-treat model in which participants were analyzed in the group to which they were assigned (intervention or control).

RESULTS

Elementary School Students

Overall pilot study design is shown in Figure 1. Among the ES students, 38 students from the intervention classrooms (90% of 42 eligible students) and 37 students from the control classrooms (88% of 42 eligible students) participated. Students not given parental consent to participate (n=9) were excluded. Baseline characteristics were similar among the ES intervention and control groups except for BMI percentile, which was higher in the intervention group (see Table 2). Follow-up data were collected from 97% of both the intervention and control ES groups. Lack of follow-up data was due to absence from school the day the data were collected.

Figure 1.
Study Design and Participant Flow



After controlling for sex, age, BMI percentile, and baseline value of dependent variables, ES students in the intervention group reported increased daily fruit and vegetable servings (from 2.3 to 2.7), while students in the control group decreased from 2.6 to 2.2 servings (p=0.05) (see Table 3). Compared with the control group, the intervention group also had increased

Table 2.
Baseline Characteristics in Elementary School Students

Characteristic	Intervention (n=38)	Control (n=37)	P-value
Age (years)	9.96	9.83	0.27
Gender (percent)			0.90
Female	47	46	
Male	53	54	
Ethnicity (percent)			0.46
White	66	68	
African American	11	11	
Hispanic	8	8	
American Indian	3	8	
Asian	0	3	
Other	13	3	
Mean BMI for age (percent)	70	60	0.05

intake of calcium-rich foods (+0.7 servings/day after adjustment; p=0.07) and grain intake (+0.7 servings/day after adjustment; p=0.08). The proportion of students who knew which food group most servings should come from increased significantly in the intervention group (0.4 to 0.5) compared with the control group (0.4 to 0.3; p=0.01). Compared to the control group, the intervention group did not have statistically significant changes in other measures including physical activity behaviors, sedentary behaviors, dietary attitude, or BMI percentile for age. In the follow-up survey, no students in the intervention group correctly answered the number of fruits and vegetables that should be consumed daily; the recommended number was the answer choice with the most servings.

High School Students

All HS students were female and either white (89%) or African American (11%); mean BMI percentile for age was 44.2%. Of the nine participating HS students, eight (89%) completed the post-intervention questionnaire. Although the HS sample for this pilot study was small and precluded detection of many statistically significant changes, we did observe nonsignificant dietary behavior changes similar to those in ES students (see Table 4). HS students reported increases in the daily servings of calcium-rich foods (1.9 to 2.5; p=0.22), daily servings of grains per day (2.3 to 2.9; p=0.17), daily servings of wheat bread (0.3 to 1.1; p=0.02), and daily servings of fruits and vegetables (1.3 to 1.9; p=0.23). The HS students also reported decreases in daily servings of white bread (1.1 to 0.6; p=0.10), sweetened beverages (1.9 to 1.3; p=0.17), french fries and chips (0.8 to 0.5; p=0.35), and sweets (0.5 to 0; p=0.10). No consistent pre-post intervention differences in HS students' dietary knowledge, physical activity behaviors, sedentary behaviors, diet/activity attitudes, or BMI percentile were detected. Attempts were made to collect qualitative feedback from the HS students about their experience, but the authors received little substantive feedback.

DISCUSSION

This pilot study evaluated the effects of a healthy diet and activity curriculum embedded within the traditional school day on the behaviors, knowledge, and attitudes of HS and ES students in rural North Carolina schools. ES students who received the 12-week IMPACT curriculum reported some improvements in dietary behaviors and knowledge when compared with students who did not participate in the curriculum. It is especially encouraging that students who participated in the IMPACT curriculum reported increased intake of fruits, vegetables, and calcium-containing foods, since these changes were emphasized in the curriculum. Increases in these food groups were modest (e.g. an unadjusted mean increase of approximately 0.5 fruit and vegetable servings/day in the intervention group). Nevertheless, even modest individual changes have the potential to improve overall diet and health in larger student populations.

Though intervention students increased fruit, vegetable, and calcium consumption, their dietary attitudes and beliefs did not change. Perhaps the IMPACT curriculum and peer modeling successfully emphasized certain dietary behaviors but did not adequately describe why the behaviors were important. Alternately, it is possible that the survey questions did not accurately assess dietary attitudes or that the 24-hour dietary recall was inaccurate, in which case a lengthier dietary recall instrument such as a three-day food record may have provided more accurate dietary information.

We did not detect significant differences in physical activity among ES students after IMPACT participation. Though about one-third of time was devoted to emphasizing activity in the curriculum, most of the time was spent participating in activity and little formal activity instruction was given. Moreover, the curriculum did not include a substantial family component or an after school component, which may be needed to increase physical activity. Additionally, it may be difficult to detect small changes in physical activity since self-report questionnaire items may have been insufficiently sensitive.

Several characteristics of the IMPACT program facilitated its implementation. Since the curriculum incorporated the standard North Carolina academic competency goals and did not increase classroom time, school administrators and teachers were willing to participate. School leadership and parents were also keenly interested in improving students' diet and activity and their support facilitated introducing this program. Following implementation of the pilot IMPACT program described here, school administrators and teachers from two other North Carolina school districts requested the curriculum.

Table 3.
Differences in Change in Knowledge, Attitudes, and Behaviors from Baseline to Follow-Up for Elementary School Students Participating in IMPACT Pilot Intervention Compared with Control Group

	Baseline		Follow-Up			
	Intervention (n=38)	Control (n=37)	Intervention (n=37)	Control (n=36)	Adjusted difference[a]	P-value
Nutrition behaviors (number servings/day)						
Fruits/vegetables	2.3	2.6	2.7	2.2	0.9	**0.05**
Calcium-rich foods[b]	2.9	2.6	3.3	2.6	0.7	0.07
Milk	1.9	1.7	1.9	1.5	0.2	0.17
Cheese	0.6	0.7	0.9	1.0	0.1	0.64
Yogurt	0.3	0.3	0.4	0.3	0.2	0.21
Grains[c]	2.2	2.2	3.0	2.4	0.7	0.08
Whole wheat bread	0.5	0.5	0.6	0.5	0.1	0.56
White bread	0.9	0.7	1.0	0.8	0.1	0.25
Rice/pasta	0.4	0.6	0.7	0.7	0.1	0.57
Cereal	0.5	0.5	0.7	0.5	0.2	0.18
Sweetened beverages[d]	2.1	2.1	2.0	2.0	0.2	0.82
Soda	0.4	0.4	0.6	0.4	0.1	0.51
Juice	1.0	1.0	0.7	0.8	-0.1	0.57
Other sugary drinks	0.7	0.7	0.7	0.7	0.1	0.67
Fries/chips	0.6	0.5	0.6	0.7	-0.2	0.29
Sweets	0.6	0.7	0.8	0.6	0.1	0.55
Physical activity behaviors						
Physical activity score[e]	7.2	6.2	7.8	6.7	1.0	0.28
Sedentary activities score[f]	4.6	2.5	4.7	3.1	0.2	0.80
Nutrition knowledge (proportion answering correctly)						
Know food group to eat the most servings	0.4	0.4	0.5	0.3	0.2	**0.01**
Know food group to eat the least servings	0.8	0.7	0.8	0.7	0.1	0.33
Know recommended number of daily fruit/vegetable servings	0.1	0.2	0	0.2	-0.1	**0.01**
Attitudes (proportion endorsing belief)						
Believe diet affects heart disease/cancer	0.6	0.5	0.5	0.5	0.0	0.81
Believe overweight affects health	0.6	0.6	0.6	0.5	0.1	0.37

a Adjusted difference is the difference in change for each variable before and after the intervention compared with the control group, after adjustment for sex, age, BMI percentile, and baseline value of dependent variables.

b Sum of daily servings of milk, cheese, and yogurt.

c Sum of daily servings of wheat bread, white bread, rice/pasta, and cereal.

d Sum of daily servings of soda, juice, and other sugary drinks.

e Sum of number of days per week of vigorous physical activity and days of moderate physical activity.

f Sum of daily hours of television, computer, and video game use.

Since the IMPACT program has the potential to reach all students within the traditional school day, this approach is promising for other school districts. While medical students provided valuable help in the training and implementation of the curriculum, teachers or volunteers could play a similar role in communities without access to medical students.

A novel aspect of the IMPACT program was the involvement of HS students as health educators for ES students. It was hoped that HS students might reinforce their own knowledge and behavior change through teaching. Though the number of HS students in the intervention was small and did not permit detection of many significant changes, encouraging trends among the HS students paralleled findings for the ES students. Like the ES students, HS students reported eating more grains, fruits, vegetables, and foods rich in calcium. Interestingly, the HS students did not improve nutritional knowledge or attitudes. It is possible that the survey did not adequately assess knowledge and attitudes, that we did not effectively influence the teens, or that our sample size was not large enough to detect these differences.

Several logistical issues made the involvement of HS students challenging. Specifically, though the two involved schools were close to each other, HS students still needed to be excused from their own classes to participate, and the same students could not participate each week. The HS students therefore had limited continuity of contact with the ES students, which may have limited their benefits as peer educators. Also evident was substantial variation in HS students' confidence and ability in assisting in 4th grade classrooms. A more rigorous selection process, additional training, and a system of rewards for the HS students could improve this component. Further studies would be needed to distinguish whether reported improvements in dietary behaviors were primarily attributable to peer modeling or to having a specialized nutrition and activity curriculum. Finally, qualitative analyses would be useful to understand the impact of the presenters on the students as well as the overall experience of participants.

Table 4.
Change in Knowledge, Attitudes, and Behaviors from Baseline to Follow-Up in High School Students Participating in IMPACT[a]

	Baseline (n=9)	Control (n=37)	P-value
Nutrition behaviors (number servings/day)			
Fruits/vegetables	1.3	1.9	0.23
Calcium-rich foods[b]	1.9	2.5	0.22
Milk	1.3	1.3	1.00
Cheese	0.6	1.0	0.28
Yogurt	0.0	0.3	0.17
Grains[c]	2.3	2.9	0.17
Whole wheat bread	0.3	1.1	0.02
White bread	1.1	0.6	0.10
Rice/pasta	0.9	0.7	0.74
Cereal	0.1	0.3	0.59
Sweetened beverages[d]	1.9	1.3	0.17
Soda	0.6	0.4	0.60
Juice	0.8	0.9	0.73
Other sugary drinks	0.4	0.1	0.35
Fries/chips	0.8	0.5	0.35
Sweets	0.5	0.0	0.10
Physical activity behaviors			
Physical activity score[e]	5.7	5.6	0.90
Sedentary activities score[f]	3.3	2.6	0.14
Nutrition knowledge (proportion answering correctly)			
Know food group to eat the most servings	0.9	0.7	0.34
Know food group to eat the least servings	0.9	0.7	0.27
Know recommended number of daily fruit/vegetable servings	0.6	0.6	1.00
Attitudes (proportion endorsing belief)			
Believe diet affects heart disease/cancer	0.6	0.5	0.81
Believe overweight affects health	0.6	0.6	0.37

a Table represents self-reported nutrition and physical activity behaviors, nutrition knowledge, and health attitudes of teen participants in IMPACT before and after program implementation.
b Sum of daily servings of milk, cheese, and yogurt.
c Sum of daily servings of wheat bread, white bread, rice/pasta, and cereal.
d Sum of daily servings of soda, juice, and other sugary drinks.
e Sum of number of days per week of vigorous physical activity and days of moderate physical activity.
f Sum of daily hours of television, computer, and video game use.

Although results from this intervention are encouraging, this study has several limitations. As a pilot project, only four 4th grade classrooms at one school participated. The small sample size limits generalizability to other schools and may have limited our ability to detect differences in some outcomes. Post-hoc power calculations demonstrated that with at least 34 subjects in each arm we had sufficient power to detect a difference of one serving per day in the outcomes which were the main focus of the intervention (daily fruit/vegetable and calcium servings; p=0.8, alpha=0.05). However, the number of subjects enrolled may have been insufficient to detect smaller differences in outcomes.

The intervention in this pilot study was directed at classrooms rather than individuals, since we theorized that classroom-level interventions are potentially effective in influencing knowledge and behavior on a large scale. While we acknowledge that classrooms constitute clusters of subjects and that larger confirmatory studies would need to incorporate multiple clusters in randomization and analysis, the aim of the current preliminary study was to evaluate the effects of the pilot program using individual-level analyses. A limitation of this approach is that risk of a type I error is increased. This risk was further increased by testing for multiple hypotheses. Also, we chose to test some additional hypotheses such as whether specific unhealthy diet behaviors decreased, such as daily consumption of sweetened beverages, fries, chips, and sweets. We acknowledge that testing a relatively large number of hypotheses further increases the chance of a type I error. However, since only three of the outcomes that we examined reached statistical significance, the likelihood of actual type I errors in our results appears low. Furthermore, because both control and intervention classrooms were at the same school, it is possible that cross-contamination occurred in which the students in the control classrooms were indirectly influenced by communicating with students from the intervention classrooms. This would have led to underestimation of differences between the intervention and control groups, which may have been greater than detected here. Finally, the baseline difference in BMI percentile limits the comparability of these groups.

While the evaluation tools used for the intervention have been validated and are age-appropriate, most of the measures collected were self-reported and subjective and were not associated with improvement in objective outcomes such as BMI percentile. Students in the intervention group may have reported improvements in behaviors in order to provide socially desirable responses. Anecdotally, however, several parents of children in the intervention group reported that their children were making healthy changes such as requesting whole grain bread instead of white bread and being more willing to eat vegetables at dinner.

Another limitation of the intervention is that it lasted only 12 weeks. Ideally, the IMPACT intervention would be incorporated into the school curriculum and reinforced throughout the school year. A longer-term study and follow-up would better gauge the effectiveness and long-term effects of the program.

With the preponderance of poor nutrition and physical activity behaviors among North Carolina's youth, schools need innovative ways to incorporate lessons about healthy habits into the preexisting curricula. The IMPACT curriculum is a promising program that can be adopted by school districts and counties to help children and teens develop healthy lifestyles. **NCMJ**

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