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Behavioral impact of a school-based healthy eating intervention for at-risk children

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BEHAVIORAL IMPACT OF A SCHOOL-BASED HEALTHY EATING INTERVENTION FOR AT-RISK CHILDREN

by

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ABSTRACT

Child health promotion is a salient public health goal. Childhood obesity rates have risen dramatically over the past few decades with more than 20% of youths overweight or obese by the time they enter middle school. Population-based strategies including those delivered through schools are needed to positively impact this trend. The IMOVE program evaluation, a quasi-experimental study involving one intervention and one comparison school, examines the influence of a school-based healthy eating program in a middle school cafeteria serving low-income, racially-diverse adolescents.

Study 1 examined the association between the availability of healthy lunch meals (IMOVE meals) in school cafeterias and lunch and snack food purchase patterns of students. The introduction of IMOVE resulted in significantly less participation in purchase of low nutritional quality snack foods from fall to spring term. Students in both schools had similarly high participation in school lunch all year long, suggesting that IMOVE participation was sustainable.

Study 2 examined the association between body mass index and purchase of IMOVE and standard school lunch meals in the intervention school. This study also identified sociodemographic predictors of participation in the school lunch program. Students who were overweight or obese had a significantly higher rate of purchase of

both types of lunches, but even more so for standard school lunch than for IMOVE meals, compared to students who were not overweight/obese. Other characteristics significantly associated with participation in IMOVE and standard school lunch were non-white race, sixth grade, and low-income status.

Study 3 examined the association between exposure to IMOVE and total daily food and nutrient intake measured using an abbreviated food screener before and after the intervention. At follow-up, students in the IMOVE school consumed sugary beverages and higher-fat milk offerings less often in their daily diets than students in the comparison school.

Efforts to combat childhood obesity through changes in the school food environment have some impact, but require the support of policy action and nutrition education initiatives to be most effective. The IMOVE program proved feasible, acceptable, and sustainable, providing a model upon which to build additional intervention components to more comprehensively impact student wellness.

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TABLES

ABBREVIATIONS

BMI	Body Mass Index
CATCH	Child and Adolescent Trial for Cardiovascular Health
DPH	Department of Public Health
DGA	Dietary Guidelines for Americans
FNS	Food and Nutrition Service
FFQ	Food Frequency Questionnaire
IOM	Institute of Medicine
IRB	Institutional Review Board
LNQ	Low nutritional quality
NSLP	National School Lunch Program
POS	Point-of-Sale
RDA	Recommended Daily Allowance
RFS	Recommended Food Score
SES	Socioeconomic Status
SBP	School Breakfast Program
SSB	Sugar sweetened beverages
SNDA-III	School Nutrition Dietary Assessment study – third round
USDA	United States Department of Agriculture

1 INTRODUCTION

Childhood obesity rates over the past few decades have risen dramatically.[1] One out of every three children ages 2 to 19 years is overweight or obese in the U.S., making it the most prevalent nutritional disease of this population and a significant public health concern.[2,3,4] Prevalence among children and adolescents has increased considerably from the mid-1960's,[5,6,7] with recent data from the National Health and Nutrition Examination Survey indicating relatively stable obesity rates among US children and adolescents since the year 2000.[4,8] From 1980 to 2002, the prevalence of overweight has tripled in children and adolescents ages 6 to 19 years.[9,10]

Based on recently revised body mass index (BMI) definitions,[11] current estimates are that 18.7% of youth in this age group are obese (> 95th percentile of BMI-for-age) and 34.7% are overweight (between the 85th and 95th percentile of BMI-for age) or obese.[4] Prevalence of overweight is higher in adolescents (ages 10-18) than in children (ages 6-9).[12] More than 20% of youth are obese or overweight by the time they enter middle school.[9] Youth today are on course to potentially be the first generation in the U.S. to live shorter, more unhealthy lives than their parents.[13]

It has been consistently documented that low socioeconomic status (SES) – the position of a person on a social and economic scale – and low-income are predictors of overweight,[14,15] although there is some evidence that this relationship varies by ethnicity and that the gap may be narrowing over time.[16,17] Children from families with low SES have a higher likelihood of engaging in behaviors that increase their risk for chronic disease, including a sedentary lifestyle and unhealthy eating marked by increased consumption of refined grains and added sugars and fats, all of which are typically less expensive and more convenient to lower-income groups.[18,19] Moreover, minority groups are at greater risk than their white counterparts of overweight/obesity.[20,21,22] New evidence shows a significant link between food prices and obesity, with fiscal pricing policies resulting in beneficial weight outcomes. In particular, increasing the cost of unhealthy foods, while decreasing the cost of healthy foods, has a measurable association with lower body weight, and the connection is more prominent for populations with low SES.[23]

1.1 Predictors and Burdens of Overweight/Obesity

Overweight is an independent risk factor for many chronic conditions that occur in childhood such as type 2 diabetes,[24,25,26] asthma,[27] chronic kidney disease,[28] hypertension,[29] and metabolic syndrome.[30,31] In addition, it has long been established that children who are obese are more likely to become obese adults, resulting in high rates of co-morbidity and mortality.[32-37] An obese 4-year old has a 20% chance of obesity persisting into adulthood while an obese adolescent has an 80% chance of becoming an obese adult.[38,39]

Adolescents who are obese are more likely to attain low SES and live in poverty as adults, mostly a result of poor self-esteem and physical health.[40] Overweight adolescents also experience psychosocial problems such as depression and anxiety, self-esteem issues, discrimination, social isolation, and overall reduced quality of life, regardless of their weight status as adults.[41-45] In addition to the medical and psychosocial consequences of being overweight, heavier children have a higher risk of absenteeism in school, possibly contributing to an academic disadvantage.[46] Overweight adolescents are vulnerable to chronic dieting, unhealthy dieting, and disordered eating behaviors,[47,48] with more recent research indicating that some of these factors are also causes of overweight in adolescents.[49]

Burdens attributed to obesity-related chronic disease and its associated behaviors are substantial from the perspectives of the individual, the family, the community, and the economy.[50] The current annual cost of childhood overweight/obesity has been estimated at $14.1 billion in direct (i.e., health care expenditures) and indirect (i.e., lost productivity) costs, $3 billion of which is in direct medical costs.[51]

The reality that obesity tracks into adulthood, and that obesity treatment strategies have limited success, translates into long-term health consequences. Many deaths can be attributed to obesity. Approximately 300,000 annual deaths occur as a direct result of two determinant behaviors of obesity: unhealthy eating habits and lack of physical activity.[52] Therefore, there is a large public health interest in moderating childhood obesity and its associated chronic conditions, specifically by addressing individual and environmental conditions that contribute to these determinant behaviors.

Obesity has a multifactorial etiology, with contributing factors being genetics, physiology, behavior, and environment.[53,54] Physiologic determinants of body composition are energy intake, energy output, and storage of energy as fat, carbohydrate, and protein. Imbalances in energy input and output ultimately lead to changes in body weight. Overweight occurs when excess calories are stored as fat, creating a positive net energy balance.[55]

Specific genes that contribute to this health condition are still being identified; it is known, however, that genetics alone are responsible for only very few obesity cases[21] and that genetic susceptibility is significantly shaped by the environment.[56] Thus, it is the interaction between genetics and environmental factors, or in many cases environmental factors combined with personal behavioral patterns, that lead to obesity risk.[53,55,57,58] One example, the built environment – the part of the environment created or modified by people – has been found to play a large role in fostering obesity through promotion of increased energy consumption and decreased energy expenditure.[58] Clearly, promoting healthier environments coupled with adopting positive personal behaviors would help reduce the obesity burden.[59]

1.2 Overweight/Obesity in Children

Reducing the prevalence of obesity among children and adolescents in the U.S. to below 5% of the population has been a key national health objective for the *Healthy People 2010* agenda. The same health objective is proposed for the *Healthy People 2020* agenda along with more focused objectives regarding BMI screening and nutrition standards in schools.[60,61] Since it is believed that dietary practices and food preferences adopted at early life stages carry over into adulthood,[62] it has long been advocated that prevention of excessive weight gain in children be recommended to achieve the most beneficial outcomes.[63,64] Traditionally, childhood obesity interventions are behaviorally based and are directed at those who are already overweight. Given the effect of obesogenic environmental influences, however, population-based environmental strategies such as those delivered through schools are needed to impact current trends in childhood obesity.[65,66]

In stark contrast to the dietary pattern promoted by the U.S. Dietary Guidelines for Americans (DGA), the diets of many American children and adolescents are high in fat, calories, and sugars but low in fruits, vegetables, low-fat dairy, and whole grains.[60,66] Although increased consumption of fruits and vegetables has been found to reduce long-term obesity risk,[67] some studies have shown that fewer than one in five children and adolescents consume the United States Department of Agriculture (USDA) recommended minimum standard of five servings per day of fruits and vegetables, with French fries comprising nearly a quarter of all vegetables consumed by young people.[66,68,69] Those from low income families consume even fewer fruits and vegetables.[70] Nutritional quality, including dietary balance and food variety, is essential in young children and adolescents to achieve proper physical, mental, and emotional growth and development.[71]

1.3 Influence of School on Children's Diets

The problem of poor diet in children and adolescents may be perpetuated by the school food environment.[72] The school food environment can play an important role in determining the overall lives, diets, and academic success of children and adolescents. Research indicates that overweight and obese children are more likely to miss school than their normal weight counterparts,[46] which in turn may negatively affect their academic performance[73] and their ability to function effectively at school[74]. Conversely, healthy nutrition and physical activity behaviors in school-aged children have been linked to improved academic performance and more desirable classroom behavior.[74]

Thus, schools present an ideal setting to provide children and adolescents with a healthy environment and both education and resources to practice healthy eating and physically active behaviors.[75] More than half of U.S. school-aged children receive lunch from a school meal program,[76] which is present in 99 percent of public schools.[77] Students consume a substantial amount of their daily calories (between 19 and 50%)[78,79] and fat[80] at school. Students are a captive population that can be reached continuously and intensively during much of the school year. Schools also offer the potential to target "at risk" youth without singling them out since environmental changes and classroom curricula can be broadly implemented.[65,74] No other institution has as much consistent and intensive contact with children during the first twenty years of life.[74] The two main points of foodservice intervention are federal meal programs (lunch and breakfast) and competitive foods (foods sold outside the formal meal programs as á la carte items, in vending machines, in school stores).[78]

The USDA requires that schools provide meals consistent with the DGA,[81,82] but these guidelines are based on the outdated 1995 guidelines. Of equal concern, these guidelines do not apply to foods and beverages that are sold á la carte, in vending machines, or in school stores (i.e., items that are not part of the reimbursable school lunch meal), meaning that snack foods, desserts, sugar-sweetened beverages, and other foods of poor nutritional quality may be widely available in school cafeterias, school stores, and vending machines.[76,83] These competitive foods have been shown to decrease the purchase of the more nutritionally complete school lunch meals,[84] and thus contribute to low intakes of fruits, vegetables, and important micronutrients.[85] Á la carte snack foods of low nutritional quality (LNQ), including sugar-sweetened beverages, chips, and cookies, are sold alongside reimbursable lunch entrees, making it challenging for students to make healthy choices when confronted with readily available, inexpensive foods that look and taste good, but offer little nutritional value.[86]

Improving the school food environment and school policies concerning food availability has been suggested as a population-based approach to address the problem of childhood obesity.[87,88] Accordingly, Congress included language in the Child Nutrition and WIC Reauthorization Act of 2004[89] that requires public school districts participating in the National School Lunch Program (NSLP) or other child nutrition assistance programs to adopt and implement a wellness policy by the first day of the 2006-2007 academic school year. School wellness policies are required to include: 1) goals for nutrition education; 2) an assurance that school meal nutrition guidelines meet the minimum federal school meal standards, especially for reimbursable meals; 3) guidelines for foods and beverages sold or served outside of school meal programs (i.e., the competitive foods); 4) goals for physical activity and other school-based activities; and, 5) implementation plans and stakeholder involvement. The potential impact of these wellness policies may be extensive. During the 2007-2008 academic year, more than 31 million students participated in the NSLP and more than 10 million in the School Breakfast Program (SBP).[90] While federal mandates are in place to enact school wellness policies, there is insufficient support to implement these plans and little oversight to ensure accountability. A recent study concluded that while most students nationwide were enrolled in a public school district with a wellness policy at the beginning of the 2007-2008 academic school year (94%), the quality of the wellness policies varied widely from district to district, with many policies being underdeveloped, disjointed, and lacking appropriate plans for implementation, monitoring, and evaluation.[90]

The NSLP and SBP are similarly organized and overseen by the USDA Food and Nutrition Service (FNS). It is the responsibility of each state to administer the programs and ensure they are meeting federal guidelines. There is flexibility in the types of foods that can be served in any given school district. One nationally consistent feature is that students residing in households with family incomes at or below 130% of the federal poverty line are eligible for free meals at school, while those in households with family incomes between 130% and 185% of the federal poverty line are eligible for reduced price meals. This plan for reimbursable school meals for low-income children facilitates access to foods that meet the government's nutritional standards for at least one or two meals each day that school is in session.

A committee of the Institute of Medicine (IOM) released in 2010 proposed recommendations to change the NSLP and SBP to update their nutrition standards and meal requirements to reflect more recent dietary guidelines and to incorporate recommended changes to the school environment to promote healthy eating in children.[91] Recognizing the importance of evaluation in determining the success of school-based programs and policies, the IOM committee also recommended that future research include studies that examine the implementation of new school meal requirements, children's acceptance of and participation in school lunch, and children's overall health status as important outcomes.[91]

School-based environmental interventions are an important component to efforts to effectively combat childhood obesity by making healthy foods available and affordable, particularly to at-risk populations. Government agencies[1,14,91] and public health advocacy groups[92] have identified schools as a target setting to implement effective public health strategies for reducing the prevalence of childhood overweight.[93] Schools are a target setting for childhood obesity interventions, given that students can be reached at multiple levels of the socio-ecological model, including the environmental, interpersonal, and individual levels. Environmental-level changes are necessary to foster and sustain individual-level behavior change.[94] Such interventions, which are comprised of strategies to alter the physical or social environment and may address availability, accessibility, or social norms,[94] can support a healthy lifestyle and reduce barriers that in turn can have a substantial impact on behaviors at the population level.[95] Recommended strategies for schools include the provision of access to food choices that are low in fat, calories, and added sugars, such as fruits, vegetables, whole grains, and low-fat or nonfat dairy foods.[14]

1.4 Effects of School-Based Interventions

Well-designed school-based interventions combine a variety of creative strategies to impact childhood obesity. While many educational interventions have been implemented to promote individual behavior change, results have included modest behavior changes and mixed results with respect to surrogate markers of obesity (e.g., waist circumference, BMI, triceps skinfold thickness). This may be because interventions focused solely on individual-level behavioral change ignore the social and built environments, which in turn can limit an individual's access to affordable, healthful foods. Thus, regardless of new information learned at the individual level, the environment does not support the newly-learned strategies for healthy behavior change.

Demographic, psychosocial, or perceived environment variables can mediate or moderate environmental effects on healthy eating.[96] Thus, successful environmental-level interventions not only enact changes to the environment, but also address individual characteristics and perceptions. Understanding the reasons an individual consumes specific foods, whether influenced by internal perceptions or external influences, is important to developing a successful school-based initiative. Specifically, minimizing access to unhealthy foods can encourage healthy eating behavior. Accordingly, an environmental approach can bring about targeted reductions in the availability of LNQ snacks and foods (including components of school meals) that are high in fat and calories thereby promoting healthy food consumption.[97-99]

Studies have demonstrated that school food environments are related to students' dietary behavior[100-102] and body weight,[103] and that school-based programs can yield positive results in preventing and reducing obesity.[104] Interventions to change school food environments have been limited,[53,105-108] however, and few have been rigorously evaluated,[108] thus producing limited evidence on which to base future recommendations.[109] Where interventions have been rigorously evaluated, positive effects have been observed on students' choice of healthy foods.[110] In a recent literature review of school-based obesity interventions, no environmental-level interventions for dietary changes were found to meet the criteria for inclusion in the review.[111] Studies lack either pre- or post-intervention assessments, and only a few studies examined food environments and school policies in nationally representative samples of students.[112] This is unfortunate given the need to identify and implement evidence-based, sustainable school-based environmental programs.

It has been argued that school-based environmental changes may be more effective at promoting obesity-related behavior change than curriculum-based educational efforts,[14] but successful school-based interventions require significant support from the school administration and the community – support that is often lacking, particularly in low SES areas.[105] Studies have shown that although school-based educational interventions were effective in changing short-term behavior, healthy behaviors were sustained long-term only when the educational interventions were coupled with an environmental component, were multi-year, and enlisted parental support.[113]

Consistent with these findings, the IOM recommends that schools provide a reliable and consistent environment with many opportunities to adopt healthy eating behaviors.[87] The reality is that often these recommendations are difficult to implement. Rigid school meal programs and the low nutritional quality of competitive foods are common challenges to healthy eating in schools.[114] Further, the financial solvency of the foodservice operation is a very real obstacle that contributes to restrictions on foodservice vendor contracts, limited availability of certain food items, limited resources to offer more nutritious food choices, and reliance on profits from the sale of competitive foods to meet financial demands. Recent USDA cost study research has shown that competitive foods are being subsidized by healthy school meals; federal funds earmarked to provide nutritious meals to low-income children are in fact covering the costs of competitive foods.[115]

Childhood obesity prevention programs require an approach that is evidence-based to ensure that the strategies have their intended effects and that limited resources are well invested. The IOM posits that "carefully designed evaluations of ongoing programs and policies are likely to answer many key questions" about the best strategies to combat childhood obesity.[87] Only a few school-based interventions that have been evaluated have demonstrated desirable changes in food group consumption, and even fewer have demonstrated positive effects on reducing saturated fat intake. Those that have been evaluated are more often behaviorally-focused interventions. Thus, there is a need not only to develop and implement new environmentally-focused interventions to address childhood obesity, but also to evaluate existing interventions in order to derive lessons learned and strategies for future childhood obesity prevention programs, particularly in schools.

There have been several multi-component interventions in school foodservice that have demonstrated effectiveness. The Child and Adolescent Trial for Cardiovascular Health (CATCH) study was a three-year, randomized trial that compared 56 intervention school cafeterias offering foods lower in fat and salt against 40 control school cafeterias. The intervention resulted in reduced intake of total fat and sodium among students enrolled in 3rd grade at the beginning of the study, but no statistically significant effects on BMI.[113,116] The CATCH paradigm was successfully adapted to schools serving low-income, minority students.[117] Other interventions promoting fruit and vegetable intake, including 5-A-Day Power Plus, a randomized trial in 20 inner-city elementary schools,[118] and Gimme 5, a 4-year randomized trial in 12 high schools,[119] increased consumption of fruits and vegetables by increasing variety, availability, and taste. One intervention strategy increased consumption of low-fat milk in elementary school children by using techniques found in social marketing campaigns including point of purchase advertising, sales promotions, product positioning, and taste testing.[120] Finally, an environmental-level, school-based, group-randomized intervention study to increase availability and intake of fruits and vegetables in elementary schools showed statistically significant increases in vegetable intake (not including potatoes) and fruit and fruit juice consumption.[100]

In minority and low-income school communities, there have been two randomized controlled trials aimed at decreasing fat intake and increasing fruit and vegetable consumption, each lasting two years. The High 5 Project, a multifaceted intervention including classroom, parent, and cafeteria initiatives, was conducted in 28 elementary schools, resulting in statistically significant increases in fruit, vegetable, and micro- and macro-nutrient intakes.[121] Teens Eating for Energy and Nutrition at School (TEENS) was conducted at 16 middle schools using a classroom curriculum, parent education component, and modifications to the school lunch menu.[122] TEENS resulted in intervention school students choosing lower fat á la carte foods. Additionally, the Pathways Study, a three-year, multi-faceted intervention in 3rd to 5th grades that included changes to school menus, demonstrated reductions in the intake of calories from fat and saturated fat at school lunch and throughout the day.[123]

School-based intervention studies have produced mixed results in examining the relationship between fruit and vegetable intake and overweight in children.[65,124] While research suggests that delivering interventions to upper elementary and middle school students may be most helpful for changing overall behaviors because of behavioral development in this life stage,[107] only a couple of interventions have targeted middle-school students.[125] Further, most of the school-based studies described above reported aggregate school-level data and did not look at patterns of individual behavior. None of the previous interventions linked individual student characteristics to BMI or other outcomes; none assessed personal predictors of school lunch participation, like BMI or SES; and none examined the impact of changes made to the school food environment on the overall quality of students' diets, including foods chosen and consumed at home.

1.5 Justification for the Present Study

The IMOVE evaluation study was initiated to address the above-mentioned limitations in prior school-based nutrition promotion research. IMOVE is a school-based environmental intervention designed for middle school cafeterias to promote healthy eating behaviors through increased access to affordable and nutritious alternative school lunch meals. The IMOVE intervention not only provides healthy school lunch alternatives, offered alongside standard school lunch, but also advertises the importance of balanced nutrition through cafeteria posters and flyers, and rewards school lunch purchases through raffle prizes. The IMOVE program evaluation, a quasi-experimental study involving one intervention and one control school, examines the influence of a school-based healthy eating intervention in a middle school cafeteria in a low-income Massachusetts community with children of mixed racial/ethnic backgrounds. Unlike most recent studies,[126] sociodemographic information was collected for each individual student who participated in the IMOVE study, allowing the unique opportunity to link individual student's sociodemographic characteristics and BMI to food purchase behavior. This design feature makes it possible to understand who is reached most effectively by this type of intervention and to identify subgroups of students who may be harder to reach and require novel, targeted strategies to engage and impact.

IMOVE meals address all areas of future study that have been proposed in the literature on environmental influences, particularly in schools. One recommendation is that future research examine whether school food environment exposures are associated with student food choices in school as well as total daily intake and overall dietary quality.[86,127] A second recommendation is that future studies should focus on access and availability of nutritious foods, a significant problem in some communities.[128] A third recommendation for future study is an examination of portion sizes since environmental factors heavily influence eating by altering the perception of the appropriate serving as well as interfere with the ability to monitor intake.[129] Typically, unappealing foods become more attractive because they are served in large containers and thus contribute to overeating.[130,131] Inspired by these recommendations, IMOVE meals are appropriately portioned, are accessible (served alongside standard school lunch meals), and are affordable (they cost the same as standard school lunch). Thus, a rigorous evaluation of IMOVE could offer invaluable insights to these areas recommended for additional research.

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2 COMPREHENSIVE METHODS

2.1 IMOVE Program Evaluation

The three studies in this dissertation draw from the evaluation of the IMOVE program. IMOVE is provided through Costa Fruit and Produce, a food purveyor based in Charlestown, MA. IMOVE is a school-based environmental intervention designed for middle school cafeterias to promote healthy eating behaviors through increased access to *affordable* and *healthy* school lunch meals with appropriate portion sizes. IMOVE meals, which are priced comparably to regular school lunch meals ($2.00 per meal, on average), meet rigorous, established nutritional criteria at the time IMOVE meals were planned and implemented for total fat, protein, and important micronutrients. IMOVE meals are served alongside standard school lunch in the school cafeteria.

In summary, there are six components of the IMOVE program. First, IMOVE includes an extensive product line of nutritious ingredients and healthy food choices. IMOVE meals provide less than 25% of calories from total fat and less than 10% of calories from saturated fat. In contrast, the federal NSLP guidelines, which are based on the outdated 1995 DGA,[1] require that a weekly school lunch menu average fewer than 30% of calories from total fat. IMOVE also offers nutritionally balanced weekly menus that exceed standard school nutrition guidelines, including the provision of at least one-third of the Recommended Daily Allowance (RDA) for protein and key micronutrients such as calcium, iron, and vitamins A and C per meal. IMOVE meals and snacks also limit amounts of sodium and added sugars.

Second, the IMOVE program offers a range of menu plans that include nutritional information, recipes, and preparation guidelines for foodservice workers, as well as ongoing support and training on the program. IMOVE offers 38 weeks of menus that utilize a 6-week menu cycle. Over time, these menus are modified by Costa's consulting dietitian based on feedback from foodservice operators to cater to the needs and cultural preferences of school-specific clientele. Foodservice managers receive formal training, implementation guidelines, and user's manuals containing menus with ingredient product information that directly links to purchase orders through Costa. Third, extra cases of fruit are shipped to the school each month at no charge, to be used at the discretion of the cafeteria manager to distribute at lunch. This gives the cafeteria staff additional resources to offer fresh fruit as á la carte or in their menu, thereby increasing awareness of the program to cafeteria managers and accessibility of fresh fruit to the students.

The remaining components of the IMOVE program serve to increase awareness of and participation in the program. Fourth, merchandising materials – specifically, point-of-sale nutritional information and action-oriented posters that empower children to "choose health" – are provided to foodservice directors to display in the school cafeterias. Fifth, a series of promotional events occur monthly throughout the school year. At these events, free samples of fruits and vegetables, arranged in eye-catching displays, are given away to students during the lunch period. Nearby educational materials tout the nutritional quality of the produce and the many ways the foods can be enjoyed. These promotions also include raffle prize drawings and give-aways, healthy foods with the IMOVE sticker logo, and attention-grabbing IMOVE posters.

Sixth, there is a rewards program tied to the purchase of IMOVE meals to incentivize students to try IMOVE lunches. Incentives to participate in IMOVE are awarded through raffles. Students receive a raffle ticket every time they purchase an IMOVE meal or salad. Winners are chosen every 4 to 6 weeks to receive prizes that promote physically active lifestyles (sports gear, back-packs, frisbees, etc). Twice yearly, a larger prize is raffled, such as a mountain bike or tickets to a professional sporting event.

Prior to this study, the IMOVE program had been offered in 14 Massachusetts middle schools with funding from the Massachusetts Department of Public Health (DPH) and private sector partners. The intervention was implemented almost exclusively in suburban communities of middle- to upper- SES and enrolled predominantly Caucasian children. Thus, the low-income and racially diverse populations most in need did not have access to this environmental-level intervention. IMOVE implementation in the 14 Massachusetts middle schools was not evaluated. Even if it had been, results from those communities would not necessarily be transferable to communities of different sociodemographic characteristics with substantial racial and ethnic diversity, various cultural backgrounds, higher numbers of risk factors, unique barriers, and fewer resources. In order to address the childhood obesity epidemic in communities at risk, and to gauge the potential impact of various intervention strategies, rigorous evaluations must be conducted.

2.2 Study Design and Population

The studies presented here utilize data from the two middle schools participating in the ongoing evaluation of the IMOVE program. The IMOVE program evaluation is a quasi-experimental study with an intervention and a comparison school from the public school district in Quincy, Massachusetts. One middle school was randomly chosen to receive the IMOVE intervention for the 2008-2009 academic year. A demographically similar comparison middle school from the same school district was also enrolled. The comparison school agreed not to receive IMOVE during the study year, but would be eligible to receive the IMOVE lunch program once the program evaluation was completed.

Protocols, data collection instruments, and consent forms were approved by the Institutional Review Board (IRB) at Boston University.

All students in the intervention school were exposed to the IMOVE program and were able to purchase IMOVE meals in their school cafeterias while still having access to the standard school lunch. Students in the comparison school had access only to the standard school lunch. Students in both schools had similar access to the same á la carte foods and beverages.

Process data was collected on healthy eating initiatives occurring in the intervention and comparison school at the time the IMOVE intervention was implemented. In the intervention school, IMOVE was the only program delivered. In the comparison school, there were no environmental-level healthy eating initiatives being delivered. However, posters for the Got Milk campaign were displayed in the school cafeteria. Additionally, there were a couple of events that occurred in the comparison school before the research was conducted, and remained at the school during the time of this research project. One was a school-wide cookout at Thanksgiving where healthy food items were served. Another was part of the local Jump Up And Go campaign that provided physical activity equipment to the physical education department at the school.

Quincy was selected for the IMOVE study because this urban public school community is racially diverse (African American = 5%; Asian = 35%; Hispanic = 3%; White = 55%; Multi-Race/Ethnicity = 2%)[2] with a majority of children from low-income families (51.2%). There were 818 students, grades 6 through 8, in the two middle schools during the 2008-2009 academic year. Characteristics for the entire sample are shown in Table 1. At any given time, about 70% of students in this school district participate in the school lunch program, in part because many are of low SES and are eligible for free/reduced price lunches. In these two schools, 98.9% of the enrolled students and 100% of the students eligible for free/reduced-priced lunch participated at least once in school lunch, during the time period of this study. Free/reduced-priced lunch is based on family income or categorical eligibility due to household participation in other federal assistance programs,[3] and participation in the program is often used as a proxy for low SES[4].

There were some demographic differences between the two schools. Students in the intervention school were, on average, about 5 months younger than the comparison school students (although grade was not significantly different), were not as overweight/obese as the comparison school students, and had a significantly different ethnic/racial profile, with more Asian/Pacific Islander students attending the intervention school and more white students attending the comparison school (Table 1).

2.3 Datasets and Data Collection

As various types of data were collected for the IMOVE evaluation, multiple datasets were created and compiled. These included cafeteria food purchase data downloaded from computerized cash register systems, anthropometry, a food and nutrient intake screener, school enrollment data, and a behavioral survey. Each dataset is described below, and where appropriate, more detail is provided in the description of each specific study that used a particular dataset. Table 2 outlines the multiple data sources and details the studies for which each was used.

The cafeteria food purchase and anthropometric datasets were derived from existing sources in the Quincy schools. For these datasets, parents were informed of the school district's research partnership and its agreement to share these data with the study team confidentially and with approval from the Boston University IRB. Parents who did not want their child's information shared with the research team were instructed to decline participation by writing to their school principal, but none chose to do so. This process of passive consent was not permitted for the food intake and behavioral surveys since these assessments were not routinely collected outside of the research study.

Students were required to have parental informed consent in order to take these surveys; thus, survey respondents represent self-selected subsamples. The food and nutrient assessment (the validated Block Kids Food Screener,[5] which measures daily food and nutrient intake) and the behavioral assessment (the IMOVE evaluation's Choices Survey) can be found in Appendix A and Appendix B, respectively.

Note that certain outcome data were collected on all students by the school (enrollment data; school lunch and IMOVE participation; food purchases and sales; and, BMI) while the food intake and behavioral assessments were completed by self-selected subsamples of students in each grade and in each school. Regardless of the data collection strategy, students were assigned a unique identifier so that data from various sources could be linked.

School Enrollment Data

Enrollment data obtained from the Quincy school district identified each student enrolled in the middle school by name, date of birth, gender, race/ethnicity, grade, and both the student's unique 4-digit student ID and a unique 7-digit state ID. The enrollment database allowed for 62 different codes for race/ethnicity. Based on the school's demographics, and to avoid sparse data, the 62 categories were combined into five: White, Black/African American, Asian/Pacific Islander, Hispanic, and Multi-

Race/Other Race. The enrollment data was the foundational database used to merge all of the other datasets as it contained both the 7-digit state ID that students used in the cafeteria cash register system and the 4-digit student ID used by school nurses when recording the anthropometric measurements and by students on their food intake and behavioral surveys.

Cafeteria Food Purchase Data

Cafeteria food and beverage purchases were tracked through point-of-sale (POS) computerized cash register systems that were provided to the participating schools. These sophisticated registers are not typically available for school foodservice because of the cost, but also because they are not mandatory for daily functions. They were provided to the participating schools for the study in order to measure changes in cafeteria food purchase behaviors. POS systems create electronic datasets that track purchases of 1) all IMOVE meals in the intervention school, 2) all regular reimbursable school lunch meals (i.e., standard school lunch) in both schools, and 3) all á la carte foods and beverages (including healthy options like fresh fruit and low-fat milk as well as LNQ items like snack chips, baked desserts, and ice cream treats) in both schools. The POS system used was Nutrikids™ (©LunchByte Systems, Rochester, New York). Cashiers were trained prior to the start of the intervention on how to enter meals (IMOVE and standard), á la carte items, and the student's unique 7-digit state ID number at each purchase.

The POS system has two databases – one that lists all enrolled students as provided by the school district, and one that lists all transactions per student and per day. The two databases both contain the unique 7-digit state ID, allowing for individual food purchases to be linked to student sociodemographic information that has been verified for the school district's database such as age, grade, gender, race/ethnicity, school, and eligibility for free or reduced price lunch (an indicator of SES). While the student database listed all enrolled students, the transaction database contained only those students who purchased either a school lunch meal (IMOVE or standard lunch) or an á la carte food or beverage at least once in the 2008-2009 school year.

Purchase transactions were tracked individually, and therefore the database could capture multiple food and beverage purchases in a given day for each student. Transactions were date-stamped and time-stamped, allowing for differentiation between breakfast and lunch purchases. Since IMOVE is strictly a lunch program, all transactions made during school breakfast were excluded from the analyses. As noted, analyses for all three studies used data collected during the 2008-2009 academic year.

Anthropometric Measurements

Anthropometric measurements were taken to obtain height and weight measures necessary to compute BMI [weight (kg)/height $(m)^2$] for each student. Students' height and weight were measured in street clothes without shoes in a private location during physical education class periods, according to standardized procedures and using equipment available to school nurses in the Quincy schools. Measurements were taken by school nurses with the assistance of trained research staff, documented on paper forms, and duplicate-entered into an Excel database. Measurements were taken on all students currently enrolled in the school. Nurses made special efforts to measure students who were absent on the original day when their classmates were measured. Anthropometric measurements were missing for 3.9% of enrolled students in the intervention school and 8.7% of enrolled students in the comparison school.

Gender-specific BMI-for-age percentiles and BMI z-scores were calculated to assess the prevalence of overweight using the USDA/ARS Children's Nutrition Research Center website.[6,7,8] In accordance with current guidelines, children were categorized as either obese (BMI-for-age ≥95th percentile), overweight (BMI-for-age 85th to < 95th percentile), healthy weight (BMI-for-age 5th to <85th percentile), or underweight (<5th percentile).[9] Some analyses used BMI as a continuous measure by employing BMI z-score, a standardized BMI that is calculated using an external reference population to statistically adjust for gender and age differences.[10] BMI z-score allows for increased interpretability over the crude BMI measure and is preferable to BMI-for-age percentile, which is poorly suited for statistical analyses.[11]

Assessments of Food and Nutrient Intake

Assessments of food and nutrient intake were made using the validated 42-item Block Kids Food Screener (Block © 2007)[5] (Appendix A). The screener measures "usual" intake of common foods and beverages in adolescent diets by asking students to report their frequency of consumption over the past week. The screener was created from the same nationally representative dietary survey data as the more extensive Block Kids Food Frequency Questionnaire (FFQ), which has demonstrated reliability and validity in adolescents, including minority adolescents,[12-14] and is one of the two most widely used FFQs in epidemiologic research. The screener assesses intakes of food groups and nutrients, including fruits and vegetables, saturated fat, and added sugars. The screener, designed to be brief in order to decrease respondent burden, is a 2-sided scannable survey.

All students were invited to complete the Food Screener at the fall baseline assessment. The subsample of students whose parents gave informed consent completed the baseline assessment in October. The same students who had consented to the baseline assessment were asked to complete the follow-up assessment in June. Students completed the screener in either a health and wellness class or in homeroom after receiving instructions from their teacher. The forms were cleaned and prepared for scanning and then sent to NutritionQuest to be scanned. Quantities and frequencies of individual food items, food groups, and selected nutrients were generated. In all, NutritionQuest produced over 200 food, food group, and nutrient variables from the 42-item survey.

Assessment of Behavioral Covariates

An online survey was administered to students via Survey Monkey to obtain behavioral covariate information. This survey, called the Choices Survey, was created using previously validated individual components to collect data on behavioral variables including current exercise habits,[15] eating competence,[16] readiness to change diet and exercise behaviors,[17] and self-esteem.[18] These variables were chosen after a review of the literature identified them as potential modifiers of the three research questions being examined here. Each variable and the scoring mechanism are explained individually below; the full survey can be found in Appendix B. If any students had a missing value for a question that was used to create a score, then that score was not generated for them, and they were excluded from the analysis for that topic.

Two questions were asked to assess leisure time activity, which was defined as "exercise you get during your free time outside of the normal school day. Do not include the exercise you get during PE (gym) class; but do include exercise you get by practicing for or playing on sports teams." Students were first asked how many times on average, during a typical week, they participated in at least 15 minutes of strenuous, moderate, or mild exercise during their free time. Weekly frequencies of strenuous, moderate, and mild activities were multiplied by nine, five, and three, respectively, and then summed to create a total weekly leisure activity score. A higher score indicated more activity at higher intensities. Students were also asked how often during a typical week they "engage in any regular physical activity long enough to work up a sweat" with response options including often, sometimes, or rarely/never.[15] In the comparison school, one outlier was excluded due to an extreme score.

Eating competence of students was assessed by the Satter Eating Competence Model. This model is based on the effectiveness and utility of hunger and the drive to survive; appetite and the need for reward; and, the biological propensity to maintain a stable and preferred body weight. Individuals who are eating competent have positive attitudes about food, skills that support acceptance of a variety of foods, self-regulation skills that give energy and support a stable body weight, and skills for managing the individual's food environment.[19] Students were asked to indicate on a 5-point Likert scale (always, often, sometimes, rarely, never) their agreement with each of 16 statements about their attitudes and feelings toward food and eating. Scores were assigned to each response based on the validated scoring scheme with "always" = 3, "often" = 2, "sometimes" = 1, and "rarely" and "never" = 0. Scores totaled 0 to 48, with higher scores indicating a higher degree of eating competence. This range was dichotomized into eating competent (score of 32 or greater) or not eating competent (score of less than 32).[16]

The Transtheoretical Model of Change serves to understand an individual's current behaviors and readiness to change those behaviors. Central to this model is the Stages of Change construct,[20] which was used in this survey to assess students' readiness to change their current exercise and eating behaviors. Consistent with past research,[17] students were given six statements about eating and exercise habits and asked to indicate which response best described their current habits: "I have no plans to do this" (precontemplation); "I have thought about doing this and will probably do it in the next 6 months" (contemplation); "I have thought about doing this and will probably do it in the next month" (preparation); "I have recently started to do this" (action); "I am already doing this and have kept it up for 6 months or longer" (maintenance). Proportions of students who fell in each stage were assessed.

Self-esteem was assessed using Rosenberg's Self-Esteem Scale.[18] Students were given a list of ten statements regarding their general feelings about themselves, including their abilities, worth, and respect, and had to indicate the degree to which they agreed with each statement using a four-point Likert scale (from strongly agree to strongly disagree). There are both positively and negatively worded items. Responses were scored from 0 to 3, and the total score was calculated as the sum of all responses for a range of 0 to 30. A higher score indicated a higher degree of self-esteem.

The survey was available to students in December 2008. After they accessed the survey through the web link on the school's web site, students were told that the survey would take 15 minutes to complete, that it was voluntary and anonymous, and that they could skip any question they felt uncomfortable answering. To foster participation, students were asked to print a verification page upon survey completion for entry into a raffle.

Students entered their 4-digit student ID to enter the survey. They were then asked sets of questions about: demographics (age, grade, race/ethnicity); leisure time physical activity; stages of change for eating and exercise habits; feelings and attitudes about food and eating (the eating competence assessment); and general feelings about themselves (the self-esteem assessment). Survey information was downloaded from Survey Monkey into an Excel database.

There were two important limitations unique to the behavioral assessment that compromised its analytical utility. First, only students whose parents gave informed consent could take the Choices Survey, resulting in a self-selected subsample (35.6% of students in the intervention school and 13.5% of students in the comparison school). Second, because of institutional barriers and limited time in the school day, the survey was not designed to be completed in class, but instead at home or on the student's own time using a computer at school. Lack of time and resources both at home and school introduced an unanticipated obstacle that severely hindered response rates. In the intervention school, teachers converted the on-line survey to a paper format and allowed students to take the behavioral survey in class, but this was not a viable option in the comparison school. These obstacles lowered participation rates for the survey, delayed the completion time line, and resulted in different protocols in survey administration between the intervention and comparison schools, which likely contributed to the groups' differential response rates. In the end, students completed the survey any time between December 2008 and June 2009, meaning that some students took this survey after nine months of exposure to the IMOVE intervention. For these reasons, results from the Choices Survey were used only for selected exploratory analyses in Study 2.

With the exception of age, the group differences observed at baseline for the full sample were also evident in the subsample of students who completed the behavioral assessment (Table 3). Regarding the behavioral assessment, there were some significant differences observed between students in the intervention and comparison schools. Both the weekly leisure time activity score and the self-esteem score were significantly higher in the comparison school than in the intervention school, with higher scores indicating higher levels of physical activity and self-esteem. Out of the 6 stages of change topics, only "readiness to increase consumption of whole grain foods" was significantly different between the two schools' respondents, with much higher proportions of students reportedly in the "action" stage in the comparison school compared to the intervention school (Table 4).

Final Analytical Dataset

The final analytical dataset used for the three studies was created by merging all of the aforementioned datasets using the 4-digit student ID numbers. Students who completed two (baseline and follow-up) Food Screeners were linked by ID so that each student had one row of data in the final dataset. In instances where students had not been assigned a student ID, their surveys were matched by name and date of birth, and they were subsequently assigned unique identifiers to link them across the various datasets. After thorough cleaning of all five datasets, there was no student where data could not be linked across more than one dataset.

Based on student participation in the various assessments described previously, some students did not have complete information for all variables in the final dataset. The final dataset contained 818 students across the two schools and over 320 variables. Study samples for the three studies varied depending on the data sources used to answer the study question.

2.4 Statistical Analysis

Statistical analyses were similar for all three studies since in each study, the primary exposure was dichotomous – for Study 1 and Study 3 intervention versus no intervention, and for Study 2 overweight versus not overweight – and all outcomes were continuous measures. In Studies 1 and 3, analyses tested whether the intervention had an effect, with the unit of observation being the student and clustering according to school. In Study 2, the unit of observation for both the dependent (participation in school lunch) and independent (BMI) variables were the individual students. Thus, based on previous literature, there was no justification for the use of hierarchical models to test the study hypotheses.[21]

To begin, descriptive analyses were conducted on the study-specific samples to assess the proportion of students within each sociodemographic category (e.g., gender, race/ethnicity, socioeconomic status, age, grade, BMI category), experimental group, and behavioral covariate category. Continuous variables that exhibited departures from normality were examined using the Wilcoxon Rank Sum test or Kruskal-Wallis test. Subsequently, stratified analyses were conducted using non-parametric tests or t-tests for continuous variables and Chi-square tests for categorical variables to assess differences between the experimental groups. For any table with a cell frequency of 5 students or less, Fisher's exact test was used.

Next, for each study, the proportion of students from the overall sample that was eligible for the study-specific sample was examined. The study-specific sample was then compared to the overall sample on important sociodemographic variables to determine the representativeness of the study sample. Within each study sample, respondents were compared to non-respondents to assess differences between those with and without complete data. The sociodemographic variables and, where appropriate, the behavioral characteristics were examined to determine if any were significantly associated with the study outcome.

Finally, multiple linear regression analysis was used to assess the effect of the intervention on the outcome, controlling for the predetermined confounders along with any suspected confounders. Parameter estimates with standard errors were reported to illustrate the estimated effect of the intervention (Studies 1 and 3) or the estimated effect of overweight status and BMI (Study 2). These analytic methods are similar to those employed in similar studies.[22] Due to little or no prior knowledge on which to base directional hypotheses, all hypothesis tests were two-sided with a 0.05 level of significance. All analyses were performed with the SAS Statistical System version 9.1.3.[23]

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Table 1. Characteristics of the Total Sample, by School

	Intervention School (n=477)[1,2] [% (n)]	Comparison School (n=341)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.6 (0.9)	13.0 (0.9)	<0.0001
Eligible for free/reduced price lunch (SES indicator)	53.9 (257)	47.5 (162)	0.07
Body Mass Index (continuous)			
BMI [mean (SD)]	20.3 (4.8)	21.9 (5.5)	<0.0001
BMI z-score [mean (SD)]	0.3 (1.2)	0.62 (1.1)	0.0003
BMI-for-age percentile [mean (SD)]	57.5 (32.4)	66.7 (28.6)	0.0003
BMI-for-age (categorical)			
Underweight (<5^{th} percentile)	7.1 (31)	2.3 (7)	0.009
Healthy Weight (5^{th}-84^{th} percentile)	63.2 (276)	60.2 (183)	
Overweight (85^{th}-94^{th} percentile)	15.3 (67)	19.1 (58)	
Obese (≥95^{th} percentile)	14.4 (63)	18.4 (56)	
Grade			
6^{th}	30.6 (146)	33.1 (113)	0.51
7^{th}	33.3 (159)	34.6 (118)	
8^{th}	36.1 (172)	32.3 (110)	
Gender			
Male	49.6 (236)	53.1 (181)	0.32
Race/Ethnicity [3]			
White	44.9 (213)	69.7 (237)	<0.0001
Black/African American	3.2 (15)	6.5 (22)	
Asian/Pacific Islander	47.7 (226)	16.8 (57)	
Hispanic	2.5 (12)	4.4 (15)	
Multi-race/Other race/ethnicity	1.7 (8)	2.7 (9)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between the intervention and comparison schools.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.

Table 2. Data Sources and Assessments

Assessment	Time Point	Exposures & Outcomes	Covariates	Study Utilizing Data Source
Point-of-sale (POS) cash register data	Daily	IMOVE meals; Standard school lunch meals; Á la carte snack foods and beverages		1, 2, 3
Anthropometry	2008-2009 academic year	Height; weight; BMI-for-age	Age Gender Race/Ethnicity Grade School SES indicator	2
Block Kids Food Screener	Fall 2008 Spring 2009	Food and nutrient intake		3
Online Choices Behavioral Survey	2008-2009 academic year	Exercise habits; Eating competence; Readiness to change; Self-esteem		2

Table 3. Characteristics of the Subsample of Students Who Completed the Choices Behavioral Survey, by School

	Intervention School (n=170)[1,2] [% (n)]	Comparison School (n=46)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.6 (0.94)	12.9 (0.90)	0.06
Eligible for free/reduced price lunch (SES indicator)	54.2 (91)	52.2 (24)	0.81
Body Mass Index (continuous)			
BMI [mean (SD)]	20.2 (4.26)	22.9 (5.50)	0.001
BMI z-score [mean (SD)]	0.27 (1.21)	0.80 (1.14)	0.006
BMI-for-age percentile [mean (SD)]	58.2 (32.40)	73.5 (27.29)	0.005
Body Mass Index (categorical)			
Underweight (<5th percentile)	6.3 (10)	2.3 (1)	0.04
Healthy Weight (5th-84th percentile)	62.7 (99)	44.2 (19)	
Overweight (85th-94th percentile)	19.0 (30)	27.9 (12)	
Obese (≥95th percentile)	12.0 (19)	25.6 (11)	
Grade			
6th	31.0 (52)	39.1 (18)	0.42
7th	26.2 (44)	28.3 (13)	
8th	42.9 (72)	32.6 (15)	
Gender			
Male	45.8 (77)	37.0 (17)	0.28
Race/Ethnicity [3]			
White	40.5 (68)	52.2 (24)	0.001
Black/African American	1.8 (3)	13.0 (6)	
Asian/Pacific Islander	54.2 (91)	28.3 (13)	
Hispanic	3.0 (5)	4.4 (2)	
Multi-race/Other race/ethnicity	0.6 (1)	2.2 (1)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between the intervention and comparison schools.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.

Table 4. Covariate Information for the Subsample of Students Who Completed the Choices Behavioral Survey, by School

	Intervention School (n=170)[1,2] [% (n)]	Comparison School (n=46)[1,2] [% (n)]	p-value[3,4]
Exercise Assessment			
Weekly leisure time activity (score) [mean (SD)]	50.9 (31.7)	81.1 (70.2)	<0.0001
Frequency of weekly leisure time activity [mean (SD)]	1.7 (0.6)	1.8 (0.8)	0.45
Eating Competence Assessment			
Eating Competent[5]	39.5 (66)	53.3 (24)	0.10
Self-Esteem Assessment			
Self-Esteem Score [mean (SD)]	20.8 (4.8)	22.8 (5.2)	0.02
Stages of Change Assessment			
Readiness to eat more fruits			
Precontemplation	10.8 (18)	2.2 (1)	0.41
Contemplation	8.4 (14)	6.5 (3)	
Preparation	9.0 (15)	13.0 (6)	
Action	35.3 (59)	39.1 (18)	
Maintenance	36.5 (61)	39.1 (18)	
Readiness to eat more vegetables			
Precontemplation	17.5 (29)	10.9 (5)	0.71
Contemplation	8.4 (14)	13.0 (6)	
Preparation	15.1 (25)	13.0 (6)	
Action	22.9 (38)	21.7 (10)	
Maintenance	36.1 (60)	41.3 (19)	
Readiness to eat more whole grain breads, cereals, and foods like brown rice and whole wheat pasta			
Precontemplation	18.9 (31)	11.1 (5)	0.01
Contemplation	9.2 (15)	4.4 (2)	
Preparation	17.7 (29)	6.7 (3)	
Action	24.4 (40)	20.0 (9)	
Maintenance	29.9 (49)	57.8 (26)	

Readiness to drink fewer sugar-sweetened beverages (soda, fruit drinks, lemonade, sweetened sports drinks like Gatorade, Powerade, etc.)			
Precontemplation	26.5 (44)	15.2 (7)	0.40
Contemplation	9.6 (16)	8.7 (4)	
Preparation	13.3 (22)	19.6 (9)	
Action	24.1 (40)	32.6 (15)	
Maintenance	26.5 (44)	23.9 (11)	
Readiness to eat fewer foods that are high in fat (fried foods, French fries, chips, dessert foods, etc.)			
Precontemplation	21.0 (35)	11.1 (5)	0.16
Contemplation	14.4 (24)	6.7 (3)	
Preparation	15.0 (25)	13.3 (6)	
Action	31.7 (53)	48.9 (22)	
Maintenance	18.0 (30)	20.0 (9)	
Readiness to exercise more			
Precontemplation	7.2 (12)	8.7 (4)	0.30
Contemplation	11.4 (19)	10.9 (5)	
Preparation	19.8 (33)	6.5 (3)	
Action	25.8 (43)	28.3 (13)	
Maintenance	35.9 (60)	45.7 (21)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) p-values indicate whether there are significant differences between the intervention and comparison schools.
4) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.
5) Eating competence was scored on a 5-point Likert scale with scores $\geq$ 32 indicate eating competence.

3 THE ASSOCIATION BETWEEN AVAILABILITY OF HEALTHY LUNCH MEALS (IMOVE MEALS) IN SCHOOL CAFETERIAS AND THE LUNCH AND SNACK FOOD PURCHASE PATTERNS OF MIDDLE SCHOOL CHILDREN

3.1 INTRODUCTION

Students spend a substantial amount of time at school and consume a considerable amount of their daily calories while there. Over 55 million children are enrolled in elementary or secondary school in the U.S., and they spend over 6 hours a day in school. More than 90% of students attend a school that offers one or more federal nutrition assistance program (i.e., school lunch or breakfast). Most students consume at least one meal at school, with many purchasing a full meal at school and/or competitive foods from á la carte offerings, vending machines, or school stores.[1]

The rise in childhood obesity has been accompanied by an increase in the number of food options and competitive foods available during the school day.[2] Some students are more exposed to these unhealthy foods than others. Middle schools and high schools are more likely to sell competitive foods than elementary schools. Moreover, unhealthy foods tend to be more available in rural schools than in urban or suburban schools. However, significant differences between low- and high-income schools have not been found.[3]

Nutritional guidelines for school meals must meet the minimum U.S. Department of Agriculture (USDA) meal standards. These guidelines include: 1) the nutritional recommendations of the 1995 Dietary Guidelines for Americans (DGA)[4] which specify no more than 30% of calories from total fat and up to 10% of calories from saturated fat; and 2) applicable Recommended Dietary Allowances (RDAs) for essential nutrients such as protein, iron, calcium, Vitamin A and Vitamin C.[5] According to the third School

Nutrition Dietary Assessment Study (SNDA-III) that evaluated the nutritional quality of school lunch meals in 398 schools nationwide serving grades 1-12 during the 2004-05 academic school year, most schools met the guidelines for protein, vitamins, and minerals in their school lunch offerings, yet only one-third of schools surveyed kept the fat content of their meals low enough to meet the dietary guideline.[6] The two major sources of saturated fat in school lunch were milk (whole and 2%) and commercially-prepared foods including pizza, burritos, breaded chicken nuggets, and other processed foods.[6,7] While 70% of schools participating in the SNDA-III serve meals that meet standards for some nutrients that contribute to healthy diets, a mere 7% of schools evaluated met all of the USDA's current regulatory standards for school lunches during the school year.[8] It is clear that while standards exist, regulatory oversight is lacking. There is widespread variability across schools and school districts and therefore a need to improve school foodservice before child health promotion goals can be realized.

Although there are nutritional guidelines in place for school lunch, the standards are outdated and may not reflect current nutritional science. Some states, including Massachusetts, have adopted nutritional standards for school lunch and breakfast that are stricter than the current requirements based on the 1995 DGA.[9] Current dietary guidelines, such as the 2005 DGA, reflect recent dietary research and are more stringent in regards to nutrients such as total fat and saturated fat.[10] Additionally, there is no consistency in what school lunch meals provide to students and there is still much room for improvement regarding the types and variety of foods offered. While 1% milk is now the most common type of milk offered in school lunch, a substantial number of schools offer whole milk or 2% milk in addition to sugar-added flavored milk (chocolate, strawberry and/or coffee-flavored). School lunch meals provide limited opportunity for children to select and consume whole-grain foods. Instead, grain consumption comes mainly from refined grains in combination meals like pizza, sandwiches, or pasta. The availability of desserts as part of school lunch and á la carte snack foods has not changed in the past 10 years, even after regulations were established to reduce saturated fat and total fat in school meals.[7]

Even more outdated than the school lunch meal regulations are the standards for competitive foods and beverages sold in schools. Competitive foods and beverages are supplemental foods to the main school lunch entrée and are not part of the federal reimbursable school lunch meal. Competitive foods include á la carte items such as chips, cookies, ice cream, candy, and sweetened beverages sold on the cafeteria line, in vending machines, school stores and snack bars, and at school fundraisers.[11,12] Since they are sold outside the realm of federal school meal programs, competitive foods and beverages are not held to the same nutritional requirements.

Because competitive foods contribute to the caloric imbalance that promotes childhood obesity, it has been argued by public health researchers, advocates, and experts that government intervention and oversight concerning the quality and availability of competitive foods in schools is justified.[13] Accordingly, in December 2010, *The Healthy, Hunger-Free Kids Act of 2010* was signed to provide children with healthy food in schools by, among other things, giving the USDA the authority to set nutritional standards for school lunch meals and competitive foods; providing reimbursement to schools that meet updated nutritional standards; setting standards for nutrition education, physical activity, and wellness policies; and establishing networks between schools and local farms to create community gardens and ensure use of local produce in the school setting.[14] Given this Act was recently signed, the USDA is still considering the specific standards for schools.

At present, however, school policies related to the accessibility and nutritional content of competitive foods and beverages are weak and not well defined. Some states, but not Massachusetts, do have self-imposed nutritional standards for competitive foods.[9] Federal regulations concerning competitive foods and beverages sold in schools prohibit the sale of foods of minimal nutritional value;[15] but there is considerable variability in competitive food and beverage standards across and within school districts, with standards being particularly lax in middle schools and high schools.[16] Since any regulations were developed more than 30 years ago, they do not necessarily reflect current knowledge or advances in nutrition research,[16] nor do they reflect the diversity, abundance, and portion distortion of our current food marketplace.

Availability and consumption of competitive foods and beverages have increased substantially during the past two decades, and these foods are now readily available throughout the day to students in public schools.[15,17] During the 2004-05 school year, roughly 40% of schoolchildren in grades 1-12 consumed one or more foods purchased from competitive sources during the school day, with the most common choices being dessert and snack items, as well as beverages other than milk or 100% fruit juice, including water but also sugar-sweetened beverages and carbonated sodas.[17] This is not surprising given that 90% of middle school students attended schools that sold á la carte foods and beverages, and 87% had access to food and beverage vending machines at school.[17]

The availability of á la carte items in school cafeterias can encourage unhealthy eating habits, especially given the low nutritional quality of the á la carte items that are typically offered. As children move to higher grade levels throughout a school system, the availability of á la carte items increases, making the school food environment more detrimental to healthy eating habits. Some studies have shown that the food environment was significantly healthier in lower grade levels compared to upper grades, regardless of the racial and socioeconomic characteristics of the student population served.[3,18] However, a more recent study of public and private elementary schools in the United States concluded that during the 2008-2009 academic year, high-calorie beverages not allowed by national guidelines were still widely available and even more so compared to the year before.[19]

The SNDA-III study found that only 14% of middle schools had á la carte offerings that excluded low-nutrient, energy-dense items (i.e., foods with a high calorie content but few nutrients). Further, only half of the middle schools participating in the study served fresh fruits or vegetables in reimbursable school lunch meals.[3] Another examination of this same data found that among middle school students, the availability of low-nutrient, energy dense foods in vending machines placed in or near the lunch line was associated with a higher index of obesity.[17]

Only recently have there been legislative efforts and industry agreements to improve school food environments by addressing unhealthy á la carte and vending machine offerings. There have been slight decreases in recent years in the availability of chocolate candy and salty snacks available in secondary public schools, but this has not translated into increased availability of healthier items like fruits, vegetables, bottled water, low-fat and low-salt snacks, or low-fat baked desserts.[20] In spite of these advancements, competitive foods and beverages are still commonly available in public schools.[3]

In a national cross-sectional study of schools offering both high- and low-fat options, when presented with low-fat snack items and reduced fat lunch meals alongside traditional cafeteria foods, students more often selected the higher fat options.[21] Accordingly, in 2007, the Institute of Medicine (IOM) addressed the issue of lenient guidelines for competitive foods and beverages by recommending specific limits on the fat, sugar, and calorie content of these products sold during the school day.[2]

Introduction of healthy food items in school cafeterias has met with some resistance in the past. A recent study showed that even when schools do offer the opportunity for students to make a healthy lunch choice, few students actually make that choice. In nine out of ten schools, a student can select low-fat lunch items, however most students make the healthy choice in only 2 out of ten schools.[8] A USDA study found a decline in student participation in school lunch when schools offered low-fat menus.[22] More recently, it was demonstrated that even if healthy dark green/orange vegetables were offered, students more commonly chose starchy vegetables during school lunch over the healthier vegetables or legumes.[7]

In this study, we hypothesized that a modified middle school food environment, achieved by offering healthier lunch meals and actively promoting healthy eating behaviors, would be associated with increased participation in the school lunch program and lower consumption of low nutritional quality (LNQ) á la carte foods among students in the intervention school compared to students in a comparison school.

3.2 METHODS

3.2.1 Intervention and Study Design

Data for this study were obtained from the quasi-experimental evaluation of IMOVE, which assessed cafeteria food purchase patterns of students in two public middle schools (one intervention and one comparison school) in the Quincy, Massachusetts school district. IMOVE is a school-based environmental intervention designed for middle school cafeterias to promote healthy eating behaviors through increased access to affordable and healthy school lunch meals with appropriate portion sizes. IMOVE meals, which are served alongside standard school lunch, are nutritionally healthier than standard school lunch meals. Standard school lunch meals adhere to the federal National School Lunch Program (NSLP) guidelines, which are based on the 1995 DGA, while IMOVE meals reflect more current nutritional research. IMOVE meals provide less than 25% of calories from total fat, less than 10% of calories from saturated fat, and offer nutritionally balanced weekly menus that exceed standard school nutrition guidelines, including the provision of at least one-third of the Recommended Daily Allowance (RDA) for protein and key micronutrients such as calcium, iron, and vitamins A and C. IMOVE meals and snacks also limit amounts of sodium and added sugars.

The IMOVE intervention not only provides healthy and affordable school lunch entrees, but also advertises the importance of healthy eating through cafeteria posters and flyers, and rewards IMOVE lunch purchases through raffle tickets and prizes. IMOVE is based on 38 weeks of menus that utilize a 6-week menu cycle. These menus are modified, based on feedback from foodservice operators, to cater to the needs and cultural preferences of school-specific clientele.

Monthly cafeteria promotions are designed to invigorate the IMOVE program and to promote overall participation in school lunch. Promotions include fresh fruit and vegetable displays and taste-testing, raffle prize drawings and give-aways, identifying healthy choices using an IMOVE sticker logo, and attention-grabbing IMOVE posters. Students receive a raffle ticket every time they purchase either an IMOVE hot meal or salad entree. Winners are chosen every 4 to 6 weeks to receive prizes that promote physically active lifestyles (sports gear, back-packs, Frisbees, etc). Twice yearly, a larger prize is raffled, such as a mountain bike or tickets to a professional sporting event.

All students in the intervention school had access to the IMOVE program and could purchase IMOVE meals in their school cafeterias while still having daily access to the standard school lunch meals. Students in both schools had access to a variety of á la carte items offered on the school lunch line including fruit, low-fat dairy, breads and other grain foods, chips, baked desserts, and frozen ice cream treats.

3.2.2 Study Sample

The study population includes students enrolled in the two schools who were listed as active in the point-of-sale (POS) computerized cash register database. A total of 818 students were enrolled in the two schools in Fall 2008 (intervention school n=477, comparison school n=341). Of those, 99.5% (n=814) of the students were active in the POS system and were therefore eligible to participate in the school lunch program. There were 475 participants in the intervention school and 339 participants in the comparison school. Protocols, data collection instruments, and consent forms were approved by the Institutional Review Board at Boston University.

3.2.3 Datasets and Data Collection

Data for this study were obtained from various datasets collected throughout the course of the intervention at both schools and then merged by unique student identifiers. The separate datasets required to answer this study question are described briefly below.

Cafeteria Food Purchase Data

The outcome variables were obtained from a POS computerized cash register system Nutrikids™ (©LunchByte Systems, Rochester, New York) that tracked daily cafeteria food and beverage purchases. These sophisticated registers are not typically available for school foodservice because of the cost, but also because they are not mandatory for daily functions. They were provided to the participating schools for the study in order to measure changes in cafeteria food purchase behaviors. The POS systems created electronic datasets that tracked purchases of all 1) IMOVE meals, 2) regular reimbursable school lunch meals (i.e., standard school lunch), and 3) á la carte foods (including healthy options such as fresh fruit and low-fat milk and low nutritional quality items including snack chips, baked goods, and ice cream treats). Cashiers were trained prior to the start of the intervention on how to enter meals (IMOVE and standard), á la carte items, and the student's unique identification number at each transaction. In this way, purchases were linked to the unique student identification number that was verified by the trained cashiers at the point of purchase.

The POS system has two databases – one that lists all enrolled students as provided by the school district, and one that lists all transactions per student and per day. The two databases can be linked through each student's state-issued ID, thereby making it possible for individual food purchases to be associated to student sociodemographic information such as age, grade, gender, ethnicity, school, and eligibility for free or reduced price lunch, an indicator of socioeconomic status (SES). While the student database contains records for all enrolled students, the transaction database contained records only for those students who purchased either a school lunch meal (IMOVE or standard lunch) or an á la carte food or beverage at least once in the

2008-09 school year.

Purchase transactions were tracked individually and therefore captured multiple food and beverage purchases on a given day for each student. Transactions were categorized as breakfast or lunch and date-stamped. School breakfast selections were not examined in this study, and therefore all breakfast transactions were excluded from these analyses.

School Enrollment Data

Enrollment data were obtained from the Quincy school district. This file contained identifiers for each student enrolled in the two middle schools along with the student's name, date of birth, gender, race/ethnicity, grade, and both the student's 4-digit school-issued ID and 7-digit state ID. The enrollment database allowed for 62 different codes for race/ethnicity. Based on the school-level data, these 62 categories were combined into five: White, Black/African American, Asian/Pacific Islander, Hispanic, and Multi-Race/Other Race/Ethnicity.

Anthropometric Measurements

Anthropometric measurements were conducted to obtain height and weight measures necessary to compute BMI (weight (kg)/height $(m)^2$) for each student. Students' height and weight were measured in street clothes without shoes in a private location during physical education class periods, according to standardized procedures and using equipment available to school nurses in the Quincy schools. Measurements for all enrolled students were taken by school nurses with the assistance of trained research staff, documented on paper forms, and duplicate-entered into an Excel database. Students who were absent on the original day when their classmates were measured were contacted by the school nurse on one of the days they returned to school, and were excused from class to be measured. Anthropometric measurements were missing for 3.9% of enrolled students in the intervention school and 8.7% of enrolled students in the comparison school.

Gender-specific BMI-for-age percentiles and BMI z-scores were calculated to assess the prevalence of overweight using the USDA/ARS Children's Nutrition Research Center website.[23,24,25] In accordance with current guidelines, children were categorized as either obese (BMI-for-age ≥95th percentile), overweight (BMI-for-age 85th to < 95th percentile), healthy weight (BMI-for-age 5th to 84th percentile), or underweight (<5th percentile).[26] Some analyses used BMI as a continuous measure by employing BMI z-score, a standardized BMI that is calculated using an external reference population to statistically adjust for gender and age differences.[27] BMI z-score allows for increased interpretability over the crude BMI measure and is preferable to BMI-for-age percentile, which can be poorly suited for statistical analyses.[28]

3.2.4 Variable Definitions

The exposed group consisted of all active students who attended the IMOVE (intervention) school; students in the comparison school were unexposed. Two primary outcomes were examined: 1) purchases of school lunch meals; and 2) purchases of á la carte foods. Purchases of school lunch meals and á la carte foods were examined during two time periods to assess shifts in purchasing behavior over the course of the school year. The two time periods represented Fall Term, which was roughly the first half of the intervention period (September 2008 – December 2008), and Spring Term, the second half of the school year that followed the winter break (January 2009 – June 2009). The construction of both outcome variables is described below.

School Lunch Meal Purchases

Participation in school lunch, defined as the purchase of either an IMOVE lunch meal or a standard school lunch meal, was the main outcome of interest. Participation was defined as the total number of days during which at least one IMOVE meal or one standard school lunch meal was purchased, divided by the total number of days on which any type of cafeteria purchase (IMOVE lunch, standard lunch, or an á la carte item) was made during the course of the intervention. Thus, for both IMOVE purchases and standard school lunch purchases, the denominator remained the same and the numerator reflected the total number of unique days on which at least one of the two types of lunch meals was purchased. The number of unique days with any type of cafeteria purchase was chosen as the denominator to take absenteeism into account so that any day that a student was in school and had the opportunity to make a cafeteria purchase was accounted for. Specifying “at least one” purchase on a given date is an important part of the variable definition since a student has the opportunity to purchase more than one school lunch or snack item on any given day. The POS system allowed for up to 15 items to be purchased in a given transaction. The final outcome for participation in school lunch was a fraction that ranged from 0, meaning the student never purchased an IMOVE or standard school lunch meal on any day that he/she made a purchase in the school cafeteria, to 1, meaning the student purchased an IMOVE meal or standard school lunch meal on every day that he/she made a purchase in the school cafeteria. Purchases were examined for the entire school year during which the intervention occurred and for the fall (September to December) versus spring (January to June) term.

School Á La Carte Snack Purchases

The secondary outcome of interest was the purchase of á la carte food items. Of particular interest were purchases of nutritious á la carte foods such as fruits and low-fat milk versus low-nutritional quality (LNQ) items. In accordance with the protocol from O'Toole, et al.[15] LNQ items were defined as foods or beverages that have low nutrient density; these foods provide calories mainly through fats or added sugars and have minimal amounts of vitamins or minerals. Á la carte items were subdivided into six categories using information on brand, portion size, and fat/calorie content – baked goods, frozen desserts, chips, fruit, low-fat dairy, and grains. The categories were further dichotomized as nutritious choices (1) or LNQ choices (0). Table 5 identifies the á la carte items offered, their nutritional quality classification, and their category.

The denominator for the snack food purchases was the same as that used for school lunch purchases, while the numerator reflected the actual number of snack purchases made. Participation was defined as the total number of purchases for the snack food category divided by the total number of days on which any type of cafeteria purchase (IMOVE lunch, standard lunch, or an á la carte item) was made during the intervention period. Again, the number of unique days with any type of cafeteria purchase was chosen as the denominator to take into account absenteeism. The numerator captured if students were making multiple purchases of a certain snack food, which was possible to determine since the POS system allowed for up to 15 items to be purchased in a given transaction. Thus, the final outcome for snack food purchase was the number of purchases of that snack category per day. Snack categories with numbers greater than one indicated that students purchased more than one snack in that category per day. Purchases were examined for the entire school year during which the intervention occurred and for the fall (September to December) versus spring (January to June) term.

3.2.5 Statistical Analyses

Individual-level data for cafeteria food purchases were collected via the POS system. This dataset was merged with the enrollment dataset in order to link student meal purchase with student sociodemographic information. Analyses tested whether the intervention introduced had an effect. With the unit of observation being the student, and with clustering according to school, hierarchical models were not warranted to test the study hypothesis.[29]

To begin, descriptive analyses were conducted on the study subsamples by exposure status (intervention school versus comparison school) to assess the proportion of students within each category of important sociodemographic variables (e.g., gender, race/ethnicity, socioeconomic status, age, grade, and BMI). Continuous variables that exhibited departures from normality were examined using the Wilcoxon Rank Sum test or Kruskal-Wallis test. Subsequently, stratified analyses were conducted using non-parametric tests or t-tests for continuous variables and Chi-square tests for categorical variables to assess differences between the two experimental groups. For any table with a cell frequency of 5 students or less, Fisher's exact test was used. Correlation coefficients were calculated for pairs of continuous variables that appeared in scatter plots to be linearly associated. These descriptive analyses were performed for the analytic subsample of students who were listed as active in the POS database (n=814).

Next, students' overall participation in the school lunch program was examined by evaluating lunch meal purchases made during the entire school year and each term (fall and spring). Additionally, participation in school lunch and á la carte purchasing was determined by examining the mean participation in each category by school over the study period. This information was used to define the study populations in each school with regard to their purchasing behavior.

Unadjusted analyses assessed participation in school lunch and á la carte snack purchases by experimental group and by time period (fall versus spring). Purchases were assessed during both the fall and spring terms, and difference scores were computed for each of the school lunch and snack variables of interest by subtracting mean participation in the fall from mean participation in the spring. Differences in mean participation from fall to spring semester were compared between the intervention and exposure schools. Additionally, the independent effect of each sociodemographic variable on school lunch and á la carte snack participation was estimated. These analyses were conducted to determine if there were any sociodemographic variables significantly associated with both the experimental group and outcome and therefore were potential confounders of the association.

Finally, regression modeling was used to assess the effect of the intervention on each of the two outcome variables (school lunch meals and snack purchases) controlling for the following set of covariates: age, gender, race/ethnicity, grade, SES, and baseline BMI through a standardized BMI z-score. This was done for each time period (fall and spring term) individually, as well as the difference in means from fall to spring term. Due to little or no prior knowledge as to the direction of the study hypotheses, all hypothesis tests were two-sided with a 0.05 level of significance. All analyses were performed with the SAS Statistical System version 9.1.3.[30]

3.3 RESULTS

3.3.1 Descriptive Analyses

Despite being from the same urban public school district, the intervention and comparison schools differed significantly in terms of race/ethnicity, age, and BMI (Table 6). Students in the comparison school were older [mean age (SD) =13.0 (0.9) years], heavier (37.4% overweight/obese), and less racially diverse (69.8% white) than students in the intervention school [12.6 (0.9) years, 29.7% overweight/obese, and 44.3% white, respectively]. Of note, there were a higher proportion of Asian students in the intervention school. Tables present t-tests or Wilcoxon Rank Sum tests depending on the distribution of the continuous variable; table footnotes indicate the test used.

3.3.2 School Lunch and Snack Participation

Almost all eligible students made at least one purchase in the school lunch line during the study period (97.3%, n=792). Twenty-two students (11 from each school) did not make any purchases and thus did not contribute data to the denominator of the participation variable. In the comparison school, there were 12 additional students who never made a school lunch purchase – they only made an á la carte snack purchase during the study period. Therefore, 6.8% of students in the comparison school (n=339) did not participate in school lunch (n=23). In the intervention school, all students (n=475) except for the 11 who never made a cafeteria purchase participated in school lunch (97.7%).

Mean participation for school lunch meals and the six categories of á la carte snack foods is shown in Table 7 (over one year) and in Table 8 (stratified by time period). Over the course of the school year (Table 7), students in the intervention school had a significantly higher level of participation in school lunch than students in the comparison school (0.770 versus 0.624, p<0.0001).

The healthy snack categories showed inconsistent findings. Mean participation in fruit purchases was significantly higher in the intervention school versus the comparison school (0.004 versus 0.000, p<0.0001), although this difference was small. Mean participation in grain purchases was significantly higher in the comparison school compared to the intervention school (0.045 versus 0.022, p<0.0001). It should be noted, however, that grains served in school were mainly refined grains and not whole grains. Thus, greater participation in grain purchases is not necessarily an indicator of healthier behaviors in the control school. Mean participation for low-fat dairy foods was not significantly different between the two schools.

In contrast, the LNQ snack categories did exhibit consistent findings. Compared to those in the comparison school, students in the intervention school had significantly lower participation in the purchase of LNQ snacks such as frozen desserts (0.094 versus 0.164, p<0.0001) and chips (0.237 versus 0.349, p<0.0001). This trend was also observed for baked desserts (0.099 versus 0.102, p=0.03) although the difference was of a much smaller magnitude.

Table 8 displays purchases during the fall (September to December) and spring (January to June) terms. Mean participation in school lunch meals was significantly higher during both the fall and spring terms at the intervention school (0.784 and 0.757, respectively, p<0.0001) than the comparison school (0.633 and 0.615, respectively, p<0.0001), with mean participation declining only slightly from the fall to the spring term in both schools. Between schools, mean purchases for some of the snack food categories were significantly different during both time periods, but exhibited little change between periods. For example, chip purchases were lower in the intervention school than the comparison school for both fall (0.233 and 0.347, respectively, p<0.0001) and spring (0.242 and 0.352, respectively, p<0.0001), but the mean difference was not different between schools (0.013 and 0.007, p=0.40). Students in the intervention school had lower mean participation in all snack food categories at both time points except for fruit and baked desserts. Mean participation in baked desserts increased in both schools. While intervention school students had a slightly higher mean participation in baked desserts in the fall term than comparison school students (0.073 versus 0.071, p=0.41), they had significantly lower mean participation in the spring term (0.119 versus 0.125, p=0.03).

In examining the shift in purchasing, frozen desserts and fruits were the only categories for which there was a significant within-school difference in means from fall to spring purchases. While the mean consumption of frozen desserts decreased in both schools from fall to spring, the decline in ice cream purchases was significantly greater for the intervention school than the control school (-0.031 versus -0.010, p=0.03). Fruit purchases were higher in the intervention school in the fall than the comparison school (0.003 versus 0.000, p<0.0001), and remained that way in the spring semester (0.004 versus 0.000, p<0.0001). All other snack categories experienced no significantly different pattern of change from fall to spring between schools (e.g., low-fat dairy, chips, baked goods, and grains).

Some sociodemographic variables were independently associated with participation in school lunch or snack purchases across schools (Table 9). Age was negatively correlated with frozen dessert purchases (r = -0.20, p<0.0001), grains (r = -0.16, p<0.0001), and low-fat dairy (r = -0.12, p=0.0009). Sixth-grade students had significantly higher mean purchases of frozen desserts and low-fat dairy compared to 7th

or 8th grade students (frozen desserts: 0.18, 0.11, and 0.08, respectively, p<0.0001; low-fat dairy: 0.07, 0.05, and 0.05, respectively, p=0.009) and lower mean purchases of chips (0.23, 0.31, and 0.30, respectively, p<0.0001). Males had lower mean purchases of frozen dessert snack items than females (0.11 and 0.14, respectively, p=0.04). Students who were eligible for free/reduced price meals exhibited higher mean participation in school lunch than those who were not eligible (0.88 and 0.52, p<0.0001), but lower mean participation in all snack categories examined, with significant differences for grains (0.01 and 0.05, respectively, p=0.03) and baked desserts (0.05 and 0.16, respectively, p<0.0001). Race/ethnicity was also significantly associated with some participation variables, with white students having the lowest mean participation in school lunch (p=0.03), but the highest mean participation in all categories of snack purchases, including both healthy snacks and LNQ snacks, with significant findings for fruit (p=0.04), grains (p=0.04), and baked desserts (p<0.0001).

3.3.3 Adjusted Analyses

Adjusted analyses were conducted using regression models to determine the estimated effect of the intervention on the school lunch and snack participation variables. Adjusted models controlled for age, gender, race/ethnicity, SES, grade, and BMI z-score. Effects were examined separately for mean participation in the fall term and spring term, and then for the difference in mean participation from fall to spring. The full set of estimated coefficients is displayed in Table 10.

After controlling for potential confounders, the intervention was estimated to have a significant positive association with participation in school lunch during both the fall and spring term. Mean participation from the fall term to the spring term declined slightly in the intervention school and not significantly more than in the comparison school. For students in the intervention school, mean participation in school lunch in the fall was 0.127 days greater than for students in the comparison school, or participation in school lunch in the intervention school occurred 12.7% more during the school year than in the comparison school. Mean participation in school lunch in the intervention school in the spring was 0.102 days greater than for students in the comparison school.

In the fall term, students in the intervention school experienced an estimated 0.047 frozen dessert purchases per day less than students in the comparison school ($p=0.0007$). Assuming 5-day school weeks in a 4-week month, this equates to approximately one frozen dessert purchase less per month for students in the intervention school. In the spring term, this difference was even more pronounced, with approximately 1.5 frozen dessert purchases less per month ($\beta = -0.077$, $p<0.0001$), which resulted in a significant mean difference from fall to spring term ($\beta = -0.031$, $p=0.006$). Students in the intervention school also purchased significantly fewer chips in both the fall and spring terms ($\beta = -0.116$, $p<0.0001$ and $\beta = -0.113$, $p<0.0001$, respectively). Between schools, the mean difference from fall to spring term was small and not significant ($\beta = 0.006$, $p=0.71$). For both baked dessert and fruit snack categories, students in the intervention school had significantly more participation than comparison school students in both the fall and spring term; between schools, however, the mean difference in participation in these snack categories was slight and not significant.

3.4 DISCUSSION

This study demonstrated that a modified cafeteria environment in urban public middle schools resulted in desirable changes in some of the students' food purchase behaviors. Participation in the school lunch program was higher in the intervention school than in the comparison school. Participation decreased somewhat from the fall to the spring term in both schools. The presence of healthier lunch meals also impacted the mean participation in á la carte snack food purchases, particularly by reducing purchases of the lower nutritional quality snack chips and dessert items while increasing the purchase of fruit. Baked dessert purchases were significantly greater during the spring term in the comparison school compared to the intervention school, after being similar in both schools in the fall term. Interestingly, the healthier snack categories did not show consistent associations with mean participation. When compared from fall to spring terms, fruit purchases significantly increased in the intervention school and remained the same in the comparison school. Frozen dessert purchases decreased in both schools, but the intervention school experienced a significantly greater decrease.

It is important to note that the participating schools did not serve sugar-sweetened beverages on the school lunch line or in competitive food sources as a result of the recent voluntary agreements between the schools and American Beverage Association to eliminate full-calorie soft drinks in schools.[31] It was therefore not possible to evaluate how IMOVE impacted the purchase of sugar-sweetened beverages at school.

After controlling for important sociodemographic variables, school lunch participation in the intervention school remained significantly higher than in the comparison school in both the fall and the spring, suggesting ongoing participation in the intervention over the course of the school year. Mean participation in school lunch declined from the fall to spring semester, but this decline was not statistically significant. During both the fall and spring terms, fruit purchases and baked dessert purchases were significantly greater for students in the intervention school, and purchases of chips and frozen desserts were significantly lower for students in the intervention school. The adjusted result for baked desserts is different than the unadjusted result possibly due to the highly significant association of baked desserts with SES and race/ethnicity, or because the baked dessert variable does not follow a normal distribution. However, between schools, only purchasing for frozen desserts was significantly different from the fall to spring term, with students in the intervention school purchasing significantly fewer frozen desserts compared to students in the comparison school. All other snack categories had similar differences in mean purchases. The consistency of differences from fall to spring terms across the two schools, with few significant declines, suggests that the intervention had a consistent effect on students' purchase behaviors.

Contrary to our hypothesis, mean participation in school lunch decreased from fall to spring term for both schools, with the intervention school experiencing a greater decrease in participation. The decline was not significant between schools, perhaps suggesting a secular trend from fall to spring term. Participation in school lunch was greater for the intervention school than the comparison school in both the fall and spring term. This may be due to the higher proportion of students eligible for free or reduced price lunch in the intervention school than the comparison school. However, given that adjusted models indicated a higher participation in school lunch for students in the intervention school, greater participation may be explained as the affect of the IMOVE intervention. While the results of this study are not consistent with our hypothesis that students in middle schools where healthy lunch alternatives are offered will purchase more school lunch meals, students in these schools did buy fewer LNQ á la carte snack items such as chips and frozen desserts in the fall and spring terms compared to students in schools offering traditional school lunch fare. A null effect for mean difference from fall to spring term was observed in the adjusted models for most of the participation outcomes examined.

A surprising finding was the high rate of participation in school lunch observed in both schools in our study, with only about 3% of students not participating. A recent estimate is that 13.5% of students nationwide do not participate in school lunch.[32] Our findings suggest that while participation is high in both schools, the IMOVE healthy meals intervention generally encouraged repeated participation in school lunch, as students in the intervention school had higher mean participation during both terms.

Participation in school lunch was greater among students who were eligible for free or reduced price lunch, suggesting that this population can be easily reached by changes in foodservice. Additionally, our finding that non-white students were more likely to participate in the school lunch program also provides evidence of the opportunity to positively impact some of the most vulnerable students through a cafeteria intervention.

The results of our study are inconsistent with earlier research that suggested that schools that provide low-fat lunches tended to have lower participation rates,[33] and that in schools where meals offer students a selection of healthful food items, the availability of these items within the meals may not be sufficient to influence students' purchase and consumption of the healthy items.[7] However, our findings do suggest that some healthy or unhealthy snack foods, such as fruit and frozen desserts, may be more influenced than others to a healthy eating intervention. Our findings also suggest that provision of a healthier school lunch meal and offering a variety of foods contributed to higher rates of participation in the school lunch program, though this could also be due to the larger proportion of students who were eligible for free or reduced price school lunch at the intervention school.

Studies have examined student participation in the NSLP and its effect on food consumption. One study found that students who participated in NSLP (i.e., those who purchased a reimbursable school lunch meal) were significantly less likely to consume competitive foods and beverages than non-participants.[17] Additionally, in the same study sample, NSLP participants were almost four times more likely to drink milk at lunch and were more likely to consume fruits and vegetables for lunch than were nonparticipants.[7] Other studies have shown that in middle school, NSLP students were less likely to fall short of dietary guidelines for essential vitamins and minerals. Specifically, these students had higher consumption of total energy and key vitamins and minerals (vitamin A, calcium, magnesium, iron, sodium, phosphorous, zinc, vitamin B12, riboflavin, potassium, fiber, and cholesterol) compared to non-participants. On the other hand, they also had lower intakes of vitamin C[34,35] and higher daily intakes of fat, saturated fat, and sodium.[35,36] Another study showed that NSLP students' lunchtime consumption of most micronutrients was below the recommended one-third of the RDA, while one-third of the total energy for the meal was supplied by competitive foods.[37]

Studies have also examined NSLP students' purchase of competitive foods. Examination of SNDA-III data from the 2004-05 school year on a sample of 395 schools showed that children who ate a school lunch meal during the school year were significantly less likely to consume competitive foods than children who did not eat a school lunch meal.[17] Other studies found that as participation in school lunch increased, competitive food sales decreased.[38,39]

Á la carte foods are often unhealthy and of low nutritional quality. The availability of these foods in middle schools has been shown to be associated with increased consumption of sugar-sweetened beverages (i.e., soft drinks, energy drinks) and other foods high in fat and calories and low in nutrients (i.e., chips, cookies, candy). In particular, access to á la carte items is associated with increased consumption of total fat and saturated fat[40,41] and decreased consumption of nutrient-rich foods and beverages, such as fruits, vegetables, and skim milk.[17,42,43,44] While the present study does not assess sugar-sweetened beverage consumption, it does assess LNQ snack foods. Given that á la carte items contribute roughly 27% of total fat calories eaten at school lunch,[45] prohibiting the sale of competitive foods and beverages or providing healthier lunch entrees, as in the case of IMOVE, could substantially affect the nutritional quality of what children consume during the day.

Parents and teachers of middle school students are as concerned about the school food environment as child health advocates. In a recent study[46] that examined a convenience sample of 350 parents and 490 teachers of middle school students receiving a school-based dietary intervention, most parents and teachers agreed that the nutritional health of students should be a priority in schools. The consensus was that more healthy snacks should be available among the competitive food sources and that lower-fat snacks and á la carte items should be offered.[46]

Research suggests, however, that simply offering low-fat options alongside traditional á la carte foods and in school lunch meals may not be sufficient to achieve and sustain healthy choices in schools. One evaluation study showed that even identified low-fat menu items can supply more total fat because ingredients such as butter or cheese are usually added.[47] This underscores the need to reassess the school food environment and enact specific policies that will make substantial changes to the quality of meals and snacks offered. While wellness policies are now in place thanks to the Child Nutrition and WIC Reauthorization Act of 2004 (P.L. 108-265, Section 204),[48] most are poorly regulated and extremely vague, rendering them difficult to enforce and therefore less impactful.[16]

This study has several limitations that require careful consideration. First, information was not collected on vending machine purchases which, in addition to á la carte cafeteria line items, contribute to competitive food purchases. In contrast to some school districts and to many high schools, the middle schools in this study did not sell sugar-sweetened beverages either on the lunch line or in school vending machines. Only bottled water and 100% fruit juice were sold in cafeteria vending machines. In addition, participating schools did not have vending machines that sold any competitive foods (chips, candy, cookies). Therefore, our findings regarding á la carte competitive foods can not necessarily be extended to the sale of vending machine foods and sugar-sweetened beverages that may be readily accessible to students in other schools. Second, all participants are from one urban school district serving a high proportion of racially diverse and low-income families. Our findings are only generalizable to middle school students of similar backgrounds. Finally, there is a possibility of uncontrolled confounding due to other personal behaviors that were not included in the analyses due to lack of information.

Although some significant findings were observed, most were not significant or null. There are some study limitations that could be contributing to null results. First, since the intervention and comparison schools were in the same school district, there is the possibility of contamination if students in the comparison schools received information on nutrition and healthy eating from peers in the intervention schools. However, since this was an environmental intervention in cafeterias rather than a nutrition education curriculum in classrooms, the likelihood that transferred knowledge or awareness influenced the behaviors of students in the comparison school is very small.

Second, Type III error, where a lack of intervention effect is due to incorrect or incomplete implementation of the intervention, could be a factor.[49] Staff members were trained to effectively deliver the intervention, but oversight throughout the course of the intervention was minimal due to budget constraints and school logistics. Third, Type II error could be possible due to low sample size, resulting in the study being underpowered to detect a true effect.

It should be noted that some of the participation outcome variables examined did not appear to be normally distributed. Accordingly, results from the Wilcoxon Rank Sum test or Kruskal-Wallis test are provided herein for unadjusted analyses where appropriate; however there is no non-parametric alternative to adjusted regression modeling. Adjusted analyses used multiple regression models and displayed similar results to the unadjusted analyses, suggesting the appropriate use of these methods.

The IMOVE program, as designed and currently implemented, was somewhat limited in its ability to make major improvements to the overall school nutrition environment as the program does not completely eliminate the less healthy food choices from school cafeterias, nor was it supported by any enhancements in policy, nutrition curriculum, or physical education. In the intervention school, candy bars were being sold for school-supported fundraisers and free pizza was observed being given away to students on several occasions in the school cafeteria, all during the regular school lunch period. Issues around profits and foodservice viability were noted as substantial barriers to the addition of larger-scale changes that are likely required for bigger impact.

This implementation of IMOVE was driven by a university-initiated research partnership. Had the impetus for child wellness promotion come from within the school district, perhaps a more comprehensive campaign that included policy and curriculum change might have been possible. In the absence of school-based administrators who support school-wide policy changes, and champions who assume leadership roles and take action within the school system, obstacles to intervention feasibility, scope, and implementation are challenging for outsiders to overcome.

The above limitations shed light on some findings and lessons learned for effective school-based interventions. First, effective school-based strategies must be comprehensive and include environmental and policy changes beyond the cafeteria foodservice. Second, initiatives that do not include the total elimination of certain unhealthy foods are less likely to positively impact overall consumption patterns, which is essential for success. Third, successful interventions require the support and input from school stakeholders to be implemented with fidelity and sustained over time.

In conclusion, if progress towards child health objectives is to be achieved, the efficacy of school-based interventions for promoting desired changes in food choice behaviors needs to be demonstrated. Our evaluation of the IMOVE program offers one such piece of evidence by showing how the introduction of healthy meals and empowering health promotion messages affected participation in school lunch and positively impacted the purchase and consumption of some less nutritious snack foods at school.

It has been argued that the competitive food environment in schools is in need of improvement.[50] While restricting access to unhealthy competitive foods in schools has occurred in recent years,[15,20] more policy efforts are needed. A key intervention strategy would take a different tact, by actually introducing more healthy food options into the school, rather than simply removing unhealthy options. However, it may not be sufficient to put healthy meals on the school lunch line and expect students to choose them. Factors such as prominence, visibility, and easy accessibility of particular foods affect students' food choice behaviors.[51]

When children are taught about healthy behaviors and good nutrition in school, but are then presented with a variety of unhealthy food choices in that same school environment, they are sent inconsistent messages. It is hypothesized that if children have access to the ability to select a healthy diet, their risk of overweight would be lower than those who are unskilled or unable to make a choice.[32] Creating messages that are consistent by changing the school food environment would encourage healthy food choices and good nutrition.

The most effective interventions to create positive behavior changes, specifically addressing childhood obesity risks, appear to be those that are multi-component interventions.[52,53] Therefore, while the IMOVE cafeteria intervention facilitated some positive changes in the purchase of unhealthy foods, it may be expected to have an even bigger impact if coupled with substantial wellness policy implementation, parent engagement and education, nutrition education and promotion, physical education initiatives, and additional environmental changes such as elimination of unhealthy competitive foods. Future studies should examine the impact of environmental-level school-based healthy eating initiatives in the context of larger, multi-component interventions that address multiple levels of the socioecological model, as well as the effects of the intervention over a longer period of time.

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Table 5. Á La Carte Items Offered and Classification of Categories

Á la carte item	Category Classification	Nutritional Quality (High or Low)
Juice	Fruit	High
Fresh fruit	Fruit	High
Fruit cup	Fruit	High
Pita	Grains	High
Dinner Roll	Grains	High
Cereal/granola bar	Grains	High
Pretzel (soft)	Grains	High
Slice of bread	Grains	High
Flavored milk	Low-fat dairy	High
Yogurt	Low-fat dairy	High
1% milk	Low-fat dairy	High
2% milk	Low-fat dairy	High
Skim milk	Low-fat dairy	High
Rice Krispie treat	Baked desserts	Low
Brownies	Baked desserts	Low
Cookies	Baked desserts	Low
Chips	Chips	Low
Ice cream	Frozen desserts	Low

Footnotes:

1) All foods were offered in both schools.

Table 6. Characteristics of the Study Sample, by School

	Intervention School (n=475)[1,2] [% (n)]	Comparison School (n=339)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.6 (0.9)	13.0 (0.9)	<0.0001
Eligible for free/reduced price lunch (SES indicator)	53.9 (256)	47.8 (162)	0.09
Body Mass Index (continuous)			
BMI [mean (SD)]	20.3 (4.8)	21.9 (5.5)	<0.0001
BMI z-score [mean (SD)]	0.3 (1.2)	0.6 (1.1)	<0.0001
BMI-for-age percentile [mean (SD)]	57.4 (32.3)	66.7 (28.7)	<0.0001
Body Mass Index (categorical)			
Underweight (<5th percentile)	7.1 (31)	2.3 (7)	0.009
Healthy Weight (5th-84th percentile)	63.2 (275)	60.3 (182)	
Overweight (85th-94th percentile)	15.4 (67)	18.9 (57)	
Obese (≥95th percentile)	14.3 (62)	18.5 (56)	
Grade			
6th	30.7 (146)	33.3 (113)	0.43
7th	33.1 (157)	34.8 (118)	
8th	36.2 (172)	31.9 (108)	
Gender			
Male	49.8 (236)	53.1 (180)	0.35
Race/Ethnicity [3]			
White	44.3 (209)	69.8 (236)	<0.0001
Black/African American	3.4 (16)	6.5 (22)	
Asian/Pacific Islander	48.1 (227)	16.9 (57)	
Hispanic	2.5 (12)	4.1 (14)	
Multi-race/Other race/ethnicity	1.7 (8)	2.7 (9)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between the intervention and comparison schools.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.

Table 7. Mean Participation in School Lunch and Snack Purchases by Intervention Status, Full Academic Year

	Intervention School (n=464)[1]	Comparison School (n=328)[1]	p-value[3,4]
Participation in School Lunch[5]	0.770	0.624	<0.0001
Snack Participation[2,5]			
Nutritious Snack Foods			
Fruit	0.004	0.000	<0.0001
Grains	0.022	0.045	<0.0001
Low-fat dairy	0.051	0.060	0.78
Low Nutritional Quality (LNQ) Snack Foods			
Baked desserts	0.099	0.102	0.03
Chips	0.237	0.349	<0.0001
Frozen desserts	0.094	0.164	<0.0001

Footnotes:

1) Values are unadjusted.
2) The same snack foods were offered in the intervention and comparison schools.
3) p-values indicate whether there are significant differences between the intervention and comparison schools.
4) The Wilcoxon Rank Sum test was used to calculate p-values.
5) Participation is a fraction defined as the total number of days during which at least one lunch purchase was made divided by the total number of days on which any type of cafeteria purchase (IMOVE lunch, standard lunch, or an á la carte item) was made.

Table 8. Mean Participation in School Lunch and Snack Purchases by Intervention Status, Difference between Fall and Spring

	Intervention School[2,3,4]			Comparison School[2,3,4]		
	Fall Term (n=450)	**Spring Term (n=461)**	**Mean Difference (95% CI) (n=447)[1]**	**Fall Term (n=318)**	**Spring Term (n=326)**	**Mean Difference (95% CI) (n=316)[1]**
Lunch Meals	0.784*	0.757*	-0.031 (-0.04, -0.02)	0.633*	0.615*	-0.023 (0.04, -0.00)
Á La Carte Category						
Fruit	0.003*	0.004*	0.002 (0.00, 0.00)***	0.000*	0.000*	0.000 (0.00, 0.00)***
Grains	0.026*	0.019**	-0.01 (-0.01, 0.00)	0.050*	0.043**	-0.005 (-0.01, 0.00)
Low-fat dairy	0.049	0.052	0.005 (-0.00, 0.01)	0.059	0.064	0.007 (-0.00, 0.02)
Baked desserts	0.073	0.119***	0.045 (0.04, 0.06)	0.071	0.125***	0.054 (0.04, 0.07)
Chips	0.233*	0.242*	0.013 (0.00, 0.03)	0.347*	0.352*	0.007 (-0.01, 0.03)
Frozen dessert	0.113*	0.081*	-0.031 (-0.04, -0.02)***	0.172*	0.158*	-0.010 (-0.03, 0.01)***

Footnotes:

1) p-values: * = p< 0.0001; ** = p<0.001; *** = p< 0.05
2) Values are unadjusted.
3) p-values indicate whether there are significant differences between the intervention and comparison schools during each given time period, and whether, between schools, the fall to spring differences are significantly different.
4) The Wilcoxon Rank Sum test was used to calculate p-values.

Table 9. Mean Participation in School Lunch and Snack Purchases by Characteristics of the Study Sample, Full Academic Year (N=792)

		Á La Carte Category[1,2,4,5]					
	Lunch Meals	Fruit	Grains	Low-Fat Dairy	Baked Desserts	Chips	Frozen Desserts
Age (correlation)	0.04	-0.03	-0.16*	-0.12**	0.02	0.04	-0.20*
Eligible for free/reduced price lunch (SES indicator)							
Yes	0.88*	0.002	0.01****	0.02	0.05*	0.18	0.09
No	0.52*	0.003	0.05****	0.10	0.16*	0.39	0.16
Body Mass Index z-score (correlation)	0.07	-0.03	-0.02	-0.02	0.03	0.03	-0.01
Grade							
6th	0.73**	0.001	0.04	0.07***	0.09	0.23*	0.18*
7th	0.68**	0.003	0.03	0.05***	0.11	0.31*	0.11*
8th	0.73**	0.002	0.02	0.05***	0.11	0.30*	0.08*
Gender							
Male	0.81	0.002	0.03	0.06	0.09	0.24	0.11****
Female	0.61	0.002	0.04	0.05	0.11	0.33	0.14****
Race/Ethnicity[3]							
White	0.56****	0.002****	0.05****	0.08	0.15*	0.37	0.15
Black/African American	0.89****	0.001****	0.01****	0.02	0.06*	0.19	0.14
Asian/Pacific Islander	0.89****	0.002****	0.01****	0.03	0.03*	0.17	0.07
Hispanic	0.84****	0.003****	0.01****	0.04	0.06*	0.19	0.14
Multi-race/Other race/ethnicity	0.79****	0.000****	0.02****	0.03	0.12*	0.28	0.14

Footnotes:

1) p-values: * = p< 0.0001; ** = p< 0.001; *** = p<0.01; **** = p<0.05
2) Values are unadjusted and display mean participation.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there is a significant association between the sociodemographic and participation variables.
5) Non-parametric tests (Wilcoxon Rank Sum test or Kruskal-Wallis) or Spearman correlation was used to calculate p-values.

Table 10. Effect of Intervention Status on Participation in School Lunch and Snack Purchases in Fall Term, Spring Term, and Between Terms (n=814)

	Intervention School[1,2,3,4]		
	Fall Term [β (SE)]	**Spring Term** [β (SE)]	**Mean Difference** [β (SE)][5]
Lunch Meals	0.127 (0.02)*	0.102 (0.03)*	-0.024 (0.01)
Á La Carte Category			
Fruit	0.004 (0.00)*	0.005 (0.00)*	0.002 (0.00)
Grains	-0.012 (0.01)	-0.010 (0.01)	0.002 (0.01)
Low-fat dairy	0.002 (0.01)	0.0008 (0.01)	-0.002 (0.01)
Baked desserts	0.024 (0.01)****	0.031 (0.02)****	0.006 (0.01)
Chips	-0.116 (0.02)*	-0.113 (0.02)*	0.006 (0.02)
Frozen dessert	-0.047 (0.01)**	-0.077 (0.01)*	-0.031 (0.01)***

Footnotes:

1) p-values: * = p< 0.0001; ** = p< 0.001; *** = p<0.01; **** = p<0.05
2) Values are adjusted for age, gender, ethnicity, SES, grade, and BMI.
3) p-values indicate whether there are significant differences between the intervention and comparison schools.
4) Values are estimated coefficients (SE) for the intervention school compared to the comparison school as calculated by linear regression modeling.
5) Mean difference is the difference in mean participation from fall term to spring term.

4 THE ASSOCIATION BETWEEN BODY WEIGHT AND PARTICIPATION IN IMOVE AND STANDARD SCHOOL LUNCH

4.1 INTRODUCTION

Research conducted on eating behaviors of overweight or obese adolescents versus adolescents who are not overweight or obese is limited. However, the research that does exist indicates that overweight adolescents engage in less healthy behaviors, including unhealthy eating and weight control behaviors.[1] Additionally, adolescent overweight status has been found to be positively correlated with consumption of sugar-sweetened beverages (SSB) (i.e., soda and fruit-flavored drinks), sweets (i.e., desserts and candy), and snack foods that are typically of low nutritional quality (LNQ).[2] Self-perception of overweight is also associated with food consumption. Adolescents who perceive themselves to be overweight have significantly poorer dietary patterns than adolescents who do not perceive themselves to be overweight.[3]

Increasing rates of obesity among children and adolescents in the United States are cause for concern, and prevention efforts focus on monitoring body mass index (BMI) at the population level. BMI is a measure of the relationship between height and weight, calculated as the ratio of weight (in kilograms) to the square of height (in meters). It is used as an index to classify adiposity, or fatness,[4] with overweight defined as a BMI-for-age between the 85^{th} and 95^{th} percentile and obese defined as a BMI-for-age greater than or equal to the 95^{th} percentile.[5] Recommendations for obesity prevention efforts include calculating BMI annually for all youths as part of normal health supervision[6] and performing annual school-based BMI screenings,[7] with community resources and professional referrals made available to guide affected or "at risk" students and their parents to make healthy lifestyle choices.[8] Some states have enacted legislative provisions to help assess the impact of childhood obesity-prevention initiatives, specifically as they relate to BMI.[9]

BMI, as an indicator for overweight status, has been researched for many years to determine its significant predictors. These have been found to include dietary self-efficacy, physical inactivity, television viewing, and socioeconomic status (SES), in addition to the biological factors of age, race/ethnicity, gender, and height.[10,11] Strong evidence links children's dietary behaviors to risk of overweight. Poor dietary choices (sweet foods, high-fat foods, large food portions) have been associated with higher BMI in children and adolescents.[2] Consumption of SSB is directly related to risk of overweight and higher BMI in adolescents,[12] and consumption of energy-dense foods that have low nutritional value is associated with high BMI and body weight in both children and adolescents.[7,13] Studies have also found a strong association between low SES and overweight, most pronounced in adolescents 12-19 years old.[14]

There are some problems associated with using BMI as an indicator of overweight status. For example, it does not distinguish between weight from fat and weight from muscle mass. Nonetheless, it is still considered the most reliable way to examine trends and patterns of overweight and obesity at the population level.[9] In children, BMI has been used historically to characterize changes in weight status over time in student populations, monitor progress towards national health objectives, and assess the effects of school-based policies and programs related to physical activity and nutrition education.[15] No studies have considered, however, whether BMI is a predictor of participation in school-based health promotion programs. Examining the relationship between BMI and participation in school-based programs may help program planners to develop effective, sustainable interventions that engage and serve the populations most at risk and in need.

Since 40% of children attending public schools are overweight, with more than 20% classified as obese,[16] improving the school food environment and school policies has been suggested as a population-based approach to address the problem of childhood obesity.[7,17] Recommendations have been offered to change the National School Lunch Program (NSLP) and School Breakfast Program (SBP) to update their nutrition standards and meal requirements to reflect more recent dietary guidelines. As well, changes to the school environment that promote healthy eating in children have been advocated.[18] The potential impact of these recommendations to change the school food environment is extensive. Students residing in households with family incomes at or below 130% of the federal poverty line are eligible for free meals while those in households with family incomes between 130% and 185% of the federal poverty line are eligible for reduced price meals. During the 2007-08 academic year, more than 31 million students participated in the NSLP, and more than 10 million students in the SBP.[19] The NSLP and SBP are similarly organized, and both are overseen by Food and Nutrition Service.[20] It is the responsibility of each state to administer the program and to ensure that it is meeting federal guidelines, which do allow flexibility in the types of foods served. While the nutritional content of meals has changed over the past decade, school lunches in particular still leave much room for improvement.[21]

Past studies differ on the role of NSLP participation and body weight in children, most likely due to different research methods. One study showed that NSLP participation increased the probability of being obese due to the excess calories offered in the standard school lunch. [20] In contrast, yet another study published shortly before the previous study, showed that children were at increased risk of gaining weight during the summer months due to lack of exposure to the school meal program and greater consumption of food at home.[22] An earlier study found that while NSLP participation increased the intake of health-promoting nutrients, it also contributed to higher intake levels of dietary fat.[23] Other researchers found that the availability of low-nutrient, energy-dense foods (foods that have a high calorie content but offer few nutrients) near the foodservice lunch line was associated with a higher BMI z-score, a standardized BMI that statistically adjusts for gender and age differences,[24] in middle school children.[25] Most recently, no association was found in multivariate analyses between school lunch participation and either higher BMI or higher incidence of overweight or obesity.[16]

Some studies focusing on the school food environment have demonstrated the negative effect of NSLP on children's weight, suggesting that the current school lunch program exacerbates the childhood obesity epidemic.[20,26,27] Recently, research has not supported this previous finding by showing no effect of NSLP on children's weight.[16] The impact of school policies and procedures related to eating has also been examined. One study demonstrated a positive relationship between BMI and school food policies and procedures that supported snacking and consumption of low-nutrient, energy-dense foods among 8th graders. Students' BMI increased by 0.10 BMI units for every additional food policy permitted in their school, suggesting that consistent exposure to certain types of school food policies may increase students' risk for weight gain.[13]

As noted above, the impact of the NSLP on child health has been studied, but the predictors of participation in school lunch have been given less attention. The current study assesses the impact of an environmental-level healthy eating initiative in a low-income middle school community. Importantly, this study offers the unique opportunity to link individual student's sociodemographic characteristics and BMI to food purchase behavior, thus providing the ability to assess who is reached by this type of intervention. The purpose of this study is to determine whether students' BMI predicts participation in the school lunch program in general and in the specific purchase of school lunch meals that are marketed as healthier choices in the school cafeteria. Our goal is to determine whether a school-based environmental intervention effectively reaches its target audience, those students most in need of a nutritional intervention to address childhood obesity risks in school.

4.2 METHODS

4.2.1 Intervention and Study Design

Data for this study were obtained from the quasi-experimental evaluation of the healthy eating intervention IMOVE which assessed cafeteria food purchase patterns of students in two public middle schools (one intervention and one comparison school) in the Quincy, Massachusetts school district. This specific study uses data collected only from the school that received the IMOVE intervention.

IMOVE is a school-based environmental intervention designed for middle school cafeterias to promote healthy eating behaviors through increased access to affordable and healthy school lunch meals with appropriate portion sizes. IMOVE meals, which are served alongside standard school lunch, are nutritionally healthier than standard school lunch meals. Standard school lunch meals adhere to the federal NSLP guidelines, which are based on the 1995 Dietary Guidelines for Americans (DGA),[28] while IMOVE meals reflect more current nutritional research. IMOVE meals provide less than 25% of calories from total fat, less than 10% of calories from saturated fat, and offer nutritionally balanced weekly menus that exceed standard school nutrition guidelines, including the provision of at least one-third of the Recommended Daily Allowance (RDA) for protein and key micronutrients such as calcium, iron, and vitamins A and C. IMOVE meals and snacks also limit amounts of sodium and added sugars.

The IMOVE intervention not only provides healthy and affordable school lunch entrees, but also advertises the importance of healthy eating through cafeteria posters and flyers, and rewards IMOVE lunch purchases through raffle tickets and prizes. IMOVE is based on 38 weeks of menus that utilize a six-week menu cycle. These menus are modified, based on feedback from foodservice operators, to cater to the needs and cultural preferences of school-specific clientele.

Monthly cafeteria promotions invigorate the program in order to increase and sustain healthy food choices, as well as to promote overall participation in school lunch. Promotions include fresh fruit and vegetable displays and taste-testing, raffle prize drawings and give-aways, an IMOVE sticker logo to identify healthy choices, and attention-grabbing IMOVE posters. Students receive a raffle ticket every time they purchase either an IMOVE hot meal or salad entree. Winners are chosen every 4 to 6 weeks to receive prizes that promote physically active lifestyles (sports gear, back-packs, frisbees, etc). Twice yearly, a larger prize is raffled, such as a mountain bike or tickets to a professional sporting event.

In addition to having daily access to the standard school lunch meals, all students in the intervention school had access to the IMOVE program and could purchase IMOVE meals in their school cafeterias. Students also had access to a variety of á la carte items offered on the school lunch line including fruit, low-fat dairy, breads and other grain foods, chips, baked desserts, and frozen ice cream treats.

4.2.2 Study Sample

The criteria for participants in this cohort study included: 1) being enrolled in the IMOVE intervention school during the 2008-09 academic school year; 2) having available anthropometric data (height and weight) to calculate BMI; and, 3) active status in the point-of-sale (POS) cash register system that tracked food purchases in school cafeterias.

A total of 477 students were enrolled in the intervention school in Fall 2008. Of those, 475 students (99.6%) were active in the POS system, indicating that they were eligible to participate in the school lunch program. Ninety-one percent of students active in the POS system also had anthropometric data and a recorded BMI and thus comprised the study sample (n=435). A total of 170 students completed the behavioral survey, but 10 of those students either did not have BMI data or were listed as inactive in the POS system. Overall, then a little over one-third of the eligible study sample (36.8%, n=160) had behavioral survey information.

Protocols, data collection instruments, and consent forms were approved by the Institutional Review Board at Boston University.

4.2.3 Datasets and Data Collection

Data for this study were obtained from various datasets collected throughout the course of the intervention and later merged through unique student identifiers. The separate datasets required to answer this study question are described briefly below. The behavioral survey can be found in Appendix B.

School Enrollment Data

Enrollment data were obtained from the Quincy school district. This file contained identifiers for each student enrolled in the two middle schools along with the student's name, date of birth, gender, race/ethnicity, grade, and both the student's 4-digit school-issued ID and 7-digit state ID. The enrollment database allowed for 62 different codes for race/ethnicity. Based on the school-level data, these 62 categories were combined into five: White, Black/African American, Asian/Pacific Islander, Hispanic, and Multi-Race/Other Race/Ethnicity.

Cafeteria Food Purchase Data

The outcome variables were obtained from a POS computerized cash register system Nutrikids™ (©LunchByte Systems, Rochester, New York) that tracked daily cafeteria food and beverage purchases. These sophisticated registers are not typically available for school foodservice because of the cost, but also because they are not mandatory for daily functions. They were provided to the participating schools for the study in order to measure changes in cafeteria food purchase behaviors. The POS systems created electronic datasets that tracked purchases of all 1) IMOVE meals, 2) regular reimbursable school lunch meals (i.e., standard school lunch), and 3) á la carte foods (including healthy options such as fresh fruit and low-fat milk and low nutritional quality items including snack chips, baked goods, and ice cream treats). Cashiers were trained prior to the start of the intervention on how to enter meals (IMOVE and standard), á la carte items, and the student's unique identification number at each transaction. In this way, purchases were linked to the unique student identification number that was verified by the trained cashiers at the point of purchase.

The POS system has two databases – one that lists all enrolled students as provided by the school district, and one that lists all transactions per student and per day. The two databases are linked by a unique 7-digit state-issued student ID, thereby making it possible for individual food purchases to be examined against student sociodemographic information such as age, grade, gender, race/ethnicity, school, and eligibility for free or reduced price lunch (an indicator of SES). While the student database contains records for all enrolled students, the transaction database contained records only for those students who purchased either a school lunch meal (IMOVE or standard lunch) or an á la carte food or beverage at least once in the 2008-09 school year.

Purchase transactions were tracked individually and therefore captured multiple food and beverage purchases on a given day for each student. Transactions were categorized as breakfast or lunch and date-stamped. School breakfast selections were not examined in this study, and therefore all breakfast transactions were excluded from these analyses.

Anthropometric Measurements

Anthropometric measurements were conducted to obtain height and weight measures necessary to compute BMI [weight (kg)/height $(m)^2$] for all students currently enrolled in the school. Students' height and weight were measured in street clothes without shoes in a private location during physical education class periods, according to standardized procedures and using equipment available to school nurses in the Quincy schools. Measurements for all enrolled students were taken by school nurses with the assistance of trained research staff, documented on paper forms, and duplicate-entered into an Excel database. Students who were absent on the original day when their classmates were measured were contacted by the school nurse after they returned to school, and were excused from class to be measured. Anthropometric measurements were missing for 3.9% of the enrolled students.

Gender-specific BMI-for-age percentiles and BMI z-scores were calculated to assess the prevalence of overweight using the United States Department of Agriculture (USDA)/ARS Children's Nutrition Research Center website.[29,30,31] In accordance with current guidelines, children were categorized as either obese (BMI-for-age ≥95th percentile), overweight (BMI-for-age 85th to < 95th percentile), healthy weight (BMI-for-age 5th to 84th percentile), or underweight (<5th percentile).[32] Some analyses used BMI as a continuous measure by employing BMI z-score, a standardized BMI that is calculated using an external reference population to statistically adjust for gender and age differences.[24] BMI z-score allows for increased interpretability over the crude BMI measure and is preferable to BMI-for-age percentile, which can be poorly suited for statistical analyses.[33]

Choices Behavioral Survey

To obtain behavioral information, an online survey was administered to students via Survey Monkey. The survey, called the Choices Survey, was created using previously validated questions to collect data on current exercise habits,[34] eating competence,[35] readiness to change diet and exercise behaviors,[36] and self-esteem.[37] A review of the literature identified these variables as potential modifiers.

As outlined previously, there were challenges in implementing the Choices Survey that resulted in low response rates. The present study is the only study of the three presented herein to utilize data from the Choices Survey. The study sample contains only students from the intervention school, which had a larger subsample of students who completed the Choices Survey. The data from the Choices Survey are used in this study in exploratory analyses to examine the behavioral variables as potential modifiers, instead of examining them as potential covariates. Thus, analyses could be conducted on this subset of students in a meaningful way.

The survey was available to students in December 2008, later than intended due to delays in Institutional Review Board approval. After students accessed the survey through the web link on the school's web site, they were told that the survey would take 15 minutes to complete, that it was voluntary and anonymous, and that they could skip any question they felt uncomfortable answering. To foster participation, students were asked to print a verification page upon survey completion for entry into a raffle. Students completed the survey anytime from December 2008 through June 2009.

Students entered their 4-digit student ID to enter the survey. They were then asked questions regarding demographics (age, grade, race/ethnicity); leisure time physical activity; stages of change for eating and exercise habits; feelings and attitudes about food and eating (the eating competence assessment); and self-esteem. Many of these question sets had a corresponding validated scoring system. Survey information was downloaded from Survey Monkey into an Excel database.

4.2.4 Variable Definitions

Exposure Definition: Overweight Status

Overweight status was defined using BMI-for-age. Two measures of BMI were used in this study. First, the BMI z-score reflects the number of standard deviations a child's BMI is from the mean BMI of the Centers for Disease Control and Prevention (CDC) reference population for the same age and sex.[38] The second measure is a binary variable that classifies a child as overweight/obese or not overweight/obese based on gender-specific BMI-for-age cutpoints established by the CDC and its Expert Committee.[32] Gender-specific BMI-for-age cutpoints are widely used to assess the risk of childhood overweight.[29,30] BMI is inherently a continuous measure, but based on these cutpoints, a categorical variable was used to classify students as underweight, healthy weight, overweight, or obese.[32] The independent variable was dichotomized as overweight/obese ($\geq 85^{th}$ percentile) versus not overweight/obese ($< 85^{th}$ percentile). These categorical definitions of overweight or obese are clinical determinations that schools report for the purposes of public health monitoring. Analyses examined BMI as both a dichotomous measure and as a continuous measure via z-score.

Outcome Definition: Participation in IMOVE and Standard School Lunch

The main outcome of interest was participation in IMOVE, defined as the total number of days on which at least one IMOVE lunch meal was purchased divided by the total number of days on which any type of cafeteria purchase (IMOVE lunch, standard lunch, or an á la carte item) was made. Secondarily, participation in both standard school lunch and any school lunch was examined, using the same formula structure as noted for IMOVE participation. Thus, for IMOVE purchases, standard school lunch purchases, and any school lunch purchases, the denominator remained the same and the numerator reflected the total number of unique days on which at least one of the two types of lunch meals was purchased (IMOVE purchases and standard school lunch purchases) or either meal was purchased (any school lunch purchases). The number of unique days with any type of cafeteria purchase was chosen as the denominator to take into account absenteeism. The distinction of "at least one" purchase on a given date is an important part of the variable definition since students can purchase more than one school lunch or snack item per day. The POS system allowed for up to 15 items to be purchased in a given transaction. The final outcome for participation in school lunch was a fraction that ranged from 0, meaning that a student never purchased the type of meal in question (IMOVE meal, standard school lunch meal, or any lunch meal) on any day that he/she made a purchase in the school cafeteria, to 1, meaning that a student purchased that type of meal on every day that he/she made a purchase in the school cafeteria.

4.2.5 Statistical Analyses

The BMI, POS, and behavioral datasets were merged by unique student identification number with the enrollment dataset. This resulting merged dataset contained all individual-level data and was used for the analysis. Given that the unit of observation for both the dependent (participation in school lunch) and independent (BMI) variables were the individual students, hierarchical models were not warranted to test the study hypothesis.[39]

First, descriptive analyses were conducted to identify the proportion of students within each sociodemographic category (e.g., gender, race/ethnicity, SES, age, grade, and BMI). These descriptive analyses were performed for the study sample who had complete BMI and POS data (n=435). Next, students for whom BMI data were available were compared to those who did not have BMI data to determine wither there were any important differences between the two groups. After that, the study sample (n=435) was compared to the overall school sample (n=477) and the smaller subsample who additionally responded to the behavioral survey (n=160) on sociodemographic variables to assess the representativeness of the study sample.

The group of students from the study subsample who completed the online behavioral survey (n=160) were compared to the group of students from the study sample who did not complete the online survey (n=275). Analyses then examined the responses from the Choices Survey by overweight status (overweight versus not overweight). The sociodemographic variables were also examined by overweight status to determine any significant associations.

Continuous variables that exhibited departures from normality were examined using the Wilcoxon Rank Sum test or Kruskal-Wallis test. Subsequently, stratified analyses used non-parametric tests or t-tests, where appropriate, for continuous variables and Chi-square tests for categorical variables. For any table with a cell frequency of 5 students or less, Fisher's exact test was used. Correlation coefficients were calculated for pairs of continuous variables that appeared in scatter plots to be linearly associated.

Unadjusted analyses assessed participation in IMOVE by overweight status and BMI z-score. The independent effect of each sociodemographic variable on IMOVE participation was assessed through regression modeling for categorical predictors or correlation analyses for continuous predictors. These analyses were conducted to determine if there were any sociodemographic variables significantly associated with both the independent and dependent measures that could potentially confound any observed associations. Standard school lunch purchases and any school lunch purchase were examined using the same methods.

Finally, regression modeling was used to assess the effect of BMI on IMOVE participation, controlling for age, gender, race/ethnicity, grade, and SES. Models were run for categorical overweight status (overweight/obese versus not overweight/obese) and continuous BMI z-score. Parameter estimates with standard errors were reported to illustrate the estimated effect of overweight status and BMI using analytic methods employed in similar studies.[40] Due to little or no prior knowledge as to the direction of the study hypotheses, all hypothesis tests were two-sided with a 0.05 level of significance. All analyses were performed with the SAS Statistical System version 9.1.3.[41]

4.3 RESULTS

4.3.1 Descriptive Analyses

Of the total school sample (n=477), a vast majority of students were eligible for the current study sample (n=435, 91.2%), and roughly one-third responded to the Choices Survey behavioral assessment (n=160, 33.5%). Students in this study had a mean age of 12.5 (1.0) years (Table 11). More than half were eligible for free or reduced price lunch (54.5%), a marker of low socioeconomic status, and were at a healthy weight (63.2%). Students were evenly distributed among the three grades and between genders, with most students being either white (45.1%) or Asian/Pacific Islander (47.6%). The study sample can be considered representative of the entire student body in the intervention school since no significant differences were found between those included (n=435) and those excluded due to missing BMI data (n=40) (Table 12). For these comparisons, tables present significance tests from t-tests or the Wilcoxon Rank Sum test depending on the distribution of the continuous variable; table footnotes indicate the test used.

Descriptive analyses were also examined for the subsample of students in this current study who completed the Choices Survey behavioral assessment (n=160). The Choices Survey subsample was compared to both the current study sample (n=435) and the total school sample from which this current study sample was drawn (n=477) to determine representativeness (Table 13). Mean age, proportions of students eligible for free or reduced price lunch, and proportions of students classified in weight categories for the Choices Survey subsample were similar for the current study sample and total school sample. A higher proportion of 8^{th} graders (43.1%) and Asian/Pacific Islander students (53.8%) completed the Choices Survey behavioral assessment than were in the current study sample or the total school sample. Additionally, respondents to the Choices Survey for the current study (n=160) and the total school sample (n=170) were compared. There were no substantial sociodemographic differences between these two Choices Survey subsamples for any of the behavioral variables assessed – exercise score and frequency, eating competence, self-esteem, or stages of change (d*ata not shown*).

Behavioral information was assessed for students in the Choices Survey subsample (n=160). Less than half of the subsample (40.3%) was eating competent and students exercised on average 1.7 (SD=0.6) times per week. Other behavioral information on the subsample can be found in Table 14.

Table 15 presents sociodemographic data on the subsample of students who did (n=160) and did not (n=275) respond to the Choices Survey for the current study. The only significant difference between those students who responded to the Choices Survey and those who did not respond to the Choices Survey was for grade (p=0.05) (Table 15).

4.3.2 Stratified Analyses

Stratified analyses were conducted by overweight status (overweight/obese versus not overweight/obese). Stratified analyses examined the sociodemographic variables by overweight status to identify factors that could potentially confound any observed associations. The proportions of students in each weight category differed significantly by grade, with the highest proportion of students who were overweight/obese in the 7th grade (41.1%) and the highest proportion of students who were in the healthy weight range in the 8th grade (38.6%, p=0.03). There were significantly more males classified as overweight/obese (62.0%, p=0.0005), and proportionately more non-Asian/Pacific Islander students in that category (p=0.001) (Table 16).

Overweight status was also examined in stratified analyses of the behavioral variables collected through the Choices Survey (n=160) (Table 17). In this subsample, there were no significant associations between overweight status and the behavioral variables, with one exception. For stages of change regarding exercise frequency, almost twice as many students who were in the healthy weight range reported that they were in the maintenance phase ("already doing it and have done for at least 6 months") compared to students who were overweight/obese (41.8% versus 24.5%, p=0.01).

4.3.3 IMOVE and School Lunch Participation

Almost all students eligible for the study made a purchase in the school lunch line during the intervention year (98.9%, n=430). Only 5 students did not make a purchase and thus were not captured in the denominator of the participation variable. There were 14 students (3.3%) who did make a purchase in the school lunch line, but that purchase was never an IMOVE purchase (n=14) or a standard school lunch purchase (n=10), indicating that they purchased only á la carte items and no meals. Thus all but 1% (n=4) of students in this school participated to some extent in school lunch over the course of the academic year, demonstrating the reach of the IMOVE program throughout the intervention school's student body.

Unadjusted mean participation in IMOVE lunch, standard school lunch, and any school lunch was assessed for the sociodemograhic variables of interest (Table 18). In general, mean participation was higher for standard school lunch (mean =0.77) than for IMOVE lunch (mean=0.72). The main predictor of interest was BMI, which was assessed as both a dichotomous variable (overweight/obese versus not overweight/obese) and a continuous BMI z-score. Although not significant, BMI z-score was directly correlated with IMOVE participation (correlation coefficient=0.065, p=0.18), standard lunch participation (correlation coefficient=0.073, p=0.13), and any lunch participation (correlation coefficient=0.073, p=0.13). When BMI was examined as a categorical variable (overweight/obese versus not overweight/obese), some significant differences did emerge. Mean participation was greater for overweight/obese students than those who were not overweight/obese and were significant for IMOVE (0.77 versus 0.70, p=0.04), standard school lunch (0.821 versus 0.741, p=0.05), and any lunch participation (0.822 versus 0.742, p=0.05).

As might be expected, mean participation in both IMOVE lunch, standard lunch, and any school lunch were significantly associated with SES, with those students who were eligible for free or reduced price lunch having higher mean rates of participation than those who were not eligible (0.852 versus 0.556, p<0.0001 for IMOVE lunch; 0.905 versus 0.595, p<0.0001 for standard school lunch; and 0.905 versus 0.596, p<0.0001 for any lunch, respectively). Race/ethnicity was also significantly associated with participation in IMOVE lunch and standard school lunch, as well as any school lunch (p<0.0001 for all three associations). Across all three outcomes, white students had the lowest mean participation rates among the racial groups, while Asian/Pacific Islanders had the highest mean participation. Age was not significantly associated with mean participation for any of the participation variables (p=0.12). Grade was associated with IMOVE participation (p=0.04), with 6th graders having the highest mean participation and 7th graders having the lowest mean participation. Similar means between grades were observed for both standard lunch participation and any lunch participation, although the relationship was no longer significant (p=0.06 for both). Gender was significantly associated with mean participation in IMOVE lunch, standard school lunch, and any school lunch (p=0.0002, p<0.0001, and p<0.0001, respectively), with higher rates of participation noted among boys.

In addition, exploratory analyses were conducted on the subsample that completed the Choices Survey to determine if any behavioral characteristics were significantly associated with IMOVE lunch, standard lunch, or any school lunch participation (*Data not shown*). Frequency of leisure time exercise was positively correlated with participation in IMOVE, standard school lunch, and any school lunch (correlation coefficient=0.26, p=0.001 for all three). Stage of change for exercise was significantly associated with all three outcome measures (p=0.002), with mean participation rates being higher for students in the precontemplation, contemplation, or preparation stage and lowest for those in the action stage or maintenance stage (p=0.002). Surprisingly, self-esteem was inversely correlated with participation in IMOVE (correlation coefficient= -0.27, p=0.0008) as well as standard school lunch and any school lunch (correlation coefficient= -0.26, p=0.001 for both).

4.3.4 Adjusted Analyses

Multivariate adjusted regression analyses were performed to examine both dichotomous BMI (overweight status) and BMI z-score as predictors of participation in IMOVE lunch, standard school lunch, and any school lunch (Table 19). Both overweight status and BMI z-score, when controlled for sociodemographic variables, significantly predicted a student's participation in IMOVE, standard school lunch, and any school lunch. In multivariate analyses, compared to students who were overweight or obese, those in the healthy weight range had 6.6% less participation in IMOVE (p=0.007), 6.8%

less participation in standard school lunch (p=0.008), and 6.8% less participation in any school lunch (p=0.008). Additionally, with each unit increase in BMI z-score, participation in IMOVE increased by 0.026 days of IMOVE lunch purchases (p=0.003), participation in standard school lunch increased by 0.028 days of standard school lunch purchases (p=0.003), and participation in any school lunch increased by 0.028 days of any school lunch purchases (p=0.003).

Adjusting for all other variables of interest, all of the sociodemographic variables examined in both the dichotomous BMI model and the continuous z-score model, with the exception of age, were significantly associated with IMOVE, standard school lunch, and any school lunch participation. Relationships between lunch participation and sociodemographic variables in adjusted models were similar as those observed in the unadjusted analyses. Students who were eligible for free/reduced price lunch experienced roughly 0.21 greater mean participation in IMOVE, standard, and any school lunch, meaning that they participated in the lunch program 21% more days than students who did not qualify for free/reduced price lunch. Males demonstrated significantly greater participation in IMOVE, standard lunch, and any school lunch compared to females (p<0.0001). Relative to the other racial/ethnic groups, white students had the lowest participation in all three aspects of the lunch program, and 6th graders had the highest participation relative to the other grades. These associations were observed for both BMI models examined.

In the subsample of students responding to the Choices Survey, the association between each behavioral variable and the participation outcomes was examined for exploratory purposes (*data not shown*). In multivariate analyses that adjusted for sociodemographic covariates, overweight status was no longer significantly associated with IMOVE, standard lunch, or any school lunch participation in this subsample of students. In contrast, BMI z-score was significantly associated with participation across all three outcomes (p=0.009 for IMOVE and p=0.005 for both standard school lunch and any school lunch).

Each behavioral variable was then entered individually into the model while adjusting for sociodemographic covariates. In each model for IMOVE, standard school lunch, and any school lunch, BMI z-score remained significant, but no behavioral variables were significant. In a separate set of models, overweight status remained unrelated to lunch participation, as did the other behavioral variables.

In full models adjusting for all sociodemographic covariates and all behavioral variables, the only behavioral characteristic that was significantly related to school lunch participation was stages of change for vegetable consumption. Those in lower stages of change (less ready to increase their vegetable intake) were more likely to participate in standard school lunch and any school lunch (p=0.05 for all associations), but were not necessarily more likely to purchase IMOVE meals (p=0.07). These associations were the same for both the BMI z-score model and the overweight status model. These results should be interpreted with caution given that the model contained many variables and analyzed a small sample.

4.4 DISCUSSION

There has been little research done on the association between the school food environment and children's weight status.[25] The research that does exist has examined BMI as the outcome of school meal participation rather than as a predictor of participation. Where it has been examined as an outcome, research has been inconclusive in relating school lunch participation to students' BMI.[16] This study examines BMI as predictor of participation in both standard school lunch and a healthy eating school lunch intervention program. This is the first study to examine such a relationship in a school offering a healthier alternative school lunch meal alongside the standard reimbursable school lunch menu.

The results of this study demonstrate that, in general, a student's BMI influences participation in school lunch. Further, BMI predicts the purchase of both standard school lunch and alternative meals marketed for nutritional health promotion whether measured by BMI z-score or overweight status (overweight/obese versus not overweight/obese), even after adjusting for sociodemographic covariates, with heavier students exhibiting higher mean participation in school lunch.

Other covariates that were direct significant predictors of participation in lunch programs were non-white racial status, younger grade, male gender, and lower SES. Exploratory analyses showed that certain behavioral characteristics may be associated with participation in school lunch programs. For example, students who were further along in the stages of change for vegetable consumption appeared to be more likely to participate in school lunch. However, given the low response rate and small sample size for these analyses, these findings should be interpreted with caution (37% of students in the study sample responded to the behavioral survey – 36.5% of 6^{th} graders, 29.5% of 7^{th} graders, and 43.4% of 8^{th} graders). Future studies should examine these associations in a larger cohort of students and over a longer period of time.

The findings of this research suggest that cafeteria interventions that promote healthy eating and increase the availability of lower-fat entrees that are portion-controlled and include more fruits, vegetables, whole grains, and low-fat dairy have substantial potential to impact students positively, including those who are most vulnerable to childhood obesity and malnutrition. Non-white students from a variety of ethnicities participated regularly in IMOVE, suggesting that IMOVE meals were sufficiently varied and culturally sensitive. Males participated to a greater extent than females, as did students from low-income families.

Although mean participation rates were higher for the standard school lunch than for the IMOVE program, our results indicate a high level of interest and participation in the IMOVE program among middle school students from a variety of sociodemographic groups represented in our study sample. Sixth graders participated in the IMOVE intervention the most, suggesting that efforts to engage younger grades and to sustain participation from year to year as students move through the school system are central to successful implementation and achieving the desired impact.

These findings have important implications for future interventions aimed at promoting healthy eating behaviors among low-income, racially-diverse middle school students. First, it is clear that there are key predictors of school lunch participation for students, such as race/ethnicity and SES. Interventions should be planned and marketed to school districts with this in mind in order to achieve high levels of program participation among some of the most vulnerable students regarding poor eating habits and obesity risks. Interestingly, the findings of this study indicate that white students are least likely to participate in school lunch overall. Second, there may be behavioral factors that predispose a student to participating in school lunch interventions such as readiness to change their behavior, level of self-esteem, eating competence, or exercise habits. These relationships deserve further study. Third, this study showed that students who were overweight or obese had significantly higher mean participation in standard school lunch and IMOVE. Fourth, mean participation in standard school lunch was higher than for IMOVE lunch among students who were overweight/obese, indicating that regardless of the lunch served, there is substantial opportunity to impact the dietary habits of overweight students since they are likely to be engaged in cafeteria programming. Taken together, these observations encourage ongoing refinements of healthy eating programs like IMOVE in order to improve their reach, marketability, and acceptance by students. It is possible that if standard school lunch were altogether replaced by healthier offerings, such as IMOVE meals, rather than offered alongside healthy choices as a competitive option, the student population most in need of a healthy eating intervention might be reached even more effectively. This model has not yet been tested.

Given the findings presented above, federal school lunch programs might be motivated to assess their current guidelines and work towards changes that would provide healthier meals that appeal to students. While students should be given options from which to choose, the only way to substantially impact food choice behaviors in school may be to consistently present a range of healthy options and forgo the traditional school lunch offerings that are high in fat, sodium, and refined carbohydrates. Federal school lunch programs are so integrated into the schools and are the foundation of school foodservice that changes of this magnitude could have substantial impact.

One solution may be to adopt the newly updated dietary guidelines into the federal school lunch program, in effect assimilating the nutritional goals of IMOVE. Another solution would require administrative and financial support from and creative partnerships with food industry partners and local public health departments in order to make programs like IMOVE available to schools. Funding partners could make it possible for program costs not to be passed on to students and families. Finally, institutional buy-in is a necessary ingredient for the success of any school-based intervention. Support from top administrators appears necessary to enact policy changes and establish leadership within school districts in order to fully support health promotion initiatives, thereby creating a supportive environment for children to adopt and maintain healthy behaviors.

Forty percent of children attending public schools are overweight, with over 20% classified as obese.[42] Although a recent study showed that prevalence of overweight and obesity was not substantially different among middle school children who did and did not participate in the NSLP, some students are disproportionately affected. Racial/ethnic differences exist: considerably more non-Hispanic African American girls are overweight or obese,[16] and the obesity prevalence among Asian adolescents is lower than the national average and lower than all other major racial/ethnic groups.[43] Similar to the need for understanding the sociodemographic predictors of overweight/obesity in order to develop prevention strategies, additional research that focuses on predictors of participation in school lunch would help to inform school-based initiatives. This research would help market prevention efforts by assisting foodservice programmers to effectively encourage equal participation in school lunch in general and in healthier options specifically.[10]

There were some strengths of this study. First, school and research staff were trained to deliver the intervention to achieve complete and correct implementation. Throughout the entire academic school year, research oversight was provided to the extent that budgetary constraints would allow. Second, school cashiers were trained prior to implementation on how to code food items in the POS system to minimize incorrect classification of foods being purchased.

Even given the strengths of the study, the IMOVE program, as planned and delivered, falls short of making broad and extensive improvements in children's diets and obesity-related risks. The IMOVE program did not completely eliminate the less healthy standard school lunch meals, á la carte food choices, or food fundraisers from the school environment. IMOVE did not offer a partner nutrition education curriculum, nor did it have a physical activity component for addressing sedentary behavior as an obesity risk factor. Issues related to profits, foodservice viability, limited curriculum time, and lack of total administrative buy-in are substantial barriers to larger-scale changes and policies that may be required to have a more substantial impact on student behaviors and overall wellness.

This study has several limitations. First, nondifferential misclassification of the BMI exposure could occur if there were errors in height and weight measurements recorded by the school nurses and study team. This source of error was minimized by relying on trained staff and nurses to collect the measurements, plus duplicate entry of the anthropometric data into the study database.

Second, these findings may be influenced by reverse causation. Because only one BMI measurement was taken, it cannot be determined if students are overweight because they eat school lunch more regularly. Nonetheless, our analysis was a prospective investigation of school lunch purchase over one academic school year, and BMI was measured within the first 1 to 3 months of the school year. In spite of this possibility, these data clearly outline an opportunity to impact overweight students by modifying the school lunch environment to provide portion-controlled healthier offerings, given the high level of participation noted among overweight students.

Finally, all participants in this study were from one middle school in one urban public school district. For this reason, findings are only generalizable to students of similar sociodemographic backgrounds. Given that the school had a large proportion of Asian/Pacific-Islander students, this could be another limitation that affects generalizability.

It should be noted that some of the participation outcome variables examined did not appear to be normally distributed. Accordingly, results from the Wilcoxon Rank Sum test or Kruskal-Wallis test are provided for unadjusted analyses where appropriate; however, there is no non-parametric alternative to adjusted regression modeling. Adjusted analyses used multiple regression models and displayed similar results to the unadjusted analyses, suggesting the appropriate use of these methods.

School-based environmental interventions may positively impact childhood obesity risks by making healthy foods available and affordable, particularly to vulnerable populations. Students in school can be reached at different levels of the socio-ecological model, including the environmental, interpersonal, and individual levels. In particular, environmental level interventions can support a healthy lifestyle outside the school environment and reduce barriers that, in turn, can have a substantial impact on behaviors at the population level.[44] Focusing on multiple levels could prove to be the most effective approach.

Recommended strategies for schools include the provision of alternative food choices that are low in fat, calories, and added sugars, such as fruits, vegetables, whole grains, and low-fat or nonfat dairy foods.[45] The IMOVE program is one such strategy that achieves these goals. This research identified BMI status as one of a few significant predictors of participation in a school-based cafeteria intervention. It also demonstrated that the school cafeteria is a viable intervention arena that has the ability to impact the nutritional status of the most vulnerable segments of the population in positive ways if modified and regulated with health promotion goals as a fixed priority.

Efforts at the federal, state, local, and community levels to change dietary behaviors of school children through interventions focused on healthy food intake should take into account not only how the environment influences students' weight and behaviors, but how students' current weight and behaviors might affect their participation in these interventions. In addition to further examining predictors of participation in both standard and alternative school lunch programs, future research that tracks weight status and relevant behaviors before and after implementation of specific changes to the food school environment, both overall and among various subpopulations, will help to determine who the interventions are affecting and to what extent.

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Table 11. Characteristics of the Study Sample

	Intervention School (n=435)[1,2] [% (n)]
Age [mean (SD)]	12.5 (1.0)
Eligible for free/reduced price lunch (SES indicator)	54.5 (237)
Body Mass Index (continuous)	
BMI [mean (SD)]	20.3 (4.8)
BMI z-score [mean (SD)]	0.3 (1.2)
BMI percentile [mean (SD)]	57.4 (32.9)
Body Mass Index (categorical)	
Underweight (<5th percentile)	7.1 (31)
Healthy Weight (5th-84th percentile)	63.2 (275)
Overweight (85th-94th percentile)	15.4 (67)
Obese (≥95th percentile)	14.3 (62)
Grade	
6th	31.5 (137)
7th	32.0 (139)
8th	36.6 (159)
Gender	
Male	49.2 (214)
Race/Ethnicity [3]	
White	45.1 (196)
Black/African American	3.2 (14)
Asian/Pacific Islander	47.6 (207)
Hispanic	2.8 (12)
Multi-race/Other race/ethnicity	1.4 (6)

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.

Table 12. Sample Characteristics for Students with Recorded Body Mass Index and without Recorded Body Mass Index

	BMI available[1,2] (n=435) [% (n)]	BMI not available[1,2] (n=40) [% (n)]	p-value[4,5]
Age [mean (SD)]	12.5 (1.0)	12.8 (0.8)	0.13
Eligible for free/reduced price lunch (SES indicator)	54.5 (237)	47.5 (19)	0.40
Grade			
6th	31.5 (137)	22.5 (9)	0.22
7th	32.0 (139)	45.0 (18)	
8th	36.6 (159)	32.5 (13)	
Gender			
Male	49.2 (214)	56.4 (22)	0.39
Race/Ethnicity [3]			
White	45.1 (196)	35.1 (13)	0.18
Black/African American	3.2 (14)	5.4 (2)	
Asian/Pacific Islander	47.6 (207)	54.1 (20)	
Hispanic	2.8 (12)	0.0 (0)	
Multi-race/Other race/ethnicity	1.4 (6)	5.4 (2)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between BMI available and BMI not available.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables. Fisher's test was used for race/ethnicity due to small sample sizes.

Table 13. Sample Characteristics for Students in the Study Sample, Choices Behavioral Survey Subsample and Total School Sample

	Study Sample (n=435)[1,2] [% (n)]	Sample Choices Subsample (n=160)[1,2] [% (n)]	Total School Sample (n=477)[1,2]
Age [mean (SD)]	12.5 (1.0)	12.6 (1.0)	12.6 (0.9)
Eligible for free/reduced price lunch (SES indicator)	54.5 (237)	55.0 (88)	53.9 (257)
Body Mass Index (continuous)			
BMI [mean (SD)]	20.3 (4.8)	20.8 (4.3)	20.3 (4.8)
BMI z-score [mean (SD)]	0.3 (1.2)	0.3 (1.2)	0.3 (1.2)
BMI-for-age percentile [mean (SD)]	57.4 (32.9)	58.4 (32.4)	57.5 (32.4)
Body Mass Index (categorical)			
Underweight (<5th percentile)	7.1 (31)	6.3 (10)	7.1 (31)
Healthy Weight (5th-84th percentile)	63.2 (275)	62.5 (100)	63.2 (276)
Overweight (85th-94th percentile)	15.4 (67)	18.8 (30)	15.3 (67)
Obese (≥95th percentile)	14.3 (62)	12.5 (20)	14.4 (63)
Grade			
6th	31.5 (137)	31.3 (50)	30.6 (146)
7th	32.0 (139)	25.6 (41)	33.3 (159)
8th	36.6 (159)	43.1 (69)	36.1 (172)
Gender			
Male	49.2 (214)	46.3 (74)	49.6 (236)
Race/Ethnicity [3]			
White	45.1 (196)	40.0 (64)	44.9 (213)
Black/African American	3.2 (14)	2.5 (4)	3.2 (15)
Asian/Pacific Islander	47.6 (207)	53.8 (86)	47.7 (226)
Hispanic	2.8 (12)	3.1 (5)	2.5 (12)
Multi-race/Other race/ethnicity	1.4 (6)	0.6 (1)	1.7 (8)

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.

Table 14. Choices Behavioral Survey Information for Study Subsample who Responded

	Study Subsample (n=160)[1,2] [% (n)]
Exercise Assessment	
Weekly leisure time activity (score) [mean (SD)]*	51.0 (31.9)
Frequency of weekly leisure time activity [mean (SD)]	1.7 (0.6)
Eating Competence Assessment	
Eating Competent[3]	40.3 (64)
Self-Esteem Assessment	
Self-Esteem Score [mean (SD)]	20.9 (4.9)
Stages of Change Assessment	
Readiness to eat more fruits	
Precontemplation	12.0 (19)
Contemplation	8.8 (14)
Preparation	8.8 (14)
Action	34.0 (54)
Maintenance	36.5 (58)
Readiness to eat more vegetables	
Precontemplation	19.0 (30)
Contemplation	7.0 (11)
Preparation	14.6 (23)
Action	24.1 (38)
Maintenance	35.4 (56)
Readiness to eat more whole grain breads, cereals, and foods like brown rice and whole wheat pasta	
Precontemplation	19.2 (30)
Contemplation	9.0 (14)
Preparation	17.3 (27)
Action	25.0 (39)
Maintenance	29.5 (46)
Readiness to drink fewer sugar-sweetened beverages (soda, fruit drinks, lemonade, sweetened sports drinks like Gatorade, Powerade, etc.)	
Precontemplation	27.2 (43)
Contemplation	9.5 (15)
Preparation	12.0 (19)
Action	24.1 (38)
Maintenance	27.2 (43)

Readiness to eat fewer foods that are high in fat (fried foods, French fries, chips, dessert foods, etc.)	
Precontemplation	20.1 (32)
Contemplation	14.5 (23)
Preparation	14.5 (23)
Action	31.5 (50)
Maintenance	19.5 (31)
Readiness to exercise more	
Precontemplation	7.6 (12)
Contemplation	11.3 (18)
Preparation	20.1 (32)
Action	24.5 (39)
Maintenance	36.5 (58)

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Eating competence was scored on a 5-point Likert scale with scores $\geq$ 32 indicate eating competence.

Table 15. Characteristics of the Study Sample by Choices Behavioral Survey Response Status

	Responded to Choices (n=160)[1,2] [% (n)]	Did not Respond to Choices (n=275)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.6 (1.0)	12.5 (0.9)	0.21
Eligible for free/reduced price lunch (SES indicator)	55.0 (88)	54.2 (149)	0.87
Body Mass Index (continuous)			
BMI [mean (SD)]	20.3 (4.3)	20.4 (5.1)	0.83
BMI z-score [mean (SD)]	0.3 (1.3)	0.3 (1.2)	0.85
BMI percentile [mean (SD)]	58.4 (32.4)	56.8 (33.3)	0.62
Body Mass Index (categorical)			
Underweight (<5th percentile)	6.3 (10)	7.6 (21)	0.44
Healthy Weight (5th-84th percentile)	62.5 (100)	63.6 (175)	
Overweight (85th-94th percentile)	18.8 (30)	13.5 (37)	
Obese (≥95th percentile)	12.5 (20)	15.3 (42)	
Grade			
6th	31.3 (50)	31.6 (87)	0.05
7th	25.6(41)	35.6 (98)	
8th	43.1 (69)	32.7 (90)	
Gender			
Male	46.3 (74)	50.9 (140)	0.35
Race/Ethnicity [3]			
White	40.0 (64)	48.0 (132)	0.30
Black/African American	2.5 (4)	3.6 (10)	
Asian/Pacific Islander	53.7 (86)	44.0 (121)	
Hispanic	3.1 (5)	2.6 (7)	
Multi-race/Other race/ethnicity	0.6 (1)	1.8 (5)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between students who did and did not respond to the Choices Survey.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.

Table 16. Sample Characteristics by Overweight Status

	Overweight/ Obese (n=129)[1,2] [% (n)]	Not Overweight/ Obese (n=306)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.4 (0.9)	12.5 (1.0)	0.63
Eligible for free/reduced price lunch (SES indicator)	58.1 (75)	52.9 (162)	0.32
Grade			
6th	27.1 (35)	33.3 (102)	0.03
7th	41.1 (53)	28.1 (86)	
8th	31.8 (41)	38.6 (118)	
Gender			
Male	62.0 (80)	43.8 (134)	0.0005
Race/Ethnicity [3]			
White	50.4 (65)	42.8 (131)	0.001
Black/African American	7.0 (9)	1.6 (5)	
Asian/Pacific Islander	35.7 (46)	52.6 (161)	
Hispanic	4.7 (6)	2.0 (6)	
Multi-race/Other race/ethnicity	2.3 (3)	1.0 (3)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between those who are and are not overweight/obese.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables. Fisher's test was used for race/ethnicity due to small sample sizes.

Table 17. Behavioral Characteristics by Overweight Status among Subsample who Completed the Choices Behavioral Survey

	Overweight/ Obese (n=50)[1,2] [% (n)]	Not Overweight/ Obese (n=110)[1,2] [% (n)]	p-value[3,4]
Exercise Assessment			
Weekly leisure time activity (score) [mean (SD)]	55.2 (33.1)	49.3 (31.3)	0.32
Frequency of weekly leisure time activity [mean (SD)]	1.7 (0.6)	1.8 (0.6)	0.40
Eating Competence Assessment			
Eating Competent[5]	34.7 (17)	42.7 (47)	0.34
Self-Esteem Assessment			
Self-Esteem Score [mean (SD)]	20.3 (49)	21.2 (109)	0.28
Stages of Change Assessment			
Readiness to eat more fruits			
Precontemplation	10.2 (5)	12.7 (14)	0.22
Contemplation	10.2 (5)	8.2 (9)	
Preparation	10.2 (5)	8.2 (9)	
Action	44.9 (22)	29.1 (32)	
Maintenance	24.5 (12)	41.8 (46)	
Readiness to eat more vegetables			
Precontemplation	24.5 (12)	16.5 (18)	0.30
Contemplation	6.1 (3)	7.4 (8)	
Preparation	14.3 (7)	14.7 (16)	
Action	30.6 (15)	21.1 (23)	
Maintenance	24.5 (12)	40.4 (44)	
Readiness to eat more whole grain breads, cereals, and foods like brown rice and whole wheat pasta			
Precontemplation	18.4 (9)	19.6 (21)	0.82
Contemplation	12.2 (6)	7.5 (8)	
Preparation	18.4 (9)	16.8 (18)	
Action	20.4 (10)	27.1 (29)	
Maintenance	30.6 (15)	29.0 (31)	

Readiness to drink fewer sugar-sweetened beverages (soda, fruit drinks, lemonade, sweetened sports drinks like Gatorade, Powerade, etc.)			
Precontemplation	14.3 (7)	33.0 (36)	0.08
Contemplation	10.2 (5)	9.2 (10)	
Preparation	18.4 (9)	9.2 (10)	
Action	22.5 (11)	24.8 (27)	
Maintenance	34.7 (17)	23.9 (26)	
Readiness to eat fewer foods that are high in fat (fried foods, French fries, chips, dessert foods, etc.)			
Precontemplation	18.34 (9)	20.9 (23)	0.95
Contemplation	12.2 (6)	15.5 (17)	
Preparation	14.3 (7)	14.6 (16)	
Action	32.7 (16)	30.9 (34)	
Maintenance	22.5 (11)	18.2 (20)	
Readiness to exercise more			
Precontemplation	6.1 (3)	8.2 (9)	0.01
Contemplation	8.2 (4)	12.7 (14)	
Preparation	18.4 (9)	20.9 (23)	
Action	42.9 (21)	16.4 (18)	
Maintenance	24.5 (12)	41.8 (46)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information on some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) p-values indicate whether there are significant differences between those who are and are not overweight/obese.
4) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables.
5) Eating competence was scored on a 5-point Likert scale with scores $\geq$ 32 indicate eating competence.

Table 18. Mean Participation in IMOVE Lunch, Standard School Lunch, and Any School Lunch by Participant Characteristics (n=430)

	IMOVE Participation [mean (SD)][1,2,3,5]	Standard Lunch Participation [mean (SD)][1,2,3,5]	Any Lunch Participation [mean (SD)][1,2,3,5]
Age (correlation coefficient)	0.065	0.066	0.066
Eligibility for free/reduced price lunch (SES indicator)			
Eligible	0.852 (0.17)*	0.905 (0.17)*	0.905 (0.17)*
Not eligible	0.556 (0.30)*	0.595 (0.32)*	0.596 (0.32)*
Grade			
6th	0.744 (0.26)***	0.793 (0.28)	0.793 (0.28)
7th	0.669 (0.30)***	0.715 (0.32)	0.715 (0.32)
8th	0.738 (0.27)***	0.784 (0.28)	0.784 (0.28)
BMI z-score (correlation coefficient)	0.065	0.073	0.073
Body Mass Index (dichotomous)			
Not overweight/obese	0.700 (0.29)***	0.741 (0.31)****	0.741 (0.31)****
Overweight/obese	0.770 (0.23)***	0.821 (0.25)****	0.822 (0.25)****
Gender			
Male	0.786 (0.22)**	0.842 (0.23)*	0.842 (0.23)*
Female	0.653 (0.31)**	0.692 (0.33)*	0.692 (0.33)*

Race/Ethnicity [4]			
White	0.578 (0.32)*	0.615 (0.34)*	0.615 (0.34)*
Black/African American	0.806 (0.17)*	0.869 (0.17)*	0.869 (0.17)*
Asian/Pacific Islander	0.838 (0.18)*	0.892 (0.19)*	0.892 (0.19)*
Hispanic	0.786 (0.12)*	0.839 (0.14)*	0.839 (0.14)*
Multi-race/Other race/ethnicity	0.723 (0.21)*	0.772 (0.22)*	0.772 (0.22)*

Footnotes:

1) p-values: * = p<0.0001; ** = p<0.001; *** = p<0.05; **** = p=0.05
2) Spearman correlation was used for continuous predictors, and non-parametric tests (Wilcoxon Rank Sum test or Kruskal-Wallis test) were used for categorical predictors to determine significance.
3) Values are unadjusted.
4) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
5) Participation is a fraction defined as the total number of days during which at least one purchase of interest was made divided by the total number of days on which any type of cafeteria purchase was made.

Table 19. Effect of BMI and Other Covariates on Participation in IMOVE Lunch, Standard School Lunch, and Any School Lunch (n=430)

	IMOVE Participation		Standard Lunch Participation		Any Lunch Participation	
	Estimate [β (SE)][3]	*p-value*	*Estimate [β (SE)]*[3]	*p-value*	*Estimate [β (SE)]*[3]	*p-value*
BMI Dichotomous (Overweight Status) Model[1]						
Overweight Status[2]						
Not Overweight	-0.066 (0.024)	0.007	-0.068 (0.026)	0.008	-0.068 (0.026)	0.008
Overweight	---		---		---	
Age	0.010 (0.025)	0.69	0.011 (0.026)	0.67	0.011 (0.026)	0.67
Eligible for free/reduced price lunch (SES indicator)						
Yes	0.210 (0.025)	<0.0001	0.216 (0.026)	<0.0001	0.216 (0.026)	<0.0001
No	---		---		---	
Grade						
6th	0.045 (0.056)	0.02	0.052 (0.059)	0.02	0.052 (0.059)	0.02
7th	-0.042 (0.036)		-0.040 (0.038)		-0.040 (0.038)	
8th	---		---		---	
Gender						
Male	0.116 (0.022)	<0.0001	0.132 (0.023)	<0.0001	0.132 (0.023)	<0.0001
Female	---		---		---	
Race/Ethnicity[4]						
White	-0.096 (0.091)	<0.0001	-0.105 (0.10)	<0.0001	-0.105 (0.10)	<0.0001
Black/African American	-0.020 (0.107)		-0.009 (0.113)		-0.009 (0.113)	
Asian/Pacific Islander	0.065 (0.091)		0.071 (0.096)		0.071 (0.096)	
Hispanic	0.040 (0.110)		0.046 (0.116)		0.046 (0.116)	
Multi-race/Other race/ethnicity	---		---		---	

BMI Z-Score Model[1]						
BMI z-score	0.026 (0.009)	0.003	0.028 (0.009)	0.003	0.028 (0.009)	0.003
Age	0.010 (0.024)	0.69	0.011 (0.026)	0.67	0.011 (0.026)	0.67
Eligible for free/reduced price lunch (SES indicator)						
Yes	0.211 (0.025)	<0.0001	0.216 (0.026)	<0.0001	0.216 (0.026)	<0.0001
No	---		---		---	
Grade						
6^{th}	0.050 (0.056)	0.01	0.057 (0.059)	0.01	0.057 (0.059)	0.01
7^{th}	-0.041 (0.036)		-0.039 (0.038)		-0.039 (0.038)	
8^{th}	---		---		---	
Gender						
Male	0.117 (0.021)	<0.0001	0.113 (0.023)	<0.0001	0.113 (0.023)	<0.0001
Female	---		---		---	
Race/Ethnicity [4]						
White	-0.107 (0.091)	<0.0001	-0.117 (0.095)	<0.0001	-0.117 (0.095)	<0.0001
Black/African American	-0.021 (0.107)		-0.011 (0.113)		-0.011 (0.113)	
Asian/Pacific Islander	0.057 (0.091)		0.062 (0.10)		0.062 (0.10)	
Hispanic	0.025 (0.110)		0.030 (0.115)		0.030 (0.115)	
Multi-race/Other race/ethnicity	---		---		---	

Footnotes:

1) Values are adjusted for the others listed in the model.
2) Overweight status is defined as overweight/obese (≥85th percentile) or not overweight/obese (<85th percentile).
3) Values are estimated coefficients (SE) for mean participation in school lunch calculated by linear regression modeling.
4) Race/ethnicity was recoded from 32 categories into a 5-group categorization.

5 THE ASSOCIATION BETWEEN EXPOSURE TO IMOVE AND USUAL FOOD AND NUTRIENT INTAKE

5.1 INTRODUCTION

Child and adolescent diets do not meet current national recommendations that specify appropriate amounts of foods, nutrients, vitamins, or minerals.[1] Intakes of nutritious foods – fruits, vegetables, dairy, and whole grains – are extremely low while intakes of foods high in fat and added sugars are exceptionally high. Only one in four adolescents meets the recommended dietary guideline that specifies five or more servings of fruits and vegetables per day, and only 7% meet the recommended guideline for adequacy of whole grain foods.[2,3] Inadequate intake of healthy foods and excessive intake of unhealthy foods disproportionately affects children and adolescents in low-income families.[4,5]

Eating behaviors in children and adolescents are strongly influenced by two important environments – school and home. At home, children's eating habits are heavily influenced by their families. Outside the home, children's diets are influenced by the foods available at school[6] and in their community. Factors associated with childhood overweight and obesity include social factors and influences, family resources, knowledge and attitudes about diet and healthy eating, availability and variety of foods, frequency of eating meals and snacks, parental misperception of health eating, and genetics.[7-12] Clearly, promoting supportive environments and healthy personal behaviors would help to reduce the obesity burden.[13]

Children spend a substantial amount of time at school. More than 80% of 5 to 19 year olds attend elementary and secondary schools,[14] and students are at school for 9 or more hours every day. Nutritional guidelines for school meals must meet the minimum U.S. Department of Agriculture (USDA) meal standards, which are based on the 1995 Dietary Guidelines for Americans (DGA).[15] These standards are outdated, however, and may not reflect current nutritional science. Current dietary guidelines, such as the 2005 DGA, are more stringent and reflect more recent dietary research. Given this, and the fact that students consume up to half of their daily calories at school,[16,17] food availability and subsequent consumption during the school day can affect students' overall dietary patterns. Therefore, there is a need to examine the association between foods available in schools and the dietary practices and food choice behaviors of school-aged youths.

Surprisingly few intervention studies have assessed how a change in the school environment translates into changes in overall food behavior. Behaviors that students learn in school can certainly be transferred to the home, especially if the home environment does not encourage healthy behaviors. Outside of school, students' behaviors, dietary choices, and access to healthy or unhealthy foods are largely influenced by the home environment. This environment has been considered the most dynamic and complex food source, especially for children; availability of food at home is influenced by availability at food outlets as well as parental influence.[18] Given the potential effect of different environments on behavior, a multi-pronged approach is warranted to foster healthy behaviors in students.

A recent cross-sectional study of a nationally representative sample participating in the third School Nutrition Dietary Assessment (SNDA-III) study, which is conducted in children grades 1 through 12 enrolled in public school, examined the school food environment and children's dietary choices during the school day. This research showed that school food environments are indeed associated with children's choices of foods and beverages. Participation in school lunch was found to contribute to fruit and vegetable intake, but half of all children did not consume any fruit or vegetables during the school day.[19] This same study also demonstrated that students who consumed school meals consumed more fruits, vegetables, and milk and that increased consumption of these foods was carried over into total dietary intake.[20]

In addition to inadequate fruit and vegetable intake, an area of concern related to the childhood obesity epidemic is the role of sugar-sweetened beverages (SSB), including soda and sugar-added fruit drinks. The drastic increase in total energy intake in children and adolescents over the years is largely attributed to increased consumption of SSB.[21] The SNDA-III showed that overall, 68% of school children consumed SSB at some location during the day, with 50% consuming them at home and 25% at school.[22] Secondary school children who consumed SSB at school consumed 229 more daily calories than children who did not consume SSB at school. School policies limiting the availability of SSB were associated with reduced consumption of sweetened beverages at school. Additionally, there was no evidence that consuming fewer SSB at school led to increased consumption of these beverages outside of school.[22] Findings from this study should be interpreted with caution since the analysis did not control for other student characteristics.

School-based environmental interventions may effectively combat childhood obesity by leading to positive behavior changes both at school and in the home, particularly for low-income populations, by making healthy foods available and affordable. However, dietary changes at school to promote healthy dietary behaviors may not easily translate to healthy behaviors at home, and specifically may present special challenges for low-income populations. Children's weight status is influenced by the cost of foods such as fruits and vegetables. Higher fruit and vegetable prices are significantly related to higher BMI percentiles in children, with the largest effects felt by those with low socioeconomic status (SES).[23] Intervention efforts should focus on making foods available, and also affordable, particularly to low SES populations.

It is known that school food environmental and policy changes have improved the types of foods served or sold to students, but the extent to which improved lunch choices influence food consumption for the whole day is poorly understood and warrants further study.[19,24] We examined the dietary behaviors of students in an intervention school that received a healthy eating cafeteria intervention and a comparison school by assessing usual food consumption from all sources, including school and home, in the past week. Our hypothesis was that students in the intervention school who were exposed to healthy lunch meals would have healthier patterns of food and nutrient intake compared to students in comparison school.

5.2 METHODS

5.2.1 Intervention and Study Design

Data for this study were obtained from the quasi-experimental evaluation of IMOVE, which assessed cafeteria food purchase patterns of students in two public middle schools (one intervention and one comparison school) in the Quincy, Massachusetts school district. IMOVE is a school-based environmental intervention designed for middle school cafeterias to promote healthy eating behaviors through increased access to affordable and healthy school lunch meals with appropriate portion sizes. IMOVE meals, which are served alongside standard school lunch, are nutritionally healthier than standard school lunch meals. Standard school lunch meals adhere to the federal National School Lunch Program (NSLP) guidelines, which are based on the 1995 DGA, while IMOVE meals reflect more current nutritional research. IMOVE meals provide less than 25% of calories from total fat, less than 10% of calories from saturated fat, and offer nutritionally balanced weekly menus that exceed standard school nutrition guidelines, including the provision of at least one-third of the Recommended Daily Allowance (RDA) for protein and key micronutrients such as calcium, iron, and vitamins A and C. IMOVE meals and snacks also limit amounts of sodium and added sugars.

The IMOVE intervention not only provides healthy and affordable school lunch entrees, but also advertises the importance of healthy eating through cafeteria posters and flyers, and rewards IMOVE lunch purchases through raffle tickets and prizes. IMOVE is based on 38 weeks of menus that utilize a six-week menu cycle. These menus are modified, based on feedback from foodservice operators, to cater to the needs and cultural preferences of school-specific clientele.

Monthly cafeteria promotions invigorate the program to increase and sustain participation. Promotions include fresh fruit and vegetable displays and taste-testing, raffle prize drawings and give-aways, an IMOVE sticker logo to identify healthy choices, and attention-grabbing IMOVE posters. Students receive a raffle ticket every time they purchase either an IMOVE hot meal or salad entree. Winners are chosen every 4 to 6 weeks to receive prizes that promote physically active lifestyles (sports gear, back-packs, frisbees, etc). Twice yearly, a larger prize is raffled, such as a mountain bike or tickets to a professional sporting event.

All students in the intervention school had access to the IMOVE program and could purchase IMOVE meals in their school cafeterias while still having daily access to the standard school lunch meals. Students in both schools also had access to a variety of á la carte items offered on the school lunch line including fruit, low-fat dairy, breads and other grain foods, chips, baked desserts, and frozen ice cream treats.

5.2.2 Study Sample

The study sample includes a self-selected subsample of students from the larger quasi-experimental study. All students were invited to complete a food screener at the fall baseline assessment. A subsample of students whose parents gave informed consent actually completed the baseline assessment in October. The same students who had consented to the baseline assessment were asked to complete the follow-up assessment in June. Students completed the screener in either a health and wellness class or in homeroom after receiving instructions from their teacher.

Participation required parental consent, which is a known barrier to participation.[25] While there was a difference in the number who completed the baseline assessment from those enrolled in the intervention school (n=174 and 477, respectively) and comparison school (n=120 and 341, respectively), a similar proportion of enrolled students in the intervention and comparison school completed the baseline assessment (36.5% and 35.2%, respectively). This cohort of students was asked to complete the same survey at the end of the school year to provide a follow-up assessment. The percentage of participating students who completed both baseline and follow-up surveys was high and similar across the intervention and comparison schools (93.1%, n=162 and 91.7%, n=110, respectively).

Protocols, data collection instruments, and consent forms were approved by the Institutional Review Board at Boston University.

5.2.3 Datasets and Data Collection

Data for this study were obtained from various datasets collected throughout the course of the intervention and later merged through unique student identifiers. The separate datasets required to answer this study question are described briefly below.

Assessments of Food and Nutrient Intake

The Block Kids Food Screener (Appendix A), a 42-item abbreviated food frequency questionnaire (FFQ), was used to estimate food and nutrient intake. This validated tool measures usual intake of common foods and beverages in adolescent diets by asking respondents to report the frequency and portion size of foods consumed in the past week.[26] For each food consumed, students choose one of six frequency response categories, ranging from never consumed to consumed every day in the past week. They also indicate their portion size by choosing from three food-specific portion options, typically representing small, medium, and large servings. The survey queries representative foods and beverages in child/adolescent diets that are consumed throughout the day, not just during school lunch.

The screener was created from the same nationally representative dietary survey data as the more lengthy Block Kids FFQ, which has demonstrated reliability and validity in adolescents, including minority adolescents,[27,28,29] and is one of the two most widely used FFQs in epidemiologic research. The screener assesses intake levels of individual food items, food groups, and nutrients, including fruits and vegetables, saturated fat, and added sugars. Participating students completed the two-sided scannable survey form in a health and wellness class or homeroom under the supervision of their teachers. Forms were cleaned and prepared for scanning and were then sent to NutritionQuest to be scanned.

School Enrollment Data

Enrollment data were obtained from the Quincy school district. This file contained identifiers for each student enrolled in the two middle schools along with the student's name, date of birth, gender, race/ethnicity, grade, and both the student's 4-digit school-issued ID and 7-digit state ID. The enrollment database allowed for 62 different codes for race/ethnicity. Based on the school-level data, these 62 categories were combined into five: White, Black/African American, Asian/Pacific Islander, Hispanic, and Multi-Race/Other Race/Ethnicity.

Anthropometric Measurements

Anthropometric measurements were conducted to obtain height and weight measures necessary to compute BMI [weight (kg)/height $(m)^2$] for each student. Students' height and weight were measured in street clothes without shoes in a private location during physical education class periods, according to standardized procedures and using equipment available to school nurses in the Quincy schools. Measurements for all enrolled students were taken by school nurses with the assistance of trained research staff, documented on paper forms, and duplicate-entered into an Excel database. Students who were absent on the original day when their classmates were measured were contacted by the school nurse after they returned to school, and were excused from class to be measured. Anthropometric measurements were missing for 3.9% of enrolled students in the intervention school and 8.7% of enrolled students in the comparison school.

Gender-specific BMI-for-age percentiles and BMI z-scores were calculated to assess the prevalence of overweight using the USDA/ARS Children's Nutrition Research Center website.[30,31,32] In accordance with current guidelines, children were categorized as either obese (BMI-for-age ≥95th percentile), overweight (BMI-for-age 85th to < 95th percentile), healthy weight (BMI-for-age 5th to 84th percentile), or underweight (<5th percentile).[33] Some analyses used BMI as a continuous measure by employing BMI z-score, a standardized BMI that is calculated using an external reference population to statistically adjust for gender and age differences.[34] BMI z-score allows for increased interpretability over the crude BMI measure and is preferable to BMI-for-age percentile, which can be poorly suited for statistical analyses.[35]

5.2.4 Variable Definitions

To be included in the exposed group in this study, students had to attend the intervention school receiving IMOVE; students attending the comparison school were considered unexposed. The primary outcome for this study was average daily food and nutrient intake, as assessed by the Block Kids Food Screener. The Food Screener uses information on food frequency and quantity to compute estimates of average daily intake of nutrients (such as saturated fat, total fat, protein, fiber, carbohydrates, and sodium) and food groups (such as whole grains, dairy, legumes, meat/poultry/fish, vegetables, and fruits), plus average daily grams of individual food items. The resulting information obtained from the Food Screener includes over 200 food, food group, and nutrient variables.

Fifty-one of the most relevant diet-related variables in this study population were examined. In addition, two additional food group variables were created that were relevant to this study population and to the research question concerning the consumption of typical school lunch foods and common á la carte foods. These variables were a) *snack foods*: cereal bars, granola bars, protein bars; snack chips; cookies, donuts, cakes; ice cream; popcorn; candy, candy bars; and b) *traditional school* *lunch foods*: French fries, hash browns, tater tots; hamburgers, cheeseburgers; hot dogs, corn dogs, or sausages; lunch meats; pizza, pizza pockets; spaghetti, ravioli with sauce; macaroni and cheese; chicken including nuggets; fish, fish sticks; burritos or tacos; beef like roast, steak, or in sandwiches; meatballs; pork; cheese; whole wheat bread. Consumption levels of these two major food categories were estimated by computing the mean of the average daily grams of the individual component foods in each food category.

Based on the characteristics of the study population, plus the limitations of the dietary information collected from the Food Screener, the Recommended Food Score (RFS)[36] was selected to create a diet quality index to characterize students' self-reported diets. The RFS is based on reported consumption of foods that are recommended by current dietary guidelines. Given the measurement error associated with reported amounts of foods consumed, this measure was originally designed to be independent of reported portions,[36] making it useful in the present study of adolescents.

An RFS was computed for each participant in the sample by summing the number of recommended foods that were reported on the Block Kids Food Screener as being eaten as least once in the past week. In this study sample, the maximum score was 21, with a higher score indicating greater adherence to the dietary guidelines (i.e., a healthier diet). From the Food Screener, the recommended foods were: cereal (whole grain only); cooked cereal (e.g., oatmeal); milk (reduced, low-fat, or non-fat only); real fruit juice; fruit (e.g., apples, bananas, oranges); applesauce or fruit cocktail; any other fruit (e.g., strawberries or grapes); potatoes other than French fries, hash browns, or tater tots (e.g., mashed or boiled potatoes); lettuce salad; tomatoes; green beans or peas; other vegetables (e.g., corn, carrots, greens broccoli); soup with vegetables;

beans (chili, pinto, or black); hamburgers or cheeseburgers; chicken; fish; beef (e.g., beef, steak); meat balls; pork (e.g., chops, roast, ribs); and, whole wheat bread or rolls. Two of the items on the Food Screener asked for type of cereal and milk consumed, and these were used to restrict those food categories for the dietary index. The remaining 18 items on the Food Screener did not meet the criteria for inclusion in the dietary index.

5.2.5 Statistical Analyses

Individual-level data were collected for the eating behaviors via the Block Food Screener. This dataset was merged with the enrollment dataset in order to link student eating behaviors with sociodemographic information. Analyses tested whether the intervention introduced had an effect. With the unit of observation being the student, and with clustering according to school, hierarchical models were not warranted to test the study hypothesis.[37]

First, descriptive analyses of important sociodemographic variables (e.g., gender, race/ethnicity, SES, age, grade, and BMI) were conducted, stratified by exposure status (intervention school versus comparison school). Continuous variables that exhibited departures from normality were examined using the Wilcoxon Rank Sum test. Results from these tests showed no differences in significance of associations when compared to the t-test, indicating that the methods used were robust against departures from normality. Subsequently, to assess the significance of differences between groups, stratified analyses used t-tests for continuous variables and Chi-square tests for categorical variables. For any table with a cell frequency of 5 students or less, Fisher's exact test was used. These descriptive analyses were performed for those who completed only the baseline diet assessment (n=294) and then for the analytical sample that completed both baseline and follow-up assessments (n=262) to show comparability of those who did and did not respond.

The analytical sample were students with repeated eating surveys (n=262). This sample was compared to the overall sample (n=818) on important sociodemographic variables to evaluate the representativeness of the study sample relative to the overall sample of students enrolled in the two Quincy schools for the 2008-09 academic school year. Stratified analyses were used to compare the students in the study with repeated eating surveys and students in the school without eating surveys.

Unadjusted means for the nutrients, individual foods, and food groups were examined for the study sample at baseline and follow-up. Difference scores were created for each of the food variables of interest by subtracting the baseline mean consumption from the follow-up mean consumption. Differences in mean scores from baseline to follow-up, by exposure (intervention versus comparison), were assessed. The continuous dietary index scores at those two time points were analyzed the same way. Sociodemographic variables were also evaluated to determine the presence of associations with the nutrient, individual food, and food group differences using regression models.

Finally, regression modeling was used to assess the effect of the intervention on each nutrient, food, and dietary index outcome, controlling for age, gender, race/ethnicity, grade, SES, and baseline BMI through a standardized z-score. Parameter estimates with standard errors were reported to illustrate the estimated effect of the intervention using analytic methods employed in similar studies.[38] Due to little or no prior knowledge as to the direction of the study hypotheses, all hypothesis tests were two-sided with a 0.05 level of significance unless otherwise stated. All analyses were performed with the SAS Statistical System version 9.1.3.[39]

5.3 RESULTS

5.3.1 Descriptive Analyses

Baseline descriptors of the study sample are provided in Table 20. The two school samples were significantly different with respect to race/ethnicity, grade, and SES. Even though there were significant differences in grade, with more students in the 8th grade in the intervention school than in the comparison school (p=0.007), age was similar and not significantly different between the two schools (p=0.07). The racial/ethnic profile was significantly different, with White students comprising the majority in the comparison school and Asian/Pacific Islander students the majority in the intervention school (80.0% and 54.6%, respectively, p<0.0001). Students in the intervention school were more likely to be eligible for free or reduced price lunch than students in the comparison school (54.6% and 33.3%, respectively, p=0.0003). All tables present significance tests from t-tests; results of testing using the Wilcoxon Rank Sum test were qualitatively similar.

The representativeness of the self-selected sample of students who completed the eating survey was evaluated against those who did not (Table 21). In the intervention school, only grade was significantly different between those completing the Food Screener and those who did not, with a higher proportion of students in the 8th grade completing it (p=0.006). Many more significant differences were observed in the comparison school between students who did and did not complete the eating survey. Here, students who did not complete the survey were significantly older (p=0.02), more likely to be eligible for free/reduced price lunch (p<0.0001), heavier (higher BMI z-score, p=0.04), more likely to be male (p=0.05), and more likely to be non-white (p=0.04).

Sociodemographic variables for the study sample were examined. The differences in race/ethnicity and SES between the two schools were also significant for the sample of students that had both a baseline and follow-up dietary assessment (p<0.0001 and p=0.003, respectively) (Table 22). Grade was not significantly different between the schools. While the difference was small, age did become significant in the study sample, with an average older age of students in the comparison school [12.8 (0.9) years versus 12.6 (0.9) years, p=0.03]. BMI (continuous z-score and categorical) and gender were not significantly different between the schools in the baseline sample or the analytic study sample.

Table 23 displays the study sample and the eligible sample of students in each of the Quincy schools to assess the representativeness and generalizability of the study results. In the intervention school, proportions and means were similar between the study sample and the eligible sample for most of the sociodemographic characteristics, with only race/ethnicity and BMI exhibiting differences between the two populations. In the comparison school, more differences in sociodemographic characteristics between the eligible sample and study sample were observed, mainly for gender, SES, BMI, and race/ethnicity.

5.3.2 Baseline and Follow-Up Consumption

Baseline and follow-up consumption of foods and nutrients were assessed, and the difference between the two time points was used as the main outcome of interest in statistical models. Unadjusted means in consumption for the nutrients (Table 24), individual foods (Table 25), and food groups (Table 26) of interest for this study population were calculated. For the nutrients of interest (Table 24), there were no significant differences between schools in baseline consumption or mean difference in consumption from baseline to follow-up, but there were some significant differences in consumption between schools at follow-up. Both average daily glycemic load (glucose scale) and total carbohydrates (in grams) exhibited a decrease from baseline to follow-up in both schools, with the decrease being non-significantly greater in the intervention school than the comparison school (glycemic load = -6.7 and -1.1, respectively, p=0.21; total carbohydrates = -16.6 and -5.8, respectively, p=0.26). This difference was enough to create significantly different intakes at follow-up between the intervention and comparison school for both glycemic load (67.8 and 78.8, p=0.01) and total carbohydrates (147.0 grams and 170.2 grams, p=0.01).

Mean difference in intake of total fat increased in both schools from baseline to follow-up by the same amount (0.4 grams, p=0.98), but the mean difference from baseline to follow-up for saturated fat increased just slightly more for the comparison school than the intervention school (0.5 and 0.2 grams, respectively, p=0.85). While the increase in teaspoon of sugars added to foods/beverages was slight for the intervention school from baseline to follow-up (0.02 teaspoons), the comparison school students experienced an increase of sugar added to foods/beverages of 1.6 teaspoons (p=0.06). As a result, the intake of sugars added to foods/beverages at follow-up was significantly different between schools (p=0.008). Intake of naturally occurring sugars decreased in the intervention school but increased in the comparison school (-9.2 and 0.4, respectively, p=0.08) from baseline to follow-up, resulting in the two schools differing significantly at follow-up (p=0.004). Both schools experienced a decrease in average daily kilocalories reported from baseline to follow-up, but the decrease was just slightly greater for the intervention school than the comparison school (-58 and -20 kilocalories, respectively, p=0.66).

Table 25 illustrates the mean intake of individual foods (in average daily grams) at baseline and follow-up and the difference between the two time points. Many of the foods that were significantly different at baseline between schools were also significantly different at follow-up, including macaroni and cheese (p=0.01 and p=0.0002), fish (p=0.02 and p=0.03), burritos/tacos (p=0.03 and p=0.04), whole wheat bread (p=0.0003 and p=0.002), cheese (p=0.002 and p=0.003), and 1% milk (p=0.02 and p=0.03). None of the mean differences over time was significantly different between schools, nor did any except 1% milk exhibit substantial differences in mean intake. This observation suggests that significant differences between schools at both time points may have been due to different patterns in food intake within the schools and not an intervention effect that arose over time.

Of note, there were some interesting associations between the schools and time points for soda/soft drinks and types of milk. Soda intake at baseline was not different between the intervention and comparison school (127.9 grams and 130.4 grams, p=0.92), but was significantly different at follow-up (p=0.02), with the intervention school reporting a decline in soda intake and the comparison school experiencing an increase in soda consumption from baseline to follow-up (-13.4 grams and 32.5 grams, respectively, p=0.08).

Consumption of different types of milk varied by school and time point. No types of milk, except for 1%, were significantly different between schools at baseline or follow-up. However, for whole milk, the mean difference between baseline and follow-up was significantly different between schools (p=0.05), with the intervention school experiencing a large decline in whole milk consumption (-42.3 grams) and the comparison school experiencing a slight increase (1.3 grams). Interesting to note, however, is that both schools experienced a non-significant decline in consumption of the lower-fat milk options (1% and non-fat), with the comparison school experiencing more of a decline in both than the intervention school.

Differences between the intervention and comparison schools that were significant but not necessarily of practical importance included baseline intake of pork (8.4 grams and 4.7 grams, p=0.01), follow-up intake of breakfast/protein bars (6.0 grams and 9.2 grams, p=0.03), and follow-up intake of popcorn (1.8 grams and 3.5 grams, p=0.03).

Food group analyses mirrored the results for individual food items, with significant differences between schools noted at baseline and follow-up for both whole grain (p=0.02, p=0.0003) and dairy (p=0.008, p=0.02) intakes (Table 26). The intervention school exhibited a non-significant decrease in whole grain consumption, while the comparison school reportedly increased consumption (-0.03 ounce equivalent and 0.05 ounce equivalent, p=0.22). A decline in dairy (cup equivalent) of similar magnitude was observed for both schools. From baseline to follow-up, mean intake of kilocalories from sugary beverages decreased in the intervention school (-5.52 kilocalories) and increased in the comparison school (13.4 kilocalories, p=0.08), with the daily frequency of sugary beverage intake remaining consistent over time in the intervention school but increasing in the comparison school (p=0.01). Analyses were conducted using frequency of consumption for foods rather than average daily gram intake and produced similar results (*data not shown*).

Students in both the intervention and comparison schools consumed approximately 1.5 cup equivalents of fruit and less than one cup equivalent of vegetables per day at baseline and follow-up (Table 26). They consumed almost 3 ounce equivalents of meat, poultry, or fish and less than 2 cups equivalent of dairy per day. Students across both schools reported consuming approximately 6.5 solid foods per day at both time points.

No significant differences were observed for the two food group variables created for this study – snack items and traditional school lunch items. Intake of snack items increased from baseline to follow-up in both schools, but the increase was non-significantly greater for the comparison school (2.9 grams) than the intervention school (1.9 grams, p=0.55). Consumption of traditional school lunch items increased just slightly for intervention school students from baseline to follow-up (0.03 grams) and decreased just slightly for students in the comparison school (-0.2 grams, p=0.91).

Given that there were few significant differences in individual foods consumed from baseline to follow-up between the schools, it is not surprising that the difference in the overall dietary index was not significantly different between schools (Table 27). At baseline, the mean dietary index score was nearly identical for the intervention and comparison schools (11.19 and 11.20, respectively). The mean score decreased at follow-up for both schools, but just slightly more so for the comparison school (11.03 and 10.90, respectively).

5.3.3 Adjusted Analyses

Adjusted analyses were conducted using regression models to determine the estimated effect of the intervention on the nutrient, individual food, and food group variables of interest. Adjusted models controlled for age, gender, race/ethnicity, SES, grade, and BMI z-score. Effects were examined for mean intake of the selected variables. Table 28 presents estimated effects for the mean difference from baseline to follow-up for only a subset of the 51 variables originally examined. The variables presented were chosen based on their significance, practical importance, or usefulness to the study question. These results include both favorable and null effects of the intervention.

Exposure to the IMOVE intervention resulted in an estimated decrease of 0.1 daily intake of sugary beverages (p=0.03) from baseline to follow-up. Additionally, exposure to IMOVE resulted in an estimated average daily gram increase of 2% milk of 75.2 grams (p=0.02) and a decrease of 48.3 grams of whole milk (p=0.08) from baseline to follow-up. The several variables that had unadjusted mean differences that were significantly different between the intervention and comparison schools were no longer significant once adjusted for confounders. In these adjusted models, the only covariates from those listed above that were significantly associated with the difference in means of the nutrient, individual food, or food group were race/ethnicity and SES, suggesting that these covariates have a significant independent effect on the mean intakes of the nutrients and foods examined for this study.

In addition to the presented adjusted analyses on mean difference of intake from baseline to follow-up, analyses were conducted on mean intakes at the follow-up time point (*data not shown*). The significant results on mean difference presented above were confirmed, with a few additional significant relationships at follow-up uncovered. At follow-up, exposure to the intervention resulted in an estimated decrease of 2.1 teaspoons of sugar added to foods/beverages (p=0.04) and an estimated decrease of 14.9 grams of sugars naturally occurring in foods (p=0.03). Exposure to the IMOVE intervention also resulted in an estimated decrease 4.6 grams of lunch meat as compared to not receiving the intervention (p=0.03).

5.4 DISCUSSION

This is the first study to investigate how the school foodservice environment influences overall dietary behavior by examining the effects of a school cafeteria intervention on students' typical food and nutrient intake. The results of this study are consistent with our hypothesis that students in the intervention school would have healthier patterns of food and nutrient intake than students in the comparison school. Specifically, by the end of the intervention school year, students in the intervention school consumed sugary beverages less frequently and reduced consumption of higher-fat milk options more frequently than students in the comparison school. There were no significant findings suggesting the reverse – i.e., that students in the comparison school had healthier intakes of any foods or nutrients than students in the intervention school.

Perhaps the most important findings relate to the consumption of sugary beverages and milk. Consumption of sugary beverages and intake of kilocalories from sugary beverages were greater for the comparison school than the intervention school, with decreases at follow-up exhibited by the intervention school but not the comparison school. Additionally, changes in milk consumption were also observed, with students in the intervention school decreasing their consumption of higher-fat milk at follow-up to a greater extent than students in the comparison school. Interestingly, students in the intervention school did not increase their intake of lower-fat options such as non-fat and 1% milk, but rather increased their intake of 2% milk.

Other interesting findings included the greater decrease from baseline to follow-up in the intervention school for average daily glycemic load and total carbohydrates. Findings such as these may have been more pronounced over a longer intervention period or with a more sensitive measure of food intake. Note, however, that even small changes in dietary behavior could have important dietary implications in the long-term. Since the nutritional importance of glycemic load is controversial, this observation warrants a closer examination of sources of simple sugars in the diet. For example, the comparison school students experienced a greater increase of sugar added to foods/beverages (1.6 teaspoons) and a smaller decrease in average daily kilocalories (-20 kilocalories) from baseline to follow-up than the intervention school (0.02 teaspoons and -58 kilocalories). Given that a typical can of soda has 9 teaspoons of sugar and 139 kilocalories, over time these slight differences could result in substantial health benefits.

Interestingly, there were no significant associations between the IMOVE intervention program and fruit and vegetable intake. This is somewhat surprising since IMOVE focused heavily on increased provision and promotion of fresh fruits and vegetables through its recipes, menus, free produce, and promotional events, but IMOVE was, nonetheless, a relatively low-intensity intervention that was confined to the school cafeteria and relied on students to make healthy choices. As designed and implemented, IMOVE does not include a nutrition education curriculum, a physical education component, a home connection, or wellness policy initiative. Use of other strategies such as a classroom component, reductions or changes in competitive foods available (through vending machines, fundraisers, and school stores), and a family education component might result in more substantial outcomes. Indeed, a multi-component intervention strategy that is fully integrated throughout the school community is what has been shown to be most effective in prior research.[40,41]

Our finding is consistent, however, with another recent study of school-based environmental change that also failed to demonstrate a significant impact on fruit and vegetable consumption.[19] That study reported that, on average, students consumed less than 1 cup equivalent of fruits and vegetables at school, a large proportion of that total coming from French fries.[22] Students in our study sample, regardless of intervention status, consumed about 1.5 cup equivalents of fruits and less than one cup equivalent of vegetables in their total daily diets. Their mean intake of vegetables was higher than that of French fries and other potatoes, suggesting the presence of other vegetables in their daily diets.

Other studies have shown small to moderate increases in fruit and vegetable consumption following a multi-sector effort, including a change to the school food environment either through school lunch or á la carte offerings.[42] Kubik et al. examined the association between dietary behaviors in 7th grade students (measured by 24-hour dietary recalls) and the types of competitive foods sold in vending machines and á la carte in cafeteria lines, and the presence of unhealthy school lunch items including fried potatoes.[43] Á la carte availability was inversely associated with fruit and vegetable intake and positively associated with total and saturated fat intake. Students from schools that did not offer á la carte foods met the USDA dietary recommendations for daily calories, while students from schools with á la carte programs exceeded the recommendations.[43] Improvements in consumption of fresh fruits and vegetables at school warrants continued attention, particularly since consumption of these nutrient-rich foods tends to drop off during middle school years.[19]

Another interesting result was related to the dietary quality index, which had not previously been examined in a school-based intervention study. The maximum index score was 21, indicating a high level of dietary quality and a better approximation of the recommended dietary guidelines. The mean scores for students in both schools were around 11, even at follow-up. This indicates that, on a weekly basis, students are getting only half of the recommended foods in their diets. This substantiates the need to increase both the variety and quality of students' diets in pursuit of health promotion goals.

The results of this study suggest a relationship between foods offered at school and overall dietary behaviors of middle school students. Our findings on milk consumption are consistent with another study that found that introduction of a school-based healthy eating intervention increased consumption of low-fat milk.[44] We also found that the frequency of intake of sugary beverages was reduced in our intervention study sample. This is an important observation considering the fact that sugar-sweetened drinks were not available in the participating schools as part of the recent Alliance School Beverage Guidelines,[45] and that children's homes are a significant source of such beverages.[19] Therefore, the IMOVE intervention in school appears to be having a positive effect in reducing consumption of sugary beverages outside of school.

While these changes in the school environment are important, school is just one of the two environments that heavily influence youth's diets. Improvements in eating behaviors at school, through the restriction of low-nutrient and energy-dense foods are warranted. This action needs to be coupled with changes at home, however, where adolescents typically consume the majority of foods. A study conducted with a nationally representative sample of children in grades 1 through 12 examined how access to foods in different environments affected children's diet quality and risk of obesity. The results showed that eating at home provided the greatest amount of energy from low-nutrient, energy-dense foods such as baked goods and SSB.[22] Thus, efforts need to focus on not only school-based programs, but also on changing the home environment.

There is no single most effective way to change behaviors both at home and at school. Including parents in short-term nutrition education interventions has led to significant increases in at-home dietary and nutritional knowledge, but these increases in knowledge have not been shown to be associated with at-home dietary habits.[46] Behaviors are transferred from one environment to the next, therefore changes to all environments that influence behavior – while also providing students with the knowledge they need to make healthy decisions – is warranted. While efforts should focus on food quality, another important issue, both at school and especially at home, is the quantity and portion sizes of foods. Portion sizes have increased substantially in recent years, with the greatest increases for food consumed in the home or in fast food establishments.[47] IMOVE meals are portion-controlled, thereby ensuring that correct school lunch portions are served in school.

This study has several limitations that warrant careful consideration when interpreting the findings. First, dietary intake was self-reported, which is subject to memory and recall errors as well as measurement error caused by inaccurately estimated portion sizes.[48] Second, the Block Kids Food Screener is an abbreviated instrument that provides a relatively crude assessment of specific dietary exposures. While it estimates usual consumption of major food groups and saturated fat intake with adequate validity, estimates of total calories, other macro- and micro-nutrients, and individual foods items are less accurate, in part due to the shortened food list. In fact, total calories appear to be underestimated in this sample. Measurement error may also contribute to outcome misclassification, which could preclude the ability to detect differences between the intervention and comparison schools. Nonetheless, this tool was chosen in response to the very real concerns related to time constraints and respondent burden that school administrators raised when we considered alternative dietary assessment tools.

Third, data were collected on a self-selected subsample of the total pool of eligible students in both schools. While the subsamples were fairly representative of the total sample of Quincy middle school students, only one-third of the students completed the eating survey and could be included in this analysis. There was also a difference in response rates between schools due to differences in survey administration and the support provided by teachers when assisting students to complete the surveys. Analyses did show some significant differences in both schools between students who did and did not complete the Food Screener. Fourth, there is a possibility of uncontrolled confounding due to other personal behaviors that were not taken into account due to lack of information. Fifth, the IMOVE intervention did not offer a parent education component, which could be critical to support behavior change at home, as suggested by past research.[46] Finally, all study participants are from one urban public school district serving low-income and racially diverse students, so the findings are generalizable only to similar populations.

There are some limitations that could contribute to a null result. First, given that the intervention and comparison schools were in the same school district, there is the possibility of contamination if students in the comparison schools received information on nutrition and healthy eating from peers in the intervention schools. This is unlikely since the intervention primarily involved exposure to foods in the school cafeteria that were not accessible to students in the comparison school, and no written educational materials were circulated that could contaminate the educational environment in the comparison school. Second, Type III error results in a null effect when there is incorrect or incomplete implementation of the intervention.[49] School foodservice staff members were trained to effectively deliver the intervention, and oversight throughout the course of the intervention was provided by the foodservice director and the staff from Costa, IMOVE's developers. Even so, the fact that the research team was external to the school system introduced some barriers to the most ideal implementation. Third, Type II error is possible due to the small sample size, making the study underpowered to detect the true effect. A larger sample size or a longer follow-up period may have resulted in more pronounced differences between the schools.

A comprehensive effort to change the school food environment needs to address school lunch, á la carte foods, vending machines, school stores, and after-school activities. A recent study showed that when access to unhealthy competitive foods was restricted in school, little compensation occurred from items brought from home.[24] That result, coupled with the present study, underscores the importance of making healthy environmental changes in all sectors of school foodservice. These environmental changes should be coupled with education on how youth can make healthy choices, which will increase the likelihood that they make healthy choices outside of school, where the range of choices offered to them is even greater. Additional research is needed in this area, particularly in light of the relatively low overall dietary quality noted among these urban middle school students, most of whom are at substantial risk for childhood obesity and other nutrition-related public health concerns.

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Table 20. Sample Characteristics for Students Completing Baseline Block Assessment, by School

	Intervention School[1,2] (n=174) [% (n)]	Comparison School[1,2] (n=120) [% (n)]	p-value[3,4]
Age [mean (SD)]	12.6 (0.9)	12.8 (0.9)	0.07
Eligible for free/reduced price lunch (SES indicator)	54.6 (95)	33.3 (40)	< 0.001
Body Mass Index (continuous)			
BMI [mean (SD)]	20.3 (4.5)	20.9 (4.6)	0.31
BMI z-score [mean (SD)]	0.3 (1.2)	0.5 (1.1)	0.25
BMI percentile [mean (SD)]	58.5 (32.2)	62.6 (29.3)	0.27
Body Mass Index (categorical)			
Underweight (<5th percentile)	6.1 (10)	1.8 (2)	0.38
Healthy Weight (5th-84th percentile)	63.2 (103)	65.5 (74)	
Overweight (85th-94th percentile)	18.4 (30)	19.5 (22)	
Obese (≥95th percentile)	12.3 (20)	13.3 (15)	
Grade			
6th	30.5 (53)	35.8 (43)	0.007
7th	25.3 (44)	37.5 (45)	
8th	44.3 (77)	26.7 (32)	
Gender			
Male	45.4 (79)	45.8 (55)	0.94
Race/Ethnicity [3]			
White	40.2 (70)	80.0 (96)	<.0001
Black/African American	1.7 (3)	4.2 (5)	
Asian/Pacific Islander	54.6 (95)	12.5 (15)	
Hispanic	2.9 (5)	2.5 (3)	
Multi-race/Other race/ethnicity	1 (0.57)	1 (0.83)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between the intervention and comparison schools.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables

Table 21. Sample Characteristics for Students Completing Baseline Block Assessment and Not Completing Baseline Block Assessment, by School

	Intervention School			Comparison School		
	Participant in Eating Survey (n=174)[1,2] [% (n)]	Non-Participant (n=303)[1,2] [% (n)]	p-value[4,5]	Participant in Eating Survey (n=120)[1,2] [% (n)]	Non-Participant (n=221)[1,2] [% (n)]	p-value[4,5]
Age [mean (SD)]	12.6 (0.9)	12.5 (0.9)	0.22	12.8 (0.8)	13.1 (1.0)	0.02
Eligible for free/reduced price lunch (SES indicator)	54.6 (95)	53.5 (163)	0.81	33.3 (40)	55.2 (122)	<0.0001
Body Mass Index (continuous)						
BMI [mean (SD)]	20.3 (4.5)	20.3 (5.0)	1.0	20.9 (4.6)	22.5 (6.0)	0.01
BMI z-score [mean (SD)]	0.3 (1.2)	0.3 (1.3)	0.84	0.5 (1.1)	0.7 (1.1)	0.04
BMI percentile [mean (SD)]	58.5 (32.2)	56.9 (33.4)	0.63	62.6 (29.3)	69.2 (28.0)	0.05
Body Mass Index (categorical)						
Underweight (<5th percentile)	6.1 (10)	7.7 (21)	0.43	1.8 (2)	2.6 (5)	0.31
Healthy Weight (5th-84th percentile)	63.2 (103)	63.1 (173)		65.5 (74)	57.1 (109)	
Overweight (85th-94th percentile)	18.4 (30)	13.5 (37)		19.5 (22)	18.9 (36)	
Obese (≥95th percentile)	12.3 (20)	15.7 (43)		13.3 (15)	21.5 (41)	
Grade						
6th	30.5 (53)	30.7 (93)	0.006	35.8 (43)	31.7 (70)	0.27
7th	25.3 (44)	38.0 (115)		37.5 (45)	33.0 (73)	
8th	44.3 (77)	31.4 (95)		26.7 (32)	35.3 (78)	
Gender						
Male	45.4 (79)	52.0 (157)	0.17	45.8 (55)	57.0 (126)	0.05

Race/Ethnicity [3]						
White	40.2 (70)	47.7 (143)	0.09	80.0 (96)	64.1 (141)	0.04
Black/African American	1.7 (3)	4.0 (12)		4.2 (5)	7.7 (17)	
Asian/Pacific Islander	54.6 (95)	43.7 (131)		12.5 (15)	19.1 (42)	
Hispanic	2.9 (5)	2.3 (7)		2.5 (3)	5.5 (12)	
Multi-race/Other race/ethnicity	0.6 (1)	2.3 (7)		0.8 (1)	3.6 (8)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
4) p-values indicate whether there are significant differences between the intervention and comparison schools.
5) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables. Fisher's Exact Test was used to calculate the p-value for categorical BMI in the Comparison School due to small cell size.

Table 22. Sample Characteristics for Students with Repeated Eating Surveys, by School

	Intervention School (n=162)[1,2,3] [% (n)]	Comparison School (n=110)[1,2,3] [% (n)]	p-value[5,6]
Age [mean (SD)]	12.6 (0.9)	12.8 (0.9)	0.03
Eligible for free/reduced price lunch (SES indicator)	53.1 (86)	34.6 (38)	0.003
Body Mass Index (continuous)			
BMI [mean (SD)]	20.4 (4.6)	20.9 (4.6)	0.39
BMI z-score [mean (SD)]	0.3 (1.2)	0.4 (1.1)	0.36
BMI percentile [mean (SD)]	59.0 (32.5)	62.5 (29.4)	0.38
Body Mass Index (categorical)			
Underweight (<5th percentile)	6.0 (9)	1.9 (2)	0.45
Healthy Weight (5th-84th percentile)	61.6 (93)	66.4 (69)	
Overweight (85th-94th percentile)	19.9 (30)	18.3 (19)	
Obese (≥95th percentile)	12.6 (19)	13.5 (14)	
Grade			
6th	32.7 (53)	36.4 (40)	0.08
7th	25.3 (41)	34.6 (38)	
8th	42.0 (68)	29.1 (32)	
Gender			
Male	46.3 (75)	45.5 (50)	0.89
Race/Ethnicity[4]			
White	42.0 (68)	79.1 (87)	p<0.0001
Black/African American	1.9 (3)	4.6 (5)	
Asian/Pacific Islander	53.1 (86)	13.6 (15)	
Hispanic	3.1 (5)	1.8 (2)	
Multi-race/Other race/ethnicity	0.0 (0)	0.9 (1)	

Footnotes:

1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Sample is all students who completed both a Block baseline and follow-up assessment.
4) Race/ethnicity was recoded from 32 categories into a 5-group categorization.
5) p-values indicate whether there are significant differences between the intervention and comparison schools.
6) The Chi-square test was used to calculate p-values for categorical variables, and the t-test was used to calculate p-values for continuous variables. Fisher's Exact Test was used to calculate the p-value for race/ethnicity due to small cell size.

Table 23. Sample Characteristics of the Study Sample compared to the Eligible Sample, by School

	Intervention School		Comparison School	
	Eligible Sample (n=477)[1,2,3] [% (n)]	Study Sample (n=162)[1,2,4] [% (n)]	Eligible Sample (n=341)[1,2,3] [% (n)]	Study Sample (n=110)[1,2,4] [% (n)]
Age [mean (SD)]	12.6 (0.9)	12.6 (0.9)	13.0 (0.9)	12.8 (0.9)
Eligibility for free/reduced price lunch (SES indicator)				
Eligible	53.9 (257)	53.1 (86)	47.5 (162)	34.6 (38)
Not eligible	46.1 (220)	46.9 (76)	52.5 (179)	65.5 (72)
Body Mass Index (continuous)				
BMI [mean (SD)]	20.3 (4.8)	20.4 (4.6)	21.9 (5.5)	20.9 (4.6)
BMI z-score [mean (SD)]	0.3 (1.2)	0.3 (1.2)	0.6 (1.1)	0.4 (1.1)
BMI percentile [mean (SD)]	57.5 (32.4)	59.0 (32.5)	66.7 (28.6)	62.5 (29.4)
Body Mass Index (categorical)				
Underweight (<5th percentile)	7.1 (31)	6.0 (9)	2.3 (7)	1.9 (2)
Healthy Weight (5th-84th percentile)	63.2 (276)	61.6 (93)	60.2 (183)	66.4 (69)
Overweight (85th-94th percentile)	15.3 (67)	19.9 (30)	19.1 (58)	18.3 (19)
Obese (≥95th percentile)	14.4 (63)	12.6 (19)	18.4 (56)	13.5 (14)
Grade				
6th	30.6 (146)	32.7 (53)	33.1 (113)	36.4 (40)
7th	33.3 (159)	25.3 (41)	34.6 (118)	34.6 (38)
8th	36.1 (172)	42.0 (68)	32.3 (110)	29.1 (32)
Gender				
Male	49.6 (236)	46.3 (75)	53.1 (181)	45.5 (50)
Race/Ethnicity [3]				
White	44.9 (213)	42.0 (68)	69.7 (237)	79.1 (87)
Black/African American	3.2 (15)	1.9 (3)	6.5 (22)	4.6 (5)
Asian/Pacific Islander	47.7 (226)	53.1 (86)	16.8 (57)	13.6 (15)
Hispanic	2.5 (12)	3.1 (5)	4.4 (15)	1.8 (2)
Multi-race/Other race/ethnicity	1.7 (8)	0.0 (0)	2.7 (9)	0.9 (1)

Footnotes:
1) Sample sizes may be different for sociodemographic variables due to missing information for some participants.
2) Some cells display means rather than percentages and are noted in the table.
3) Eligible sample is all students enrolled in the school.
4) Study sample is all students who completed both a Block baseline and follow-up assessment.
5) Race/ethnicity was recoded from 32 categories into a 5-group categorization.

Table 24. Mean Nutrient Intake at Baseline, Follow-Up, and Difference, by School

	Intervention School (n=162)[1,3,4,5]			Comparison School (n=110)[1,3,4,5]		
Nutrient[6]	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**
Saturated fat (grams)	17.8 (16.3, 19.3)	18.0 (16.1, 19.9)	0.2 (-1.7 2.1)	19.0 (16.9, 21.1)	19.5 (17.3, 21.6)	0.5 (-1.6, 2.6)
Sugar/syrup added to foods/beverages (teaspoon)	8.0 (6.9, 9.0)	8.0 (7.0, 8.9)*	0.02 (-1.1, 1.1)	8.5 (7.3, 9.8)	10.1 (8.8, 11.4)*	1.6 (0.4, 2.8)
Average daily Glycemic Index (glucose scale)	48.8 (48.2, 49.4)	49.1 (48.5, 49.7)	0.3 (-0.5, 1.0)	48.7 (47.9, 49.4)	49.4 (48.7, 50.0)	0.7 (-0.0, 1.4)
Average daily Glycemic load (glucose scale)	74.5 (68.9, 80.2)	67.8 (62.2, 73.4)**	-6.7 (-12.5, -1.0)	80.0 (72.7, 87.2)	78.8 (72.0, 85.6)**	-1.1 (-7.6, 5.3)
Average daily kilocalories	1305 (1211, 1398)	1247 (1131, 1361)	-58 (-170, 54)	1366 (1232, 1499)	1346 (1218, 1474)	-20 (-149, 109)
Total protein (grams)	55.1 (50.9, 59.2)	55.4 (49.2, 61.5)	0.3 (-5.5, 6.1)	56.2 (50.0, 62.4)	56.0 (49.3, 62.6)	-0.2 (-7.3, 6.8)
Total fat (grams)	50.3 (46.1, 54.6)	50.7 (44.9, 56.5)	0.4 (-5.2, 6.0)	51.0 (45.2, 56.9)	51.4 (45.5, 57.3)	0.4 (-5.6, 6.3)
Total carbohydrate (grams)	163 (151, 175)	147 (135, 158) **	-17 (-29, -5)	175 (160, 192)	170 (156, 185) **	-6 (-20, 8)
Total fiber (grams)	10.7 (9.8, 11.6)	9.2 (8.4, 10.1) **	-1.5 (-2.3, -0.6)	11.6 (10.2, 13.0)	10.6 (9.5, 11.7) **	-1.0 (-2.3, 0.3)
Total sugars, naturally occurring in foods/ juices (grams)	94.4 (87.0, 101.7)	85.2 (78.4, 91.9)*	-9.2 (-16.3, -2.0)	101.1 (92.2, 110.0)	101.5 (92.5, 110.5)*	0.4 (-7.7, 8.5)
Sodium (mg)	1904 (1754, 2054)	1814 (1625, 2004)	-90 (-282, 103)	2006 (1775, 2238)	1874 (1666, 2083)	-132 (-376, 112)

Footnotes:

1) p-values: * = p<0.01; ** = p<0.05
2) Mean difference is the difference in nutrient intake from baseline to follow-up.
3) Values are unadjusted means (95% CI).
4) p-values indicate whether there are significant differences between the intervention and comparison schools at the specified time points.
5) The t-test was used to calculate p-values for continuous variables.
6) Units of each variable are displayed in the table under "Nutrient".

Table 25. Mean Intake of Individual Foods at Baseline, Follow-Up, and Difference, by School

	Intervention School (n=162) [1,3,4,5]			Comparison School (n=110) [1,3,4,5]		
Food (average daily grams) [6]	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**
Granola bars / Protein bars	5.7 (4.0, 7.4)	6.0 (4.3, 7.6) ***	0.3 (-1.5, 2.0)	7.5 (5.0, 10.0)	9.2 (6.7, 11.7) ***	1.7 (-1.4, 4.8)
Milk						
2%	89.1 (62.0, 116.3)	119.7 (89.1, 150.2)	30.5 (-0.0, 61.1)	103.5 (65.0, 142.1)	89.5 (51.6, 127.4)	-14.1 (-53.6, 25.5)
Whole	97.8 (67.9, 127.7)	55.5 (34.7, 76.3)	-42.3 (-70.8, -13.8)	70.5 (38.9, 102.0)	71.8 (40.2, 103.4)	1.3 (-32.3, 34.9) ***
1%	48.3 (25.5, 71.2) ***	43.5 (23.1, 63.8) ***	-4.9 (-24.6, 14.9)	101.0 (61.8, 140.1) ***	84.0 (50.8, 117.2) ***	-17.0 (-63.0, 29.0)
Chocolate	31.9 (16.1, 47.8)	21.6 (7.6, 35.5)	-10.4 (-27.4, 6.6)	34.8 (12.7, 56.9)	28.9 (7.5, 50.2)	-6.0 (-31.9, 20.0)
Non-fat	12.8 (1.7, 24.0)	7.5 (1.4, 13.6)	-5.3 (-15.8, 5.1)	24.3 (4.3, 44.3)	15.8 (2.2, 29.5)	-8.5 (-30.9, 14.0)
Soda / soft drinks	127.9 (97.1, 158.6)	114.5 (92.8, 136.3) ***	-13.4 (-44.6, 17.8)	130.4 (91.8, 168.9)	162.8 (127.5, 198.2) ***	32.5 (-11.4, 76.4)
French fries / tater tots	14.4 (11.1, 17.8)	12.3 (9.8, 14.8)	-2.2 (-5.6, 1.3)	12.5 (9.1, 15.9)	10.9 (8.2, 13.5)	-1.7 (-5.7, 2.4)
Hamburgers	22.7 (18.0, 27.3)	28.9 (22.5, 35.3)	6.2 (0.2, 12.3)	16.4 (11.5, 21.3)	22.4 (18.2, 26.6)	6.0 (0.1, 12.0)
Hot dogs	7.4 (5.3, 9.6)	9.9 (7.1, 12.7)	2.5 (-0.7, 5.7)	7.3 (4.6, 10.1)	9.2 (6.3, 12.0)	1.8 (-1.5, 5.2)
Lunch meats	7.5 (5.6, 9.3)	8.2 (6.3, 10.1)	0.7 (-1.6, 3.0)	9.5 (6.5, 12.4)	10.5 (7.5, 13.5)	1.0 (-2.2, 4.3)
Pizza	24.5 (19.0, 30.0)	23.1 (18.4, 27.8)	-1.4 (-7.9, 5.0)	24.0 (16.6, 31.3)	19.7 (15.3, 24.1)	-4.2 (-11.5, 3.0)
Spaghetti / lasagna	39.2 (29.8, 48.6)	34.0 (23.9, 44.1)	-5.2 (-16.8, 6.4)	53.9 (37.1, 70.7)	45.4 (34.5, 56.3)	-8.5 (-26.4, 9.4)
Macaroni and Cheese	16.6 (11.3, 21.8)***	9.8 (6.6, 13.0)*	-6.7 (-12.5, -0.9)	29.5 (19.7, 39.3) ***	26.5 (17.1, 35.9)*	-3.0 (-12.5, 6.5)
Chicken	28.1 (23.3, 32.9)	27.8 (22.6, 33.0)	-0.3 (-6.0, 5.5)	22.3 (16.5, 28.1)	22.6 (17.5, 27.7)	0.3 (-6.0, 6.1)
Fish	10.4 (7.4, 13.4) ***	10.7 (7.6, 13.7) ***	0.3 (-3.0, 3.5)	5.2 (2.5, 7.9) ***	5.7 (2.5, 8.9) ***	0.5 (-3.1, 4.0)
Burritos / Tacos	6.3 (3.2, 9.3) ***	8.0 (4.4, 11.6) ***	1.7 (-2.5, 5.9)	15.8 (6.2, 25.4) ***	16.0 (8.5, 23.6) ***	0.2 (-9.7, 10.1)
Beef like roast	10.7 (8.3, 13.2)	13.2 (9.3, 17.2)	2.5 (-1.9, 6.9)	8.9 (6.0, 11.7)	12.5 (8.5, 16.5)	3.6 (-1.0, 8.3)
Other meat	6.4 (4.3, 8.3)	8.2 (5.0, 11.4)	1.8 (-1.9, 5.5)	7.6 (4.6, 10.6)	7.1 (3.6, 10.5)	-0.6 (-5.0, 3.8)

Pork	8.4 (6.2, 10.6) ***	8.8 (6.3, 11.2)	0.3 (-2.0, 2.7)	4.7 (3.1, 6.3) ***	8.6 (5.0, 12.2)	3.9 (0.3, 7.6)
Popcorn	3.0 (1.9, 4.0)	1.8 (1.1, 2.6) ***	-1.1 (-2. 4, 0.2)	3.4 (2.1, 4.6)	3.5 (2.1, 5.0) ***	0.2 (-1.5, 1.9)
Snack chips	10.4 (8.6, 12.2)	9.8 (8.1, 11.6)	-0.6 (-2.7, 1.5)	9.1 (7.3, 10.8)	9.0 (7.0, 10.9)	-0.1 (-1.6, 1.4)
Ice cream	30.7 (23.8, 37.6)	43.2 (34.6, 51.8)	12.5 (2.7, 22.3)	34.2 (24.8, 43.6)	49.6 (40.0, 59.2)	15.4 (3.9, 26.9)
Candy	4.2 (3.1, 5.3)	4.3 (3.1, 5.5)	0.1 (-1.2, 1.3)	3.7 (2.6, 4.9)	4.8 (3.2, 6.4)	1.1 (-0.6, 2.7)
Cookies / Cakes	6.7 (4.6, 8.9)	7.1 (4.5, 9.7)	0.4 (-2.2, 2.9)	7.6 (5.1, 10.0)	6.5 (4.3, 8.6)	-1.1 (-3.7, 1.5)
Cheese	5.5 (4.2, 7.0) **	5.3 (4.3, 6.4) **	-0.2 (-1.7, 1.4)	10.0 (7.4, 12.5) **	8.7 (6.5, 10.8) **	-1.3 (-4.0, 1.4)
Whole wheat bread	8.1 (6.3, 9.9) *	8.5 (6.6, 10.3) **	0.4 (-1.7, 2.4)	15.2 (11.4, 19.0)*	14.3 (10.8, 17.9) **	-0.8 (-4.6, 3.0)

Footnotes:

1) p-values: * = p<0.001; ** = p<0.01; *** = p<0.05
2) Mean difference is the difference in food intake from baseline to follow-up.
3) Values are unadjusted means (95% CI).
4) p-values indicate whether there are significant differences between the intervention and comparison schools at the specified time points.
5) The t-test was used to calculate p-values for continuous variables.
6) Units of each variable are in average daily grams.

Table 26. Mean Intake of Food Groups at Baseline, Follow-Up, and Difference, by School

	Intervention School (n=162) [1,3,4,5]			Comparison School (n=110) [1,3,4,5]		
Food Group[6]	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[2]**
Fruit / fruit juice (cup equivalent)	1.7 (1.5, 1.9)	1.4 (1.2, 1.6)	-0.3 (-0.5, -0.1)	1.7 (1.5, 1.9)	1.6 (1.4, 1.8)	-0.1 (-0.3, 0.1)
Vegetables, excluding potatoes and legumes (cup equivalent)	0.9 (0.8, 1.0)	0.8 (0.7, 0.8)	-0.2 (-0.3, -0.1)	0.9 (0.8, 1.0)	0.7 (0.6, 0.8)	-0.2 (-0.3, -0.1)
Potatoes, including French fries (cup equivalent)	0.4 (0.3, 0.4)	0.3 (0.3, 0.4)	-0.1 (-0.1, -0.0)	0.3 (0.3, 0.4)	0.3 (0.2, 0.3)	-0.1 (-0.1, 0.0)
Whole grains (ounce equivalent)	0.4 (0.4, 0.5)***	0.4 (0.4, 0.5) *	-0.03 (-0.1, 0.1)	0.6 (0.4, 0.7) ***	0.6 (0.5, 0.7) *	0.1 (-0.1, 0.2)
Meat, poultry, fish (ounce equivalent)	2.8 (2.4, 3.1)	3.0 (2.5, 3.5)	0.23 (-0.2, 0.7)	2.4 (2.1, 2.8)	2.7 (2.2, 3.2)	0.3 (-0.3, 0.8)
Dairy (cup equivalent)	1.7 (1.5, 1.8) **	1.5 (1.4, 1.7) ***	-0.1 (-0.3, 0.0)	2.0 (1.8, 2.2) **	1.8 (1.6, 2.0) ***	-0.2 (-0.4, 0.0)
Legumes (cup equivalent)	0.02 (0.01, 0.03)	0.02 (0.01, 0.03)	-0.01 (-0.02, 0.00)	0.04 (0.02, 0.07)	0.03 (1.01, 0.04)	-0.02 (-0.04, 0.01)
Kilocalories from sugary beverages	52.8 (40.1, 65.5)	47.3 (38.3, 56.2) ***	-5.5 (-18.4, 7.3)	53.8 (37.9, 69.7)	67.2 (52.6, 81.8) ***	13.4 (-4.7, 31.5)
Frequency of consumption of sugary beverages	0.3 (0.2, 0.3)	0.3 (0.2, 0.3) **	0.00 (-0.04, 0.04) ***	0.3 (0.2, 0.3)	0.4 (0.3, 0.4) **	0.1 (0.0, 0.2) ***
Consumption of solid foods (grams)	642.2 (591.8, 692.5)	591.6 (534.4, 648.9)	-50.6 (-107.4, 6.2)	644.0 (569.9, 718.0)	598.9 (536.3, 661.5)	-45.0 (-117.0, 27.0)
Approximate number of solid foods consumed per day	6.7 (6.2, 7.2)	6.1 (5.6, 6.7)	-0.5 (-1.1, 0.0)	6.7 (5.9, 7.4)	6.6 (5.9, 7.3)	-0.1 (-0.8, 0.6)
Snack items (grams)[7]	10.1 (8.7, 11.6)	12.0 (10.1, 14.0)	1.9 (-0.2, 4.0)	10.9 (9.0, 12.9)	13.8 (11.6, 15.9)	2.9 (0.6, 5.1)
Traditional school lunch items (grams)[8]	14.4 (12.9, 15.9)	14.4 (12.4, 16.5)	0.03 (-2.1, 2.1)	16.2 (13.7, 18.6)	16.0 (13.7, 18.3)	-0.2 (-2.9, 2.6)

Footnotes:

1) p-values: * = p<0.001; ** = p<0.01; *** = p<0.05
2) Mean difference is the difference in food group intake from baseline to follow-up.
3) Values are unadjusted means (95% CI).
4) p-values indicate whether there are significant differences between the intervention and comparison schools at the specified time points.
5) The t-test was used to calculate p-values for continuous variables.
6) Units of each variable are specified under "Food Group".
7) Foods that comprise the category snack items include: cereal bars, granola bars, protein bars; snack chips; cookies, donuts, cakes; ice cream; popcorn; candy, candy bars.
8) Foods that comprise the category traditional school lunch items include: French fries, hash browns, tater tots; hamburgers, cheeseburgers; hot dogs, corn dogs, or sausages; lunch meats; pizza, pizza pockets; spaghetti, ravioli with sauce; macaroni and cheese; chicken including nuggets; fish, fish sticks; burritos or tacos; beef like roast, steak, or in sandwiches; meatballs; pork; cheese; whole wheat bread.

Table 27. Recommended Food Score, by School

	Intervention School[3] (n=162)	Comparison School[3] (n=110)	p-value[4,5]
Food Score Baseline [mean (SD)][1,2]	11.2 (3.4)	11.2 (3.3)	0.98
Food Score Follow-up [mean (SD)][1,2]	11.0 (3.8)	10.9 (3.9)	0.78
Difference in Recommended Food Score[1,2] [mean (SD)]	-0.2 (3.0)	-0.3 (3.2)	0.76

Footnotes:

1) Recommended Food Score is modeled after Kant et al.[36]
2) Participants receive one point for all foods consumed that are part of the dietary index. The foods are included in the index include:
    a. Cold cereal (whole grain only)
    b. Cooked cereal (e.g., oatmeal)
    c. Milk (reduced, low-fat, or non-fat only)
    d. Real fruit juice
    e. Fruit (e.g., apples, bananas, oranges)
    f. Applesauce, fruit cocktail
    g. Other fruit (e.g., strawberries or grapes)
    h. Potatoes other than French fries, hash browns, or tater tots (e.g., mashed or boiled potatoes)
    i. Lettuce salad
    j. Tomatoes
    k. Green beans, peas
    l. Other vegetables (e.g., corn, carrots, greens broccoli)
    m. Vegetable soup
    n. Beans (chili, pinto, or black)
    o. Hamburgers or cheeseburgers
    p. Chicken
    q. Fish
    r. Beef (e.g., beef, steak)
    s. Other meat in a meal (e.g., meatballs)
    t. Pork (e.g., chops, roast, ribs)
    u. Whole wheat bread or rolls
3) Values are unadjusted means (SD).
4) p-values indicate whether there are significant differences between the intervention and comparison schools at the specified time points.
5) The t-test was used to calculate p-values for continuous variables.

Table 28. Effect of Intervention Status on Select Food and Nutrient Intake Mean Differences (n=272)

Nutrient/Food[4]	Intervention School [β (SE)][1,3]	p-value[2]
Saturated fat (grams)	-0.1 (1.8)	0.94
Sugar/syrup added to foods/beverages (teaspoon)	-1.7 (1.0)	0.10
Average daily kilocalories	-46.0 (109)	0.67
Total protein (grams)	1.5 (5.82)	0.80
Total fat (grams)	-0.5 (5.3)	0.92
Total carbohydrate (grams)	-12.5 (11.8)	0.29
Total fiber (grams)	-0.8 (0.9)	0.38
Sodium (mg)	-1.2 (193.0)	0.99
Soda / soft drinks (grams)	-48.3 (32.9)	0.14
French fries / tater tots (grams)	-3.9 (3.4)	0.25
Macaroni and Cheese (grams)	-4.2 (6.9)	0.54
Burritos / Tacos (grams)	4.9 (6.1)	0.42
Ice cream (grams)	-2.5 (9.8)	0.80
Snack chips (grams)	0.00 (1.9)	1.0
Fruit / fruit juice (cup equivalent)	-0.2 (0.17)	0.22
Vegetables, excluding potatoes and legumes (cup equivalent)	-0.04 (0.09)	0.66
Dairy (cup equivalent)	0.20 (0.14)	0.17
Kilocalories from sugary beverages	-19.9 (13.6)	0.14
Frequency of consumption of sugary beverages	-0.1 (0.05)	0.03
Consumption of solid foods (grams)	-25.0 (58.2)	0.67
Snack items (grams)	-0.8 (2.0)	0.69
Traditional school lunch items (grams)	-0.32 (2.1)	0.88
Milk (grams)		
Whole	-48.3 (27.9)	0.08
2%	75.2 (32.0)	0.02
1%	31.6 (29.2)	0.28
Non-fat	2.5 (14.8)	0.86

Footnotes:

1) Values are adjusted for age, gender, ethnicity, SES, grade, and BMI.
2) p-values indicate whether there are significant differences between the intervention and comparison schools.
3) Values are estimated coefficients (SE) for the intervention school compared to the comparison school, as calculated by linear regression modeling.
4) Out of 51 variables total, only select food and nutrient variables with substantial differences or interesting findings are presented in this table.

6 CONCLUSIONS

The role that school foodservice has played in the childhood obesity epidemic has been of recent concern, and there is growing national attention on school meals and how the school food environment can be modified to improve children's diets and weights.[1] To date, however, relatively few environmental-level interventions have been implemented, and even fewer have been rigorously evaluated to identify best practices for widespread dissemination. Because childhood is a pivotal time to introduce positive healthy eating behaviors, interventions focused on this population should be considered a public health priority. School-based interventions are a necessity given that children spend so much time at school and are a captive audience while there.

Population-based policies and programs that include environmental changes are the most likely interventions to be successful in combating childhood obesity. Numerous studies have supported the assertion that reversal of the childhood obesity epidemic is unlikely to occur in the absence of changes to school and other food environments.[2] Reducing consumption of low-nutrient and energy-dense foods at school by removing sugar sweetened beverages (SSB) and high-fat foods from school lunch lines and vending machines, improving and increasing the variety of á la carte food choices, and improving the nutritional quality of school lunch meals by adding more fruits and vegetables are required strategies, especially for the student populations most affected by childhood obesity and most at risk of developing unhealthy behaviors. IMOVE was implemented in an at-risk urban community and was rigorously evaluated to test an environmental initiative to address the problem of childhood obesity.

Study 1 demonstrated that the introduction of IMOVE, a school-based healthy eating initiative, resulted in significantly fewer purchases of LNQ snack foods such as frozen desserts and, while not significant, suggested that students exposed to the intervention may have increased their purchase of fruit offerings from fall to spring term. Students in the intervention school had higher unadjusted mean participation in school lunch than students in the comparison school. However, when this analysis was adjusted to take into account the influence of important sociodemographic characteristics – including eligibility for free or reduced price lunch, which was more common among students in the intervention school – this difference between the schools was no longer significant.

Study 2 showed that body mass index was an important predictor of participation in both IMOVE and the standard school lunch program. Both BMI z-score and weight classification predicted a student's likelihood of participating in both the IMOVE and standard lunch program. Students who were overweight or obese purchased both types of lunches at a significantly higher rate than students who were not overweight/obese. Other characteristics that were significantly associated with participation in IMOVE and standard school lunch were being non-white, eligible for free or reduced price lunch, male, and in the 6^{th} grade.

Finally, Study 3 provided evidence that in their daily diets, students in the IMOVE school consumed sugary beverages and chose higher-fat milk options less frequently at follow-up than students in the comparison school. This observation suggests that modifications to the school food environment can potentially influence changes in overall dietary behaviors to some extent. Although non-significant, several other encouraging differences between students in the intervention and comparison schools were observed for key nutrients (saturated fat, carbohydrates) and other foods (traditional lunch foods such as macaroni and cheese, lunch meats, and burritos/tacos). An intervention with a longer duration and more diverse components (i.e., nutrition education curricula, parent education, etc.) might influence overall dietary behavior even more substantially.

Programs to address childhood obesity risks should focus on the communities and populations that are most vulnerable, in particular those for whom access to and availability of healthy foods are limited. The delivery of environmental programs to these populations is warranted given that healthy food options have to be made available in order for healthy food choices to occur. Low-income families living in urban neighborhoods typically have less access to healthy food and beverage choices than their higher-income counterparts. Accordingly, in an effort to prevent obesity, the CDC recently has recommended several strategies, including strategies for schools, to promote the availability and affordability of healthy foods and beverages.[3] The CDC has also been funding more evaluation research to identify effective interventions, particularly programs and policies targeting improved eating habits and physical activity in low-income communities.[4] A recent report to the White House recommended that healthy foods be provided in schools through improvements in federally-supported school lunch and breakfast programs, upgrading the nutritional quality of competitive foods, and improving nutrition education and the overall school environment.[5] These federal initiatives and increased funding opportunities show a strong commitment to finding a solution to the problem of childhood obesity.

Environmental and policy changes are necessary to improve children's diets and reduce obesity. Some policy changes have taken effect, mainly as a result of the Child Nutrition and WIC Reauthorization Act of 2004, which requires local agencies to adopt wellness policies that include nutritional guidelines for schools.[6] To date, however, there has been little evaluation to determine whether, and which, policies are effective.

Ongoing improvement in school meals is essential to the health and well-being of children. More rigorous evaluations are needed, plus a more thorough understanding of who participates in school lunch and the reasons for participation.

In December 2010, *The Healthy, Hunger-Free Kids Act of 2010* was signed to provide children with healthy food in schools by, among other things, giving the USDA the authority to set nutritional standards for school lunch meals and competitive foods; providing reimbursement to schools that meet updated nutritional standards; setting standards for nutrition education, physical activity, and wellness policies; and establishing networks between schools and local farms to create community gardens and ensure use of local produce in the school setting.[7] While the specific nutritional standards and regulations of this Act have not yet been determined by the USDA, this is a promising step in changing the current foodservice environment for students to encourage and foster not only healthy eating behaviors, but overall wellness.

Other effective health promotion efforts, most notably those targeting tobacco use, have employed comprehensive, multi-sector approaches. These efforts have proven that policy and environmental changes can have a profound effect on individual behavior change at the population level. Following that approach, school-based interventions to prevent obesity in children should address nutrition, physical activity, and sedentary behaviors through environmental change.[8,9] Stated simply, it cannot be expected that students will adopt healthy behaviors if the environment does not encourage these behaviors or, worse, if it is detrimental to these behaviors.[10]

Stronger policies are needed to provide healthy meals to students and limit access to competitive foods throughout the school day. Study findings indicate that the home environment is a key factor in the diets of children and ultimately their risk of overweight or obesity. Therefore, while much needs to be done in the school environment, changes at home are essential, too. Behaviors learned in one environment transfer to another. Thus, while parents play a key role in modeling behaviors to their children, children can also become role models for their parents and agents of change in their homes. The behavioral influences of knowledge and attitudes about food and nutrition can effectively be bidirectional.

The biggest barriers to successful implementation of school-based interventions often include: priority status being given to traditional academics and state academic examinations; limited funding, staff time, and parental support; inadequate communication between health educators, school administrators, and foodservice staff; advertising and sale of unhealthy foods and beverages within or near the school;[11,12] and lack of accountability for health and wellness educational outcomes. Our implementation of IMOVE encountered many of these same barriers, in addition to others, including the many challenges associated with bringing an outside research initiative into public schools and low rates of return on informed consent which contributed to low participation rates for the surveys. Despite these barriers, the intervention was successfully implemented in a low-income, racially-diverse inner city community and positive effects were observed.

The results of the IMOVE program evaluation lead to several recommendations, both for future implementations of IMOVE and for changing existing school foodservice. First, changes to the school foodservice program, such as increasing the variety and availability of healthy foods and raising awareness about those foods in the cafeteria environment, lead to increased participation in the school lunch program. This provides evidence of a financial incentive for schools, making programs like IMOVE a profitable option. Increased variety of foods and increased awareness can be accomplished independent of a program such as IMOVE so long as there is buy-in from key stakeholders, administrators, faculty, staff, students, and parents.

Second, the introduction of IMOVE at school contributed positively to student's food choices both at school and in their total daily diets, at least during the course of our year-long study. More studies are needed to assess the longer-term impact of such an intervention, but the results presented here are promising.

Third, aside from the efforts related to research data collection, the IMOVE cafeteria intervention itself was implemented with minimal support from the research team once the foodservice staff was trained and systems were in place. IMOVE was largely effective due to the effort and support of the school administration, the foodservice director and staff, and the liaison from Costa Fruit and Produce who coordinated and hosted the promotion events at the intervention school. For any environmental-level intervention to be effective, particularly those in schools, ongoing support and buy-in from foodservice staff are absolutely essential.[13]

The monitoring and evaluation of programs and policies is critical to changing behaviors and sustaining them over time. A number of school-based interventions have been implemented to modify dietary guidelines for school meals and promote positive behavior changes regarding nutrition and exercise. Research concerning the sustainability of such interventions has been limited. Consistent positive results in reducing obesity in school-aged children by lowering BMI or reducing obesity-related risks in school-aged children have not been observed. Thus, long-term evaluations of short-term interventions, using both quantitative and qualitative outcome measures, are needed.[14]

The three studies presented here add to the emerging but relatively sparse literature on effective school-based environmental interventions in low-income, racially diverse communities by not only assessing the effects of introducing a healthy eating intervention in middle schools, but also by examining predictors of participation in that program. Of note, the studies examined participation in á la carte and standard school lunch, both of which have recently come under scrutiny by public health professionals and policy-makers since they are based on outdated dietary guidelines. The evaluation of IMOVE assessed participation in standard school lunch, a healthy alternative, and á la carte snack items; the types of students most likely to participate; and how the availability of a healthy alternative to standard school lunch affects usual dietary intake of foods and nutrients. The IMOVE program was successful as delivered, as a stand-alone cafeteria intervention. It may have been even more effective in changing behaviors, however, if it had been offered as one part of a multi-level intervention effort that included a nutrition curriculum and a physical activity component.

The results of this research and other rigorous evaluations should be disseminated to aid policy-makers and school administrators in establishing effective school policies to address childhood obesity risks and should provide guidance to school foodservice staff to develop menus that include more nutritious foods that are well received by different cultures and populations.

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APPENDIX A: BLOCK KIDS FOOD SCREENER

ID NUMBER

Think about everything you ate or drank last week. Remember what you had for breakfast, lunch, dinner, after school, while watching TV, at bedtime, and on the weekend.

Please write your name in this box. *Use a pencil to complete this survey.*

	HOW MANY DAYS LAST WEEK DID YOU EAT OR DRINK IT?						HOW MUCH IN ONE DAY?		
	None last week	1 day last week	2 days last week	3-4 days last week	5-6 days last week	Every day last week			
Cereal, like corn flakes, Frosted Flakes	○	○	○	○	○	○	○ 1 bowl	○ 2 bowls	○ 3 bowls
Cooked cereal, like oatmeal	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Eggs, breakfast sandwiches or breakfast burritos	○	○	○	○	○	○	○ 1 egg	○ 2 eggs	○ 3 eggs
Breakfast bars, granola bars, Protein bars	○	○	○	○	○	○	○ 1/2	○ 1	○ 2
Glasses of milk	○	○	○	○	○	○	○ 1 glass	○ 2 glasses	○ 3+glasses
Real fruit juice, like orange juice, apple juice, or Mexican fruit drinks like licuados (DO NOT include soda)	○	○	○	○	○	○	○ 1 glass	○ 2 glasses	○ 3+glasses
Drinks like Coke or 7-Up, Sunny Delight, Hawaiian Punch, or aguas frescas (DO NOT include diet soda)	○	○	○	○	○	○	○ 1 bottle	○ 2 bottles	○ 3+bottles
Apples, bananas, or oranges	○	○	○	○	○	○	○ 1/2	○ 1	○ 2
Applesauce, fruit cocktail	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Any other fruit, like strawberries, grapes	○	○	○	○	○	○	○ A little	○ Some	○ A lot
French fries, hash browns, tater tots	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Other potatoes, like mashed or boiled	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Ketchup or salsa	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Lettuce salad	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Tomatoes, including on salad	○	○	○	○	○	○	○ 1/4 tomato	○ 1/2 tomato	○ 1 tomato
Green beans or peas	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Other vegetables, like corn, carrots, greens, broccoli	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Vegetable soup, tomato soup, any soup or stew with vegetables in it	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Chili beans, pinto beans, black beans, including in burritos	○	○	○	○	○	○	○ A little	○ Some	○ A lot

Turn this page over -------->

	HOW MANY DAYS LAST WEEK DID YOU EAT OR DRINK IT?						HOW MUCH IN ONE DAY?		
	None last week	1 day last week	2 days last week	3-4 days last week	5-6 days last week	Every day last week			
Refried beans	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Hamburgers, cheeseburgers	○	○	○	○	○	○	○ 1 small	○ 1 large	○ 2 large
Hot dogs, corn dogs, or sausage	○	○	○	○	○	○	○ 1	○ 2	○ 3
Lunch meat like boloney, ham, Lunchables	○	○	○	○	○	○	○ 1 slice	○ 2 slices	○ 3+ slices
Pizza or pizza pockets	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Spaghetti or ravioli <u>with tomato sauce</u>	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Macaroni and cheese	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Chicken, including nuggets, wings, tenders, also in sandwiches or stew	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Fish, fish sticks or sandwiches, tuna, shrimp	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Burritos or tacos	○	○	○	○	○	○	○ 1/2	○ 1	○ 2
Beef like roast, steak or in sandwiches	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Meat balls, meat loaf, beef stew, Hamburger Helper	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Pork, like chops, roast, ribs	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Popcorn	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Snack chips like potato chips, Doritos, Fritos, tortilla chips	○	○	○	○	○	○	○ A few	○ Small bag	○ Large bag
Ice cream	○	○	○	○	○	○	○ 1 scoop	○ 2 scoops	○ 3 scoops
Candy, candy bars	○	○	○	○	○	○	○ Mini	○ Small	○ Large
Cookies, donuts, cakes like Ho-Hos	○	○	○	○	○	○	○ A little	○ Some	○ A lot
Cheese. Remember cheese in sandwiches or nachos with cheese or quesadillas	○	○	○	○	○	○	○ 1 slice	○ 2 slices	○ 3+ slices
Whole wheat bread or rolls (NOT white bread)	○	○	○	○	○	○	○ 1 slice	○ 2 slices	○ 3 slices

What kind of cereal did you eat? (MARK THE ONE YOU ATE THE MOST OF)

- ○ Plain Cheerios, Grape Nuts, Shredded Wheat, Wheaties, Wheat Chex, Kix
- ○ Honey Nut Cheerios, Cap'n Crunch, Lucky Charms, Life, Golden Grahams, Frosted Mini Wheats, Raisin Bran
- ○ Other sweet cereals, like Frosted Flakes, Froot Loops
- ○ Any other cereal, like Corn Flakes, Rice Krispies

What kind of milk did you drink? (MARK ONLY ONE)

○ Whole milk ○ Reduced fat 2% milk ○ Low fat 1% milk ○ Nonfat milk ○ Chocolate milk ○ Soy milk ○ Lactaid milk ○ Don't know

Please tell us about yourself

Are you ○ Male ○ Female

How old are you? ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16 ○ 17

APPENDIX B:
CHOICES BEHAVIORAL SURVEY

The Choices Survey

Introduction

The purpose of this survey is to understand food choices, exercise habits, and health-related attitudes of middle school students.

This survey will take about 15 minutes to complete. This survey is voluntary and it is also anonymous. Your responses will not be linked with your name. Instead, we ask that you enter the ID number we gave you at the beginning of the survey to allow us to record your responses. If there are questions you choose not to answer, you can leave them blank. However, we hope you will answer each question as completely as you can.

When you finish taking this survey, please print out the final page that congratulates you on reaching the end. Write your name on this page and return it to school. Your name will be entered into a raffle to win a gift card to thank you for your time and effort.

Your answers are important to us!

Thank you for participating in this survey!

The Choices Survey

ID Number

1. Please enter your ID number in the space below:

ID Number ____________________

The Choices Survey

Information About You

First, please tell us about yourself.

2. Are you...

- ◯ Male
- ◯ Female

3. How old are you?

- ◯ 11
- ◯ 12
- ◯ 13
- ◯ 14
- ◯ 15

4. What grade are you in?

- ◯ 6th grade
- ◯ 7th grade
- ◯ 8th grade

5. Are you... (You may mark more than one)

- ☐ African American
- ☐ Hispanic or Latino
- ☐ Portuguese
- ☐ Vietnamese
- ☐ Chinese
- ☐ Asian, of other nationality
- ☐ American Indian or Alaskan native
- ☐ White
- ☐ Other

6. What school do you go to?

- ◯ Atlantic Middle School
- ◯ Broad Meadows Middle School
- ◯ Keith Middle School
- ◯ Normandin Middle School

The Choices Survey

Food Choices

Next, we'd like to know about the foods you ate and the beverages you drank during the past 7 days (a week). Think about all the meals and snacks you had in the past week. Think about foods you ate at home, at school, at restaurants, with friends, or anywhere else.

Choose one answer for each question by clicking the circle to indicate your answer.

7. During the past 7 days (one week), how often did you eat or drink the following foods and beverages?

	Not at all in the past week	1-3 times last week	4 to 6 times last week	Once every day last week	Twice each day	3 times each day	4 or more times each day
100% fruit juices such as orange juice, apple juice, or grape juice (Do not count punch, Kool-Aid, sports drinks, or other fruit-flavored drinks)	○	○	○	○	○	○	○
Fruit, not counting fruit juices	○	○	○	○	○	○	○
Green salad	○	○	○	○	○	○	○
French fries, fried potatoes, or potato chips	○	○	○	○	○	○	○
Potatoes, not counting French fries, fried potatoes, or potato chips	○	○	○	○	○	○	○
Carrots	○	○	○	○	○	○	○
Other vegetables, not counting potatoes, green salad, and carrots	○	○	○	○	○	○	○
A can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite (Do not include diet soda or diet pop)	○	○	○	○	○	○	○
Glasses of milk (Include the milk you drank in a glass or cup, from a carton, or with cereal. Count the half pint carton of milk served at school as equal to one glass.)	○	○	○	○	○	○	○

The Choices Survey

Leisure Time Physical Activity

Next, we'd like to know about your leisure time physical activity. Leisure time activity means the exercise you get during your free time outside of the normal school day. Do not include the exercise you get during PE (gym) class; but do include exercise you get by practicing for or playing on sports teams.

Enter the number of times each week you do these different kinds of exercise. If you do not participate, please enter the number zero ("0") instead of leaving it blank.

8. During a typical 7-Day period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time (enter the appropriate number that tells the amount of times per week).

STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling) ____________

MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing) ____________

MILD EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking) ____________

9. During a typical 7-Day period (a week), in your leisure time, how often do you engage in any regular physical activity long enough to work up a sweat (and your heart beats rapidly)?

◯ Often

◯ Sometimes

◯ Never or rarely

The Choices Survey

Habits Last Year

Next, we'd like to know how your current eating and exercise habits compare to your habits one year ago.

10. How do your current EATING HABITS compare to your eating habits at this same time last year?

- ◯ My current eating habits are about the same as they were at this same time last year.
- ◯ My current eating habits are healthier than my eating habits were at this same time last year.
- ◯ My eating habits one year ago were healthier than my current eating habits are.

11. How do your current EXERCISE HABITS compare to your exercise habits at this same time last year?

- ◯ My current exercise habits are about the same as they were at this same time last year.
- ◯ My current exercise habits are healthier than my exercise habits were at this same time last year.
- ◯ My exercise habits one year ago were healthier than my current exercise habits are.

Changing Habits

We'd like you to tell us more about your current eating and exercise habits, and whether or not you have any plans to make changes in your current habits. Think about your habits right now when answering these questions.

Please choose one answer for each statement by clicking the circle to indicate your answer.

12. Which response best describes your current habits when it comes to:

	I have no plans to do this	I have thought about doing this and will probably do it in the next 6 months	I have thought about doing this and will probably do it in the next month	I have recently started to do this	I am already doing this and have kept it up for 6 months or longer
Eating more fruits	○	○	○	○	○
Eating more vegetables	○	○	○	○	○
Eating more whole grain breads, cereals, and foods like brown rice and whole wheat pasta	○	○	○	○	○
Drinking fewer sugar-sweetened beverages (soda, fruit drinks, lemonade, sweetened sports drinks like Gatorade, Powerade, etc.)	○	○	○	○	○
Eating fewer foods that are high in fat (fried foods, French fries, chips, dessert foods, etc.)	○	○	○	○	○
Exercising more	○	○	○	○	○

The Choices Survey

Eating Attitudes

Next, we'd like you to tell us about your feelings and attitudes about food and eating.

Please choose one answer for each statement by clicking the circle that best describes your agreement with the statement (always, often, sometimes, rarely, or never).

13. Please choose one answer for each statement:

	Always	Often	Sometimes	Rarely	Never
I am relaxed about eating.	○	○	○	○	○
I am comfortable about eating enough food.	○	○	○	○	○
I enjoy food and eating.	○	○	○	○	○
I am comfortable with my enjoyment of food and eating.	○	○	○	○	○
I feel it is okay to eat food that I like.	○	○	○	○	○
I experiment with new food and learn to like it.	○	○	○	○	○
In a situation where I don't have much control over the food choices, I can "make do" by eating foods that are not necessarily my favorites.	○	○	○	○	○
I eat a wide variety of foods.	○	○	○	○	○
I assume I will get enough to eat.	○	○	○	○	○
I eat as much as I am hungry for.	○	○	○	○	○
I eat until I feel satisfied.	○	○	○	○	○
I focus on my food and pay attention to myself when I eat.	○	○	○	○	○
I make my food choices based on what I want to eat, and not because of what others (friends, family, etc.) are eating.	○	○	○	○	○
I make time to eat.	○	○	○	○	○
I have regular meals.	○	○	○	○	○
I think about nutrition when I choose what I eat.	○	○	○	○	○
I generally plan ahead for feeding myself. I don't just grab food when I get hungry.	○	○	○	○	○

The Choices Survey

General Feelings

Next is a list of statements that ask about your general feelings about yourself.

Please choose one answer for each statement by clicking the circle that best reflects your feelings.

14. Please click the circle that indicates the degree to which you agree with the statement (strongly agree, agree, disagree, strongly disagree).

	Strongly agree	Agree	Disagree	Strongly disagree
On the whole, I am satisfied with myself.	○	○	○	○
At times, I think I am no good at all.	○	○	○	○
I feel that I have a number of good qualities.	○	○	○	○
I am able to do things as well as most other people my age.	○	○	○	○
I feel I do not have much to be proud of.	○	○	○	○
I feel useless at times.	○	○	○	○
I feel that I'm a person of worth, at least on an equal plane with others.	○	○	○	○
I wish I could have more respect for myself.	○	○	○	○
All in all, I am inclined to feel that I am a failure.	○	○	○	○
I take a positive attitude toward myself.	○	○	○	○

IMOVE Program

15. Have you ever heard of the IMOVE program?

- ◯ Yes
- ◯ No
- ◯ I'm not sure

16. What school do you go to?

- ◯ Atlantic Middle School
- ◯ Broad Meadows Middle School
- ◯ Keith Middle School
- ◯ Normandin Middle School

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