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Are Vending Machine Selections Healthier? Trends in Dietary Quality of Vending Machine Food and Beverage Selections among NHANES Participants Age 6-19 Years between 2003-2012

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ARE VENDING MACHINE SELECTIONS HEALTHIER? TRENDS IN DIETARY QUALITY OF VENDING MACHINE FOOD AND BEVERAGE SELECTIONS AMONG NHANES PARTICIPANTS AGE 6-19 YEARS BETWEEN 2003 - 2012

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Abstract

Dietary intake is related to 4 major causes of death and may be influenced by the food environment, which includes the $64.3 billion revenue-producing vending machine industry. Most machines contain low nutrient energy dense foods and beverages associated with poor dietary choices, while healthier vending initiatives are seen as a strategy to increase access to healthy foods. Elementary and secondary schools have increasingly adopted healthier vending standards in response to federal child nutrition regulation and student wellness policy implementation, however an association between vending and diet has not been made using a large sample of nationally representative data. The purpose of this cross-sectional study was to compare the overall dietary quality among National Health and Nutrition Examination Survey (NHANES) participants age 6 – 19 years relative to foods and beverages sourced from vending machines. Healthy Eating Index (HEI-2010) scores were derived using ten years of NHANES dietary interview data collected from 2003 – 2012. Quantitative statistical analyses were used to test for significant differences among mean HEI-2010 scores. Kcal consumption decreased and diet quality modestly improved over the years among children who use vending machines, though vending machine use was negatively associated with dietary quality. These findings provide evidence in support of national policy designed to improve dietary intake in children, that should over time, help lead the next generation of children to live healthier lives.

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"The best way to pay for a lovely moment is to enjoy it." — Richard Bach.

Dedication

Dedicated to the memory of my dad, Daniel Zavala Calvillo. A man highly esteemed by those who knew him because he was gracious and good, and a father deeply missed but fondly remembered because he was the best.

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Chapter 1

Introduction

Background

Food intake plays a significant role in human health and development, and nutrition is directly related to four of the top ten major causes of death, including heart disease, cancer, stroke and diabetes (Centers for Disease Control and Prevention [CDC]/National Center for Health Statistics, 2013). Excess caloric intake leads to a state of positive energy balance which can subsequently lead to weight gain and obesity, another risk factor for many chronic diseases and conditions.

While the average per capita consumption of calories in the US has steadily risen over the decades, the nutritional quality of the typical American diet has declined. Americans consumed 192 more calories per capita per day between 2005-2008 than they did in 1977-78 (Lin & Morrison, 2012), and nearly 90% of the US population over the age of 1 year consumed more sodium than the tolerable upper intake level (UL) set by the Institute of Medicine (IOM). About 70% consumed more added sugars and saturated fats than the maximum limits recommended in the Dietary Guidelines (as cited in U.S. Department of Health and Human Services [DHHS] & USDA, 2015a). In its duty to protect the nation's health and address the shortcomings of the standard American diet, the US DHHS and the USDA jointly released the 2015-2020 Dietary Guidelines for Americans which recommend following a healthy eating pattern while limiting the intake of added sugars, saturated and *trans* fats, and sodium (2015b).

Past Dietary Guidelines have made recommendations on an individual level, but the latest edition incorporate a fifth Guideline calling on support for healthy eating patterns by all people and across multiple settings, taking into account that individual food choices may be influenced

by external factors (US DHHS & USDA, 2015b). Similarly, the CDC recommends several strategies to help foster a healthy food environment and reduce the incidence of malnutrition, chronic disease, and obesity – among them is increasing access to healthy foods. Some ways to increase access include: ensure that healthy food retailers like grocery stores are located within walking distance of community residents, provide healthy school breakfasts and lunches to needy students, and make it possible for SNAP (Supplemental Nutrition Assistance Program) recipients to use their benefits at farmers' markets to purchase fresh fruits and vegetables (CDC, 2010). The Community Preventive Services Task Force (CPSTF) has included the workplace as a site where environmental changes may potentially help employees make healthier food choices (2013).

Workplaces, schools and other public places often have cafeterias, concession stands, and/or vending machines to make it more convenient to obtain foods and beverages. However, most public food and beverage offerings do not support the Dietary Guidelines recommendations, hindering healthy choices (Center for Science in the Public Interest [CSPI], 2014). USDA research shows that food [obtained] away from home (FAFH) tends to have a lower diet quality and more calories than food prepared at home (Mancino, Todd, Guthrie & Lin, 2010). Rather than provide an opportunity to complement a healthy eating pattern, FAFH options generally provide the added possibility to purchase unhealthy foods that may exacerbate overconsumption of calories, added sugar, sodium and fat.

Vending machines may be used to increase access to healthy foods, or they may serve as a barrier to individuals who are trying to make healthier food and beverage choices. Efforts to improve the food environment with regards to vending machines have included creating nutrition guidelines for foods and beverages sold in machines and using marketing techniques, such as the

4 P's of marketing, to encourage healthy choices by the consumer. The 4 P's include strategies such as:

- Product: requiring a specific amount of food and/or beverage options to meet the predetermined set of nutrition guidelines or eliminating altogether those foods and beverages that do not meet nutrition guidelines
- Price: pricing healthier choices at a lower cost than the unhealthy choices
- Placement: placing healthier options in more prominent visual fields than the unhealthier ones
- Promotion: bringing attention to the healthier items with special graphics or advertisement, and prohibiting the marketing of the unhealthier items (Nemours Foundation, 2010).

Policies, systems, and environments (PSE) may be changed to facilitate healthy behaviors, such as better food choices. Public health organizations are using PSE change initiatives more commonly, recognizing that health related behaviors are difficult, if not impossible, to perform when surroundings do not support those behaviors (Honeycutt et al., 2015). An example of policy that may be viewed as a large-scale PSE intervention to improve public health is the Healthy, Hunger Free Kids Act of 2010, a federal law that made changes to the nutrition standards for school meals and is expected to improve the health of the next generation of children (USDA FNS, 2016).

Over the past decade, food manufacturers and food service providers have responded to new federal nutrition program regulations and consumer demand for healthier foods and beverages by altering the nutrient profiles of their products. Food service companies that provide the principal source of food for institutions or worksites are favorably positioned to improve food

environments (Stevens, Stelmach & Davis-Street, 2014) and public health advocates are astutely aware of the food industry's potential to help – or hinder – people's efforts to eat better. The negative effects on diet quality from FAFH appear to be shrinking over the last few years and may be a result of regulations and the food industry's efforts to improve the nutrient quality of its products combined with better consumer choices (Todd, Mancino & Lin, 2010).

Since 2003, government researchers have collected the purchase location of foods and beverages consumed by participants in the What We Eat in America (WWEIA) dietary interview component of the National Health and Nutrition Examination Survey (NHANES) (U.S. Department of Agriculture [USDA], 2014). Studies using this data show that the major sources of sodium and energy in calories in the average American diet come from retail stores (Drewnoski & Rehm, 2013a, 2013b) – food that is usually taken home for preparation and consumption, not from FAFH. Drewnoski & Rehm's research showed that energy from vending machines accounted for less than 1% of the total caloric intake in NHANES participants across an 8-year period (2013a), leading one to question whether the time and effort spent on PSE changes around vending machines is really worthwhile.

Purpose

The purpose of this study is to explore how food and/or beverages obtained from vending machines impact dietary quality among the NHANES subpopulation of vending machine users.

Significance

Vending machines are found in a wide variety of locations, such as factories, educational institutions, government and military buildings, offices, hospitals, public places, etc. and thus are a part of the environment that all people are exposed to who work in and visit those locations; they also produce a significant amount of revenue. According to the Vending Times, the amount

of revenue produced by the vending machine industry was $64,350,000 and 56% of those sales were for cold beverages including sodas. There were 6,900,000 vending machines in the US, and the average per capita amount spent per year being $27 (as cited in Statistic Brain Research Institute, 2016). A 2011 industry report shows that the number of vending machine locations in primary and secondary schools was 17,500 in 2010 that generated $910,000,000 (Vending Times, 2011).

Although research exists exploring the impact of food [obtained] away from home (FAFH) on dietary intake, the research is conflicting with some studies associating FAFH adversely with diet quality, while others report that FAFH is not as significant to dietary intake as food consumed inside of the home. Additionally, study authors may define FAFH differently; one definition may include fast-food and full-service restaurants, another may require that the majority of energy consumed from a meal has to come from a restaurant yet excludes beverages, and another may include other places where food is available along with restaurants, such as cafeterias. The existing literature does not describe how foods and beverages dispensed from vending machines impact the total daily diet in those people who use vending machines, instead it includes vending as a component of FAFH, diluting its effect on total diet when examined across an entire population rather than among a subpopulation of vending machine users.

While research is limited on the dietary impact of vended foods and beverages, there is a considerable amount of literature published regarding vending machines as part of the school food environment. In addition, there have been notable efforts to improve the school food environment since the USDA has made changes to regulations that govern the foods served in the National School Lunch and School Breakfast Programs. These regulations include language requiring school food authorities participating in these federal child nutrition programs to create

and implement school wellness policies. Thus, much of the existing literature on the success of school wellness policies contains references to vending machines and their contribution to the overall school health environment, and in some cases their impact on student dietary choices. Besides exploring the impact on diet quality of vending machine users, it would be interesting to determine if vended food and beverage selections have improved in dietary quality since the inception of school wellness policies.

The principal aim of this study is to explore the contribution of vended foods and beverages to the overall dietary quality of vending machines users between the ages of 5 and 19 years using dietary intake data collected through the NHANES. A secondary aim of this study will be to determine if vending machine selections have improved over the span of 10 years from 2003 - 2012 with reference to dietary quality. Another aim will be to see if a difference in overall diet quality exists between school-aged users and non-users of vending machines, and among different demographics within only those school-aged children who used vending machines.

Chapter 2

Literature Review

Improving Nutrient Quality through Policy, System and Environmental (PSE) Changes

Policy, system and environmental (PSE) changes may help nudge consumer behavior towards making healthier food choices. Strategies to help make it easier for people to eat better may be accomplished voluntarily at an organizational or community level through the adoption of nutrition guidelines or incentives, while others may be mandated through government regulations or policy. The School Breakfast Program (SBP) and the National School Lunch Program (NSLP) are two examples of federal programs used to implement national child nutrition policy that are subject to federal regulations.

Federal Child Nutrition Programs

Early child nutrition programs in American school settings were motivated by charity and the need for healthy military recruits. The program grew during the great depression to help provide jobs, feed children and use surplus foods. The National School Lunch Act was later passed in 1946 *"…to safeguard the health and well-being of the nation's children and to encourage the domestic consumption of nutrition agricultural commodities…"* which included requirements that had to be met by participating schools in exchange for technical assistance and meal reimbursement. The first Child Nutrition Act passed in 1966, which established funding for feeding programs, and placed regulatory responsibility under the USDA. This act has undergone many modifications since then to address budgetary, educational, political and health-related issues relevant to the time period in which reauthorization has taken place (National Food Service Management Institute [NFSMI], 2011).

The WIC and Child Nutrition Reauthorization Act of 2004 helped prompt the USDA to update school food regulations and include nutrition standards that reflected the current Dietary Guidelines for Americans and other government dietary guidance of the day (NSFMI, 2011). The revisions attempted to expand the scope of responsibility of school food authorities by mandating the establishment of school wellness policies, which would not only regulate meals provided under the federal child nutrition programs, but also gave school districts the potential to regulate foods and beverages sold in competition with these school meals, known as competitive foods. Implementation of SWPs was expected to take effect at the start of the 2006-2007 school year, however it was an unfunded mandate that could not give school food authorities authority to enforce the policy outside of the confines of school food service, and so the SWP requirement produced policies that were never fully implemented in many school districts for a variety of reasons.

The predominant reason for not fully implementing SWP was the need to use food to create school revenue, as cited in 83% of the 303 responses that food service directors gave in a 2007 study about the development and implementation of school wellness policies (Longley & Sneed, 2009). In order to calculate how much revenue school beverage contracts generated for schools, the CSPI conducted the first national study in 2006 of its kind and reviewed 120 school beverage contracts from 16 states. The CSPI estimated that commissions from vending machines, school stores and a la carte sales combined with cash advance payments varied between $0.60 and $93, with the average being $18.11 per student annually, depending on the contract negotiated with each school administrator. Schools were able to use this revenue freely as non-discretionary funds, and often also received non-cash items such as branded scoreboards, uniforms, sports equipment and scholarships (CSPI, 2006). Despite fundraising being cited as the

top reason for not fully implementing SWP, changes to vending machines may be perceived as one of the easiest strategies to improve the school food environment. A 2008 study that reviewed the wellness policy language for 37 rural Colorado elementary schools found that 95% of the schools addressed vending machines in their policy, albeit weakly as a recommendation and only as a mandate in one of the schools (Belansky, 2013).

The Healthy, Hunger-Free Kids Act of 2010 (HHFKA) required the USDA to revised child nutrition regulations to include updated nutrition standards for school meals as well as all competitive foods (USDA FNS, 2016). The Smart Snacks in Schools nutrition standards were implemented in July 2014 to regulate all foods sold in schools, but allowed school districts the flexibility to determine what to do about other foods in the school environment such as those given away during special classroom celebrations (USDA FNS, 2015). The HHFKA also includes policy language requiring changes to the school environment in order to promote student wellness, and the USDA requires this be accomplished through the establishment of the local School Wellness Policy (USDA FNS, 2016). Although the HHFKA sounds like a promising policy to improve student wellness, it may again be limited in that it is a USDA regulation for school food authorities that have limited control over the school food environment outside of the school food service, and no control over what a school administrator allows under his/her jurisdiction.

Policy Effectiveness

Vending machine policies can effectively help modify the food environment. A study using wellness policy data and school level practices data from the School Health Policies and Programs Study found that among 39 states and 198 school districts, having state policy language that banned junk food sales from vending machines was significantly associated with

less junk food sold in elementary schools, though a significant association was not observed in middle schools, and no association was seen among high schools (Kubik et al., 2010). In 2005, California passed SB12, a law establishing nutrition guidelines for competitive foods, and SB965 for beverages, to be fully implemented in California schools by 2009. To evaluate whether these standards could be executed, a sample of 19 schools from 6 communities enrolled in the Healthy Eating, Active Communities program, agreed to participate in research and committed to follow the standards early, starting in 2005. Data on foods accessible by students in all school food venues was collected in 2005 and then again in 2008 for comparison. Compliance with the nutrition laws for snack foods from vending machines went from 18.1% in 2005 to 67.1% in 2008, and compliance for beverages increased from 44.6% to 87.1%. Foods and beverages from vending machines had the lowest percentage of adherence in 2005 compared to any other venue in the school food environment, yet made the greatest improvements through beverage machines (Samuels, Hutchinson, Craypo, Barry & Bullock, 2010).

Modifications to the school food environment can be sustained and help improve population risk indicators over time. After 9 years of having district-wide competitive food standards in place, the Boston Public School (BPS) system was able to confirm their continued effectiveness with a school food environment audit in 115 schools. Elementary schools had the highest adherence to standards at 93.6%, middle schools were at 84.6%, and high schools were 79.2% compliant. Overall, 96% of its students did not have access to sugar-sweetened beverages (SSBs) during the school day. The authors further noted that 2013 Youth Risk Behavioral Survey (YRBS) data showed that only 16.8% youth in Boston consumed one serving of SSBs per day as compared to 27.0% of youth in 42 other states, citing a possible connection between the BPS policy and lower consumption rates (Mozaffarian et al., 2016).

The absence of policy or regulation makes a healthier food environment more unlikely. Private schools typically do not participate in federal nutrition programs and thus are not subject to their food regulations, nor are they required to have wellness policies. This may help explain findings by Pasch et al. that public school vending machines sold a higher percentage of foods and beverages that met IOM standards than private schools did in Minneapolis (2011). In a study that included 2,065 elementary schools and 10,719 children, students were 5 times more likely to purchase SSBs in schools with policies that allowed SSBs, than in schools with policies prohibiting their sale. This study showed that offering healthier beverages in the presence of SSBs did not make their purchase more likely either. When 100% juice and water alternatives were available, students were still 3 times more likely to purchase SSBs if they were accessible (Jones, Gonzalez & Frongillo, 2010).

Barriers and Facilitators

Barriers to full policy implementation include factors associated with the vending industry. An intervention designed to improve the school food environment in 4 Maine high schools included changing vending machine contents to reduce their fat, sugar, and portion sizes. One year after program implementation, the intervention schools had significant improvements in their vending offerings, with 84% of snacks and 98.9% beverages meeting the standards, however when the portion size limitations were imposed, those percentages dropped to 34.4% and 68.2% respectively, showing that package sizes generally exceeded the local school nutrition standard. Additionally, the variety of items offered in snack vending machines dropped from 358 to 142 items, indicating limited availability of vendor products that met the standards (Whatley Blum et al., 2007).

Pouring contracts with SSB vendors, incentives and vending profits also have been shown to impede full execution of vending machine policies. Although nationally representative data from 1,519 middle and high schools included in the Youth, Education, and Society (YES) study showed that access to sodas in school vending machines had dropped from 2007 to 2009, this data also showed that access to non-soda SSBs remained unchanged. Significant associations were found between having bottling contracts or receiving incentives/profits and increased access to SSBs. Furthermore, having a school wellness policy or nutrition guidelines in place was associated with greater control for schools to have a "say" in the contents of vending machine (Terry-McElrath, O'Malley & Johnston, 2012).

The adoption of healthy vending policies, although supported by science, is not without its opposition – even among those in organizations that promote health and wellness. The National Recreation and Parks Association's webpage on health and wellness proclaims, "Leading the nation to improved health and wellness through parks and recreation" (2016), and it is generally accepted that parks and recreation facilities are designed to promote fitness and physical activity, and thereby health, for people of all ages. However, the implementation of healthy vending initiatives in these venues may be hampered by their "perceived negative cost consequences" such as lost revenue and profits, lack of control over vending machine contents, public demand for treats or other indulgent foods, and a disinclination to create formal policies (Silberfarb, Savre, & Geber, 2014). Another negative perception is that vending policies are overly paternalistic, as was the case with Arkansas Act 1220 passed in 2003, a state law designed to tackle childhood obesity which also placed restrictions on school vending machines. Major concerns expressed by parents and staff – not students – included concerns that school revenue would be lost, that students' rights to free choice should remain intact, and students would offset

restrictions by getting unhealthier foods elsewhere. These concerns were later debunked (Phillips, Ryan & Raczynski, 2011).

Healthy vending machine initiatives need not be regarded through a negative lens however, especially when it comes to venues where children are present. The Chicago Park District, the largest municipal park system in the nation, was able to successfully implement a 100% Healthier Snack Vending Initiative. Sales showed steady increases over the 14 months that they were tracked, and 88% of park patrons and 100% of staff surveyed provided positive feedback regarding the initiative. The success of this initiative led the way for the subsequent award of a healthy beverage vending contract (Mason et al., 2014). In Minneapolis middle schools, the Teens Eating for Energy and Nutrition at School (TEENS) study found that 90% of parents and teachers surveyed thought healthier foods should be available in vending machines and school cafeterias, while only 20% of parents and 12% of teachers thought students should be able to purchase sodas and candies at school (Kubik, Lytle & Story, 2005).

The effect of healthy food and beverage policies may extend beyond the location where they are implemented. Of the students surveyed in two Los Angeles Unified School District high schools claiming that existing school nutrition policies had an impact on their food and beverage consumption at school, the majority also reported eating fewer of the banned items away from school (Vecchiarelli, Takayanagi & Neumann, 2006). Another study which surveyed 2,292 adolescent students at intervention and control schools, determined that milk consumption outside of school was significantly associated with a modified school food environment offering only water or milk to drink (Wordell, Daratha, Mandal, Bindler & Butkus, 2012). Competitive foods, such as foods from vending machines, may indirectly impact the nutrient quality of foods served in the cafeteria. For example, in a comparison of school lunch fat content among schools

with different policies or characteristics that participated in the School Nutrition Dietary Assessment-III, authors found that meal fat contents were positively associated with the presence of competitive foods from a la carte sales and vending machines (Newman, Guthrie, Mancino, Ralston & Musiker, 2009).

Changes to vending machines should only be one strategy – among several others – carried out along with policy to achieve the overall goal of creating a health-promoting food environment. A study in Michigan evaluated the effectiveness of implementing multiple policies and practices on the outcome of student diet among 1,176 middle school students from 55 schools over a period of two school years between 2007 and 2010. The study included four different intervention groups, among them were: a control group for data collection only, schools using the Healthy School Action Tools (HSAT) to start a nutrition marketing or education plan, schools with a student-led School Nutrition Advances Kids (SNAK) project team to carry out their plans, and schools implementing the 2003 Michigan State Board of Education Healthy Food and Beverage Policy standards. Although no particular practice or policy prevailed in effectiveness, students attending the schools that implemented at least three policy and practice changes had improved dietary intake, with the most improvement seen in students attending schools that made between three and six policy and practice changes (Alaimo et al., 2013). In a different study, two practices that were shown effective in reducing purchases of SSBs and other less healthy foods in addition to a having vending machine policy included cutting off access to vending machines during lunchtime and/or having a closed campus (Neumark-Sztainer, French, Hannan, Story & Fulkerson, 2005).

The involvement of school staff, students, parents and the community through school and district level wellness councils may also play a role. In a Midwest metropolitan area, audits were

done to evaluate and assign a food score based on the nutrient quality of foods and beverages found in vending machines in 89 middle and high schools, and principals were asked about the presence of wellness councils in their schools. Vending machine food scores were better and associated with schools that had district and/or school wellness councils (Kubik, Lytle & Farbakhsh, 2011).

School Food Environment

The school food environment consists of the venues on school grounds that support any opportunity to obtain food, such as the federal child nutrition programs that include the School Breakfast Program (SBP) and the National School Lunch Program (NSLP), as well as competitive food sales, thus named because they compete with federal meal programs. Competitive food venues include vending machines, student or school stores, a la carte food sales, and snack bars (Kubik, Lytle, Hannan, Perry & Story, 2003). The school food environment may be broader yet than the school grounds, extending to places where students might stop to obtain food on their way to and from school. This may include mobile food vendors selling food in the surrounding vicinity after school hours, whose customers may consist of a large percentage of students. A mobile food vendor may help increase access to healthier foods or contribute negatively to the food environment (Tester, Yen & Laraia, 2010). This rationale could also be extended to recreation centers, libraries, and other places where out of school programs are offered to students and food is available.

Vending machines are a well-documented part of the school food environment, and published research shows that they are ubiquitous, contain mostly low nutrient energy dense (LNED) foods, and have been widely accessible to students. Results from the 2005-2006 US Health Behavior in School-aged Children (HBSC) survey revealed that out of 182 schools

surveyed, 83% had vending machines that sold mostly LNED foods (Rovner, Nansel, Wang & Iannotti, 2011). In 2006-2007, only 18% of the beverages and 22% of the snack foods in Minneapolis school vending machines met the nutrition criteria set by the Institute of Medicine despite it being the school year that required wellness policies be implemented nationally in schools participating in the federal child nutrition programs (Pasch et al., 2011). Despite reduced access to vending machines in Arkansas schools 5 years after implementation of their comprehensive statewide school nutrition policy in 2003, 37.2% of schools surveyed continued to grant their students with lunchtime access, 75.5% still contained sodas, and 75% contained chocolate candy (Phillips et al., 2010). Vending machine audits done prior to July 2014 in 4 rural Appalachian middle schools showed an average of 78.2% of the beverages and only 36.6% of the snacks in their vending machines would meet the anticipated USDA Smart Snacks in Schools standards due to excess amounts of fat and sodium. Virginia's Nutritional Guidelines for Competitive Foods were not as strict as the Smart Snacks in School standards, and this study showed that more than 50% of the foods and beverages these schools offered would need to be replaced (Mann, Kraak & Serrano, 2015).

The school food environment may impede healthier choices for students trying to manage their weight with better nutrition. In a qualitative study of 22 overweight and obese teenagers, the teens took pictures of the barriers and facilitators to healthful choices that they encountered throughout their day, providing researchers with snapshots of a school and community food environment saturated with obesity promoting prompts. The teens cited easy, abundant and quick access to less healthful foods through vending machines, including comments on sports beverage machines being located right outside the gym "…*which makes it harder not to want it because you've just been doing exercise*" (Watts, Lovato, Barr, Hanning & Masse, 2015). Among

adolescent students, exposure at school to sugar sweetened beverages (SSB) through vending machines and other school venues was found to be a predictor of SSB consumption, and district SSB policy was a predictor of exposure. According to their statistical model, authors predicted that for every SSB changed to a non-SSB in a vending machine, consumption could be expected to decrease by 2.8% (Johnson, Bruemmer, Lund, Evens & Mar, 2009).

Just as the food environment can interfere with healthier choices, policy and subsequent environmental changes can be used to passively promote health. A study using statistical models that compared the body mass indexes (BMIs) and school lunch statuses (free/reduced, regular price, or none) of 4,870 eighth grade students in 40 states to the strength of language contained in state laws regulating school nutrition standards showed two important associations. First, students who received free/reduced lunches in states with strict standards had smaller BMI differences as compared to the other students who did not receive them, however students who received free/reduced lunches in states with weak standards were twice as likely to be obese as compared to their counterparts who did not get school lunches. The second finding was that compensation through the purchase of foods from other venues was not evident in states with the strictest standards (Taber, Chriqui, Powell & Chaloupka, 2013).

Implementation of vending machine policy may be more effective however, when done as part of a multipronged effort, otherwise unintended consequences may result. Student consumption of soda was higher in schools without vending machine access when the state did not also tax sodas or prohibit their sale throughout the remainder of school food venues (Taber, Chriqui, Vuillaume & Chaloupka, 2014). In another study, adolescents who participated in 3-5 days of physical education classes consumed more SSBs for every additional day they participated in PE class; the association was greatest among schools that sold SSBs and had

vending machines (Chen & Wang, 2013). It is difficult to know if other factors in the nutrition environment, such as the placement of sports beverage vending machines near or inside the gym, could have influenced student consumption, however availability of SSBs in schools appears to be the underlying issue.

Disparities

Students belonging to underrepresented minority groups may be disproportionately impacted by the presence of vending machines, as the 2005 YouthStyles Survey showed among its 869 student participants. Although the majority of the respondents who did not use school vending machines were white, most black and Hispanic students used the machines. This study found that the odds for students to make vending machine purchases was 2.84 times greater for non-Hispanic black vs white students (95% CI =1.56-5.20), and 2.04 times greater for Hispanic or other vs. white students (95% CI =1.34-3.11) (Thompson, Yaroch, Moser, Finney-Rutten & Agurs-Collins, 2010). Moreover, in a Massachusetts middle school study, mean intakes of SSBs was higher among black and Hispanic students as compared to white students, at 2.08 and 1.49 servings as compared to 1.16 servings respectively (Wiecha, Finkelstein, Troped, Fragala & Peterson, 2006).

On the other hand, vulnerable populations may stand to make the most improvements when policies are put in place. In a study examining associations between state school competitive food policies and student SSB consumption, larger effect sizes were seen when associations were examined by race/ethnicity. Associations were strongest in non-Hispanic Black students, such that SSB consumption decreased by 0.12 servings daily when strong vending machine policies were in place, and by 0.19 daily servings when policies targeted

concession stands. Although small on a daily basis, multiplied across the period of one week the difference becomes 0.84 to 1.33 servings per week (Taber et al., 2011).

Improvements to the food environment may be overlooked or underutilized with vulnerable populations. For example, researchers found that Minnesota alternative schools had a greater prevalence of high-fat salty snacks than regular schools. They also found that SSB access decreased significantly over the 6-year period between 2002 and 2008 in regular schools, but not in alternative schools (Kubik, Davey, MacLehose, Coombes & Nanney, 2015). Policies related to healthy foods and beverages were weaker and used less frequently in areas with a greater concentration of children and underrepresented minority populations. These findings were the result of the development of a policy indicator checklist (PIC) as part of the Childhood Obesity Research Demonstration (CORD) Project that was tested in schools, childcare centers, and communities located in highly diverse areas in Texas, Massachusetts, and California (Lee et al., 2015).

Many schools in the US have high rates of students that qualify for free/reduced lunches, and this is an indication of poverty, which is linked to academic disadvantage. The school poverty index is one method for schools to identify the percentage of students falling below federal poverty guidelines. School poverty was associated with dietary behaviors in the 2005-2006 HBSC; it was negatively associated with fruit and vegetable intake and positively associated with intake of chips and SSBs (Rovner, Nansel, Wang & Iannotti, 2011). However in a survey of 6,732 secondary school principals across 28 states, schools with the most low-income students had better policies with regards to LNED foods, yet poorer availability of fruits and vegetables, while schools with high minority student enrollment had similar or better food environments as compared to the other schools (Nanney, Davey & Kubik, 2013). A possible

explanation is that schools with high rates of students that qualify for free/reduced lunches often qualify for the Title I program from the US Department of Education (DOE) entitling them to receive additional monies to help schools help students make academic gains (US DOE, 2015). This additional funding and support may extend to help make improvements in the food environment.

Regional differences in food environments with respect to vending machines may exist, even within a small geographic area. In a comparison of New Hampshire and Vermont schools with town, rural, or urban settings, all high schools afforded easy access to SSBs through their vending machines, however town schools had twice the amount of access and marketing as their urban counterparts (Adachi-Mejia, 2013). Location and size also played a role in that small and rural schools had fewer policies in place supporting healthier school food environments when compared with larger schools and those in urban settings (Nanney, Davey & Kubik, 2013). While these schools may not be considered in the traditional sense of "at-risk" schools with regards to their student population, the nature of their location or setting may put their students at risk for exposure to a food environment unsupportive of healthy eating behaviors.

Vending Machines and Diet

Vending choices are associated with dietary intake in children and college students (Rovner, Nansel, Wang & Iannotti, 2011) and higher SSB intake by employees in the workplace (Davy et al., 2014). Changing selections in vending machines may improve dietary intake, by making it easier to obtain healthier foods (Pelletier & Laska, 2013).

The availability of competitive foods in schools, such as those found in vending machines, has been shown to have an adverse effect on the dietary quality of students. In a nationally representative sample of 2,309 students in grades 1-12 participating in the School

Nutrition Dietary Assessment Study (SNDA III), 22% consumed competitive foods, with the highest proportion of caloric consumption attributed to competitive foods among the high school students. Energy and sugar intakes were higher for the students that consumed competitive foods, while sodium, fiber, B vitamins and iron intakes were lower, indicating that competitive foods and beverages adversely impacted student diets (Kakarala, Keast & Hoerr, 2010). The TEENS study showed that availability of snack vending machines was negatively associated with fruit consumption, so that for every snack machine in a school, average fruit consumption fell by 11% (Kubik, Lytle, Hannan, Perry & Story, 2003). Rovner et al. showed that fruit and vegetable intake was influenced by its availability in vending machines so that if fruits and vegetables were sold, intake was higher and vice-versa. This relationship was also seen with the consumption of sweets (Rovner, Nansel, Wang & Iannotti, 2011).

However, just as Rovner et al. showed that increased availability of healthier foods was associated with increased intake, when competitive foods meet federal nutrition standards their effect on diet intake may be positive. For example, Michigan middle school student diets improved in those students attending schools that introduced healthy competitive foods in vending machines or a la carte sales. These students' intakes of fiber, vitamins A and C, fruits, vegetables and whole grains significantly increased as compared to students in schools that simply implemented healthier food policies or removed a la carte sales (Alaimo et al., 2013).

Frequent use of vending machines has been associated with poor dietary choices. In a sample consisting of 869 students from the YouthStyles 2005 consumer survey, students who used vending machines 3 or more times per week were more likely to purchase pizza or fried foods at least once per week from the school cafeteria, eat candy or drink soda at least once daily, and have free access to school vending machines. The survey asked about purchases of

LNED food items such as chips, candies and sodas, so these vending machines purchases did not consist of healthier foods (Thompson et al., 2010). In a Massachusetts study of 1,474 middle school students, 43% of the students had made school vending machine purchases over the past 7 days. Of the students who used vending machines, 71% purchased SSBs. For students who made 1-3 purchases per week from vending machines, there was a 0.21 increase in daily SSB servings, and for students making ≥4 purchases the increase was 0.71 more servings daily as compared to those students not using vending machines (Wiecha et al., 2006).

Students in schools that have competitive food standards may have a better dietary intake than students in schools that do not have such standards. In 2009, California had strong laws for competitive foods and snacks in schools, which restricted fats, added sugars and calories. Using data from the National Youth Physical Activity and Nutrition Study (NYPANS), researchers compared the dietary intake of 114 high school students from California with the dietary intake of 566 students representing 14 other states that had no laws in place. California students consumed 158 fewer calories, 18 less grams of added sugar, and 170 fewer calories at school as compared to the students from the 14 other states without standards (Taber, Chriqui & Chaloupka, 2012). In a separate study, Taber et al. analyzed the associations between school competitive food policies and BMI percentiles and/or SSB consumption among 90,730 high school students in 33 states using data from the School Health Policies and Programs Study (SHPPS) and the 2007 state Youth Risk Behavior Survey. Although no associations were found with BMI, associations existed with SSB consumption such that students consumed 0.07-0.09 less servings of soda per day depending on what type of policy existed in their schools (Taber et al., 2011).

Concerns over Sales

Since vending machines are sources of revenue, the resulting impact on sales due to changes in product mix for healthier items is a real concern. Healthier food items tend to cost more and have shorter shelf lives, so lower consumer demand and product turnover has a greater potential to adversely affect the bottom line. The Ann Arbor Public School (AAPS) district reported a decrease of 39% in SSB revenue and a 40% reduction in snack machine revenues, after making changes to their vending machines that complied with their school wellness policy. SSB machines were turned off during lunchtime, which may have been the principal reason for decreased sales, however the snack machines remained available during lunch. Coincidently, the school district reported greater participation rates in the school meal program bringing in additional revenue which may have offset the lost vending machine revenue (Han-Markey et al., 2012).

Availability of LNED foods and beverages in schools may be profit driven. Data from the YES study between the years of 2007-2012 tied the receipt of profits at the school district level to lower access to LNED foods and greater fruit and vegetable access. Conversely, when individual schools kept the profits, students had greater access to LNED foods, and less access to fruits and vegetables. This was also seen when vendors controlled vending machine contents instead of leaving the control to the school district (Terry-McElrath, Hood, Colabianchi, O'Malley & Johnston, 2014).

Summary

In summary, vending machines are widely found in schools and as such are a part of the competitive food venues making up the school food environment (Rovner et al., 2011; Kubik et al., 2003). Choices found in vending machines tend to be LNED foods and beverages which

generally are associated with poor dietary choices (Thompson et al., 2010; Wiecha et al., 2006). Over the past 7 years, federal regulations have required that all foods offered in schools meet strict nutrition standards to promote student wellness (NSFMI, 2011; USDA FNS, 2016).

School Wellness Policies provide an example of how policies may be used to help improve the school health environment, especially when vending is one of several strategies implemented to create a healthier school food environment. Vending policies have been found to be sustainable and acceptable to consumers, parents and staff working at places where children frequent (Mason et al., 2014; Kubik et al., 2005). When vending machines are used to offer healthier foods, such as fruits and vegetables, they may help improve dietary intake (Rovner, et al., 2011), and may impact dietary behaviors in a positive direction even outside of the school environment (Vecchiarelli et al., 2006; Wordell et al., 2012).

Vending machines have been used to create non-discretionary revenue for schools (Longley & Sneed, 2009), although most schools only received about $18.11 per student per year (CSPI, 2006). Healthier vending machines may result in reduced sales, however those reduced sales may be offset by increased sales of school meals (Han-Markey et al., 2012). Black and Hispanic students may use vending machines in a greater proportion than their white peers (Thompson et al., 2010; Wiecha et al., 2006), but they also stand the most to gain from healthy vending policies (Taber et al., 2011). Disparities extend beyond ethnicity and race, and are evident also according to type of students served (Kubik et al., 2015), size of school, location (Nanney et al., 2013), and whether a school is rural or urban (Adachi-Mejia, 2013).

Past research on vending machines and children has largely consisted of studies on policy, association with dietary intake, and usually as just one element among many others in the food environment. This study proposes to examine the dietary quality of only those foods and

beverages sourced from vending machines using self-reported dietary intake records collected during NHANES interviews of school-aged children over a 10-year period. This research is novel since vending machine users have not been grouped as a sub-population among NHANES participants in the past.

Chapter 3

Methods

Conceptual Framework

The conceptual framework informing this study was developed by Thomas Frieden to explain what types of interventions have the greatest impact on population health, the Health Impact Pyramid (2010). He proposed that five tiers of interventions exist to address public health in general, each with a corresponding increase or decrease in impact on population health depending on what tier along the pyramid is implemented. At the base of the pyramid are interventions that target socioeconomic factors, also known as the social determinants of health, which have the greatest potential to improve health. The second tier involves changing the context to make the healthy choice the default choice, and may include policy, systems and environmental (PSE) changes that affect all people regardless of socioeconomic or health status, such as a municipal water fluoridation program or the fortification of refined wheat flour with folic acid (National Institutes of Health Office of Dietary Supplements, 2016). Tier three includes long-lasting protective interventions that require individuals to take action and include immunization programs. Moving up the pyramid to tier four are clinical interventions that help prevent or manage disease, but are not as effective as the lower tiers because clinical care may only reach those with access, may be limited by quality of care, and also requires patient adherence. At the top of the pyramid is tier five, education and counseling, which is least effective as it is accomplished on the individual level and simply teaches behavior change which may or may not be consistent with the individual's environment (Frieden, 2010).

Strategies that include modifying the contents of food and beverage machines may extend beyond a single tier in the Health Impact Pyramid. Healthier vending fits well into the lower

second tier of making the default choice the healthy choice. One way this may be accomplished is by creating federal policy establishing nutrition guidelines that apply to all food and beverages sold in schools that participate in federal child nutrition programs, a strategy that would apply to all students regardless of socioeconomic status. Food manufacturers have reformulated many of their products to meet the new guidelines, thus another way to change the context. Finally, exposure to better food choices should help increase acceptability of these foods by children, especially the youngest, yet another tier two result achieved through the changing of norms. Because changing vending contents should help improve food choices and overall diet, this strategy could also be seen as part of a base tier intervention to reduce obesity and chronic disease that addresses one of the social determinants of health: access to healthy food.

Because competitive foods sold from vending machines in schools that participate in federal child nutrition programs have become increasingly subject to regulations requiring they meet stricter nutrition guidelines since the 2006-2007 school year, one may reasonably expect to see a change in the nutrient quality of vended foods and beverages selected by school-aged children over time. This study will examine the dietary quality of only those foods and beverages sourced from vending machines using self-reported dietary intake records collected during NHANES interviews of school-aged children over a 10-year period.

Study Population

This study included only school-aged children between the age of 6 -19 years who had valid day one NHANES dietary interviews during the ten-year period between 2003 and 2012. As this research was focused on the dietary quality of foods and beverages obtained from vending machines, all research questions relied on a subpopulation consisting of vending machine users. During the dietary recall, NHANES participants were asked, “Where did you get

(this/most of the ingredients for this) {FOODNAME}?" and the response was coded to agree with one of 24 possible sources, including vending machines, which was coded as number fourteen. For the purpose of this study, vending machine users were defined as participants who indicated a vending machine as the source of at least one food or beverage during their day one NHANES dietary interview.

Responses from all school-aged children between the age of 6 -19 years were used to determine the findings for research question three. Each NHANES participant represents 50,000 U.S. residents and was selected to reflect the diverse composition of the nation, including a variety of ages and races/ethnicities (CDC National Center for Health Statistics [NCHS], 2015a). Some sub-populations were oversampled to ensure adequate representation for specific conditions or populations of national health interest, and sample weights are included in all data sets to enable construction of nationally representative data (Mirel et al., 2013).

Data Sources

This research used secondary data obtained from the National Health and Nutrition Examination Survey (NHANES) day 1 dietary interviews, known as the What We Eat in America (WWEIA) survey. NHANES is a biennial set of studies that examine about 5,000 people each year, in 15 different counties across the United States each year. The data sets are publicly available for download on the Centers for Disease Control NHANES website for each two-year cycle of dietary data and consist of two separate days of data sets for dietary interviews listing individual foods, as well as another set of separate data sets for total nutrient intakes. Also included are dietary variable lists and technical support files that provide SAS codes to add food code descriptions to the individual foods data set (CDC NCHS, 2015a).

Each NHANES participant is assigned a respondent sequence number to facilitate matching between the demographic, dietary, examination, laboratory, and questionnaire data sets. Dietary interview data for individual foods includes detailed information about source, time and occasion of consumption, and the macro- and micronutrient content for each food and beverage consumed. Each food or beverage is assigned an 8-digit food code based on the USDA Agricultural Research Service (ARS) Food and Nutrient Database for Dietary Studies (FNDDS), a database which provides food composition data. The first digit of the coding scheme refers to the major food group, while the second and third digits further specify subgroups of the major food group (USDA ARS, 2016). Total nutrient intake data sets include nutrient totals, but also include data on whether each participant was following a special diet. Demographic data of interest to this study includes gender, race/ethnicity, and age.

In addition to NHANES data files, the Food Patterns Equivalents Database (FPED) was required to generate Healthy Eating Index (HEI-2010) scores. The FPED is a tool that converts foods and beverages from the Food and Nutrient Database for Dietary Studies (FNDDS) into food pattern components, such as cups or ounces of a specific food group like whole grains. SAS-ready data sets with corresponding participant sequence numbers are publically available for each NHANES cycle from 1994 through 2012 (USDA ARS, 2016). All data files used in this study are listed in Appendix 1.

Human Subjects Protection

All NHANES data for the period between 2003 and 2012 was collected using approved National Center for Health Statistics (NCHS) Research Ethics Review Board (ERB) protocols (CDC NCHS, 2015b). As secondary, de-identified and publicly available data, the UNLV

Biomedical Institutional Review Board classified this study as an excluded activity – *not human subjects research* – under 45 CFR 46.101(b)(4) (Appendix 2).

Data Transformation and Analysis

The HEI-2010 scores and data analysis for this paper was generated using SAS software, Version 9.4 of the SAS System for Windows. Copyright © 2015 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

HEI-2010 Scores

SAS software codes available on the National Cancer Institute (NCI) website were modified and used to generate HEI-2010 scores using NHANES demographic data, dietary data, and corresponding FPED files. The HEI-2010 measures total diet quality using density ratios based off of the 12 different dietary components listed on Table 3.1. The first nine components are considered adequacy components and the last three are moderation components to limit in the diet. Foods and beverages that meet the standard for these dietary components per 1000 kcals receive the maximum points within their specific category; a maximum score in each component yields a total score of 100, while the minimum equals zero.

The HEI-2010 had not been used to assign scores to individual foods in the past because the tool is intended to assess overall diet quality, not nutrient quality; however, because its score is derived on a density basis it was deemed possible to use this score as a measure of a food's individual contribution to diet. While no one food could be expected to achieve an overall perfect score of 100, foods that contain more of the desirable dietary components and less of the undesirable ones making up the HEI-2010 score should achieve a higher score and vice versa.

Table 3.1. *Healthy Eating Index HEI-2010 components and scoring standards*

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total Fruit	5	≥ 0.8 cup[1]	No fruit
Whole Fruit	5	≥ 0.4 cup[1]	No whole fruit
Total Vegetables	5	≥ 1.1 cup[1]	No vegetable
Greens and Beans	5	≥ 0.2 cup[1]	No dark green vegetables or beans and peas
Whole Grains	10	≥ 1.5 ounce[1]	No whole grains
Dairy	10	≥ 1.3 cup[1]	No dairy
Total Protein Foods	5	≥ 2.5 ounce[1]	No protein foods
Seafood and Plant Proteins	5	≥ 0.8 ounce[1]	No seafood or plant proteins
Fatty Acids	10	(PUFAs+MUFAs)/SFAs ≥ 2.5	(PUFAs+MUFAs)/SFAs ≤ 1.2
Refined Grains	10	≤ 1.8 ounce[1]	≥ 4.3 ounce[1]
Sodium	10	≤ 1.1 gram per 1000 kcal	≥ 2.0 grams per 1000 kcal
Empty Calories	20	≤ 19% of energy	≥ 50% of energy

Note. [1]Equivalents per 1000 kcals. [2]Includes fruit juice.[3]Includes all forms except juice.[4]Includes any beans and peas (called legumes in HEI-2005) not counted as Total Protein Foods (called Meat and Beans in HEI-2005).[5]Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.[6]Beans and peas are included here (and not with vegetables) when the Total Protein Foods (called Meat and Beans in HEI-2005) standard is otherwise not met. [7]Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.[8]Ratio of poly- and monounsaturated fatty acids to saturated fatty acids.[9]Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is >13 grams/1000 kcal. Intakes between the minimum and maximum standards are scored proportionately (Guenther et al., 2013).

Research Questions, Methods and Hypothesis

Research Question One

Is there a significant difference over time among the mean Healthy Eating Index (HEI) scores of food and beverage selections made by school-aged children between the ages of 6-19 years from vending machines across the 5 NHANES cycles taken between 2003 and 2012? The dependent variable was the mean of the HEI scores for food and beverage selections made by

children age 6-19 years from vending machines, and the independent variable was the biennial NHANES cycles with 5 levels: (1) 2003-2004, (2) 2005-2006, (3) 2007-2008, (4) 2009-2010, and (5) 2011-2012.

The NCI SAS code to calculate HEI-2010 scores for an individual, using FPED, was modified to read in only those foods and beverages that came from vending machines and were consumed by the population of interest. An issue that surfaced while using the HEI-2010 tool to score individual foods instead of an entire meal or total diet was that the tool assigned a score of "0" when a food or beverage contained zero kcals and no other nutrients or food components, thus water received a score of zero. This became a concern given that a cola-type soft drink received an HEI-2010 score of 20 while water received a zero. The soft drink, containing no nutrients other than sodium and kcals, did not generate any scores in the adequacy components, but did receive a score of 10 for having a ratio of $\leq$ 1.1 grams of sodium per 1000 kcals in the sodium component and a score of 10 in the refined grains component for having a ratio of $\leq$ 1.8 ounce refined grains per 1000 kcals.

Data and HEI-2010 scores were analyzed using the PROC SURVEYREG command to generate a one-way analysis of variance (ANOVA), followed up with a Tukey HSD (Honestly Significant Difference) post-hoc analysis when differences between NHANES cycle HEI score means were significant.

Hypothesis for Question One

H_0: There is no difference among mean HEI scores of food and beverage selections made from vending machines across the 5 biennial NHANES cycles taken between 2003 and 2012.

H_A: At least two mean HEI scores of food and beverage selections made from vending machines differ across the 5 biennial NHANES cycles taken between 2003 and 2012.

Research Question Two

Did mean HEI-2010 scores of foods and beverages from vending machines differ among school-aged children between the age of 6-19 years that used vending machines according to gender, age group, or race/ethnicity? The outcome variable was the mean of the HEI-2010 scores and the predictors consisted of dichotomized demographic variables including gender (male or female), race/ethnicity (white or other-not white) and age group (6-11 or 12-19).

The NCI SAS software code to calculate HEI-2010 scores for an individual, using FPED, was modified to read in only the relevant data for children between the age of 6-19 years who used vending machines.

Weighted means for demographic tables were created using the PROC SURVEYMEANS command, and the multiple linear regression model was created using the PROC SURVEYREG command. All counts were generated using the PROC SURVEYFREQ command with sample weights applied.

Hypothesis for Question Two

H_0: There is no relation among the demographic variables of gender, age group or race/ethnicity among school-aged children between the age of 6-19 years that used vending machines.

H_A: At least one demographic variable of gender, age group or race/ethnicity is useful to explain or predict mean HEI scores among school-aged children between the age of 6-19 years that used vending machines.

Research Question Three

Did total diet quality (mean HEI-2010 scores) differ between vending machine users and non-users aged 6-19 years across NHANES cycles taken between 2003 and 2012? The dependent variable was the mean of the population HEI-2010 scores and the independent variable had two levels, (1) vending machine users and (2) non-users aged 6-19 years.

The NCI SAS software code to calculate HEI-2010 scores for each cycle of NHANES data, using FPED, Population Ratio method was modified to read in data belonging to children between the age of 6 -19 years who used vending machines and for those that did not use vending machines. The vending machine user data consisted of a small sample, making it impossible to properly calculate HEI-2010 scores using the population ratio method. To overcome this problem, the sample size was increased by combining NHANES cycles instead of comparing them individually as originally intended.

The two cycles from 2003-2006 were combined along with the three cycles from 2007-2012. These years were selected for comparison periods as policy changes in federal child nutrition programs did not require the implementation of school wellness policies until after the 2005-2006 school year. Thus, school vending machine offerings were unlikely to be noticeably different in nutrient quality until the policy implementation incited their change. Additionally, all five cycles were combined to enable comparison between vending users and non-users for the entire 10-year period.

The two HEI-2010 population means for each corresponding NHANES period between 2003 and 2012 were compared. Standard errors and 95% confidence intervals were calculated to determine whether significant differences existed between the two population means.

Hypothesis for Question Three

H_0: There is no difference in total diet quality (mean HEI scores) between vending machine users and non-users aged 6-19 years.

H_A: There is a difference in total diet quality (mean HEI scores) between vending machine users and non-users aged 6-19 years.

Chapter 4

Results

Research Question One: Dietary Quality of Vended Foods and Beverages Over Time

Descriptive information of vended foods and beverages

The frequency of vending machine responses as a source of foods or beverages gradually decreased among school-aged children by 119 items, or 60%, between the 2003 and 2012 (Table 4.1). During that time period, the frequency of vended water increased gradually and became a larger proportion of the total vended items, such that in the 2003-2004 cycle there were zero children reporting consumption of water sourced from a vending machine compared to 2011-2012, where 17 instances of water made up 21% of the sample of 80 items.

Table 4.1. *Quantity, Dietary Quality and Caloric Content of Vended Foods and Beverages Consumed by Children Age 6-19 years by NHANES Cycle as Measured by HEI-2010*

	Including water			Calories from all food & beverage		Excluding water		
		HEI-2010 score					HEI-2010 score	
Cycle	*n*	*M*	*SE*	*M*	*SE*	*n*	*M*	*SE*
2003-2004	199	27.84	1.46	194.52	12.42	199	27.84	1.46
2005-2006	175	25.34	1.35	170.28	12.83	159	28.13	0.87
2007-2008	108	24.48	1.33	143.86	11.05	96	27.33	0.91
2009-2010	76	26.14	2.25	164.53	14.63	64	29.86	2.72
2011-2012	80	19.45	3.89	83.02	12.01	63	28.66	2.00
Total	638	25.11	0.87	157.84	6.59	581	28.16	0.67

Note. The maximum HEI-2010 score is 100. Calories are the same including and excluding water. Data from NHANES 2003-2012 Demographic and Day 1 Individual Foods Files.

The types of foods and beverages obtained from vending machines varied. Items reported most often belonged to the USDA Food and Nutrient Database for Dietary Studies (FNDDS) defined food coding group number 9: *grain products and sugars, sweets, and beverages*. In all, 360 beverages and 278 foods made up the total vended foods consumed by children (Table 4.2).

Table 4.2. *HEI-2010 Scores and Caloric Content of Vended Foods and Beverages Consumed by Children Age 6-19 years according to USDA FNDDS Food Coding Sub-Groups*

		HEI-2010 score		Calories	
USDA Food Group or Sub-Group	*n*	*M*	*SE*	*M*	*SE*
Milks and milk beverages					
Milk and milk drinks	3	28.89	--	179.25	--
Creams and cream substitutes	2	18.74	--	172.35	--
Milk desserts, frozen	1	18.62	--	165.00	--
Natural Cheeses	1	25.07	--	114.00	--
Meat, Poultry, Fish, and Mixtures					
Other beef items	2	15	0.00	152.09	46.30
Chicken	1	37.63	--	428.00	--
Sausages and lunchmeats	4	24.37	5.84	87.89	5.19
Dry Beans, Peas, Other Legumes, Nuts, & Seeds					
Nuts, nut butters, and nut mixtures	5	63.43	--	156.07	--
Grain Products					
Yeast breads, rolls	10	30.33	0.21	274.62	75.44
Cakes, cookies, pies, pastries, bars	36	25.07	0.28	313.23	49.21
Crackers and salty snacks from grain products	92	37.99	1.57	171.62	8.96
Waffles and French toast	2	32.89	--	132.50	--
Mixtures, mainly grain, pasta, or bread	1	23.14	--	402.00	--
Fruits					
Citrus fruit juices	9	55.00	--	202.30	--
Fruit juices ad nectars excluding citrus	9	49.36	--	214.24	--
Vegetables					
White potatoes, chips and sticks	36	52.50	0.02	169.41	2.43
Sugars, Sweets, and Beverages					
Sugars and sweets	85	29.82	0.57	187.96	13.05
Nonalcoholic beverages	275	21.14	0.50	154.46	8.17
Water, noncarbonated[a]	60	1.60	1.35	1.89	1.14
Sports drinks	4	20.94	--	88.27	--
Total	638	25.11	0.87	157.84	6.59

Note. [a] Glaceau water contains calories and is included in this category. The maximum HEI-2010 scores is 100. Data from NHANES 2003-2012 Demographic and Day 1 Individual Foods Files.

Dietary quality of vended foods and beverages

Mean total HEI-2010 scores for individual foods and beverages decreased by 8.39 points or 30% during the period spanning 2003-2012. With the exclusion of water, the mean HEI-2010 scores increased by 3%, or 0.82 points. The mean energy value consumed by school-aged children for vended foods and beverages decreased by 111.50 kcals, or 57% during that same period.

Results of statistical analysis for Question One using HEI-2010 as dependent variable

A one-way between subjects Analysis of Variance (ANOVA) was conducted using the PROC SURVEYREG command to compare the mean HEI-2010 scores of vended food and beverages across the 5 levels of biennial NHANES cycles. The ANOVA results indicated there was not a significant difference among HEI-2010 scores due to NHANES cycle for the five biennial cycles [$F(4, 633) = 1.30$, $p = 0.2797$].

Results of statistical analysis for Question One using HEI-2010 excluding water

A second one-way between subjects ANOVA was conducted to compare the mean HEI-2010 scores of vended items, excluding water, across the 5 levels of biennial NHANES cycles. There was not a significant difference among HEI-2010 scores due to NHANES cycle for the five biennial cycles [$F(4, 576) = 0.75$, $p = .5590$].

Additional testing using calories as dependent variable

Mean kcal consumption from vended items decreased from the highest mean value of 195 kcals per vended item in 2003-2004, to the lowest mean value in 2011-2012 of just 83 kcals (Figure 4.1).

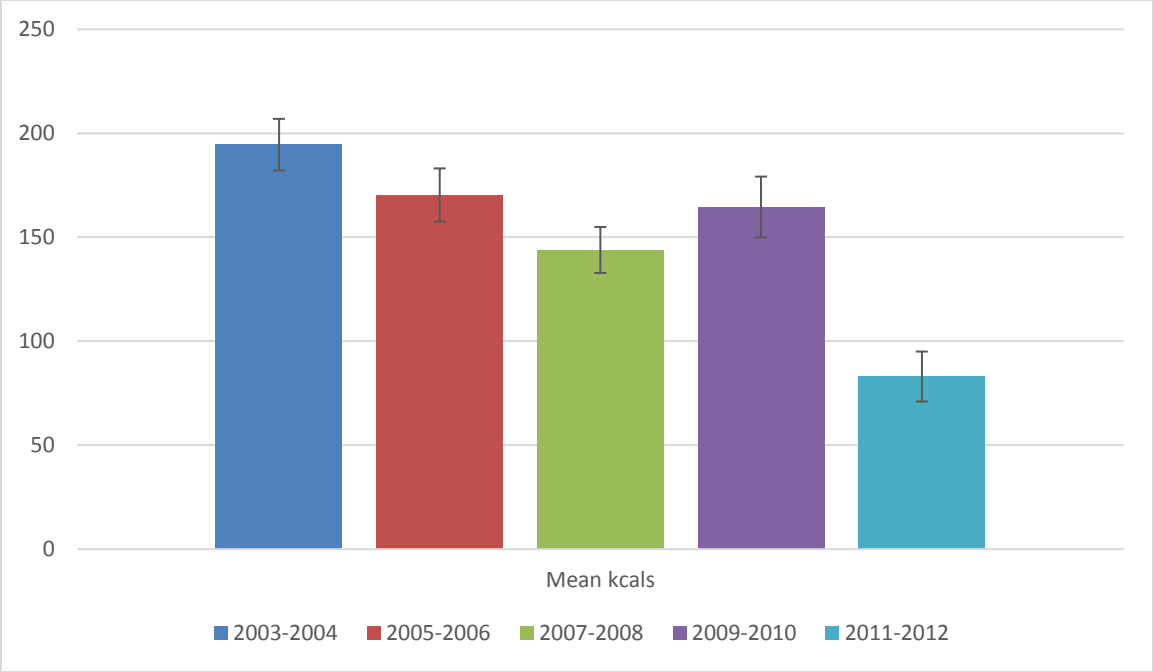

Figure 4.1. Mean kcals for vended foods and beverages consumed by children, age 6-19 years, from NHANES day 1 individual dietary intake files.

A final one-way between subjects ANOVA was conducted to compare the mean energy content of vended food and beverages across the 5 levels of biennial NHANES cycles. There was a significant difference among HEI-2010 scores due to NHANES cycle for the five biennial cycles [$F(4, 633) = 10.43$, $p < .0001$]. Post hoc comparisons (Table 4.3) using the Tukey-Kramer test indicated that the mean energy content of vended items in all cycles differed significantly.

Table 4.3. *Tukey-Kramer Comparison for Energy in Calories of Vended Foods and Beverages Consumed by Children Age 6-19 years by NHANES Cycle*

Comparisons	*Mean Difference in Calories*	*SE*	95% CI	
			Lower Bound	*Upper Bound*
2003-2004 vs. 2005-2006	24.24	17.92	-11.48	59.97
2003-2004 vs. 2007-2008*	50.66	17.14	16.50	84.83
2003-2004 vs. 2009-2010	29.99	21.78	-13.42	73.40
2003-2004 vs. 2011-2012**	111.50	18.18	75.27	147.74
2005-2006 vs. 2007-2008	26.42	17.42	-8.31	61.16
2005-2006 vs. 2009-2010	5.75	21.96	-38.03	49.53
2005-2006 vs. 2011-2012**	87.26	18.44	50.50	124.03
2007-2008 vs. 2009-2010	-20.67	21.45	-63.44	22.09
2007-2008 vs. 2011-2012**	60.84	17.70	25.56	96.12
2009-2010 vs. 2011-2012**	81.51	22.32	37.02	126.01

Note. *$p < 0.05$, ** $p < 0.01$; data from NHANES 2003-2012 Day 1 Individual Foods Files.

Research Question Two: Demographics Predictors in HEI-2010 Scores among Users

Descriptive characteristics of school-aged children who used vending machines

Table 4.4 lists demographic characteristics for the children between the age of 6 - 19 years who reported consuming foods and/or beverages obtained from vending machines during the period ranging from 2003 - 2012. Male and female participation was similar, and the majority of the children belonged to the 12 - 19 year old group. Race/ethnicity was dichotomized, and 124 (27%) children were white, while 332 (73%) of the children in the raw sample reported being a race/ethnicity other than white.

Dietary quality among vending machine users

Weighted mean HEI-2010 scores among demographic sub-groups of vending users varied between the lowest mean score of 38.50 (*SE* = 1.75) observed in males during the 2005-2006 cycle to the highest score of 49.04 (*SE* = 3.72) in 2009-2010 among 12-19 year-olds (Table

Table 4.4. *Demographic Characteristics of NHANES 2003-2012 Participants, Age 6-19 year Who Consumed Items from Vending Machines, with Day 1 Reliable Diets, Unweighted and Weighted Frequencies*

	2003-2004		*2005-2006*		*2007-2008*		*2009-2010*		*2011-2012*		*2003-2012*	
	Raw	*Weighted*	*Raw*	*Weighted*	*Raw*	*Weighted*	*Raw*	*Weighted*	*Raw*	*Weighted*	*Raw*	*Weighted*
	n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*
Gender												
Males	82	1,397,773	63	1,064,830	34	1,089,369	22	479,564	33	1,095,047	234	5,126,583
HEI (*SE*)	40.34 (1.56)		8.50 (1.75)		44.25 (4.07)		46.50 (4.59)		43.15 (2.27)		41.96 (1.33)	
Females	60	1,065,016	68	1,365,554	33	1,128,534	32	1,086,821	29	558,573	222	5,204,498
HEI (*SE*)	40.45 (3.56)		42.97 (2.12)		40.81 (1.56)		48.45 (4.26)		43.85 (3.56)		43.22 (1.40)	
Age Group [a]												
6-11	6	190,987	14	408,356	16	546,679	10	206,551	18	313,925	64	1,666,498
HEI (*SE*)	48.93 (3.38)		44.44 (3.07)		44.42 (7.59)		40.02 (4.17)		39.59 (3.44)		43.49 (2.94)	
12-19	136	2,271,802	117	2,022,028	51	1,671,225	44	1,359,833	44	1,339,696	392	8,664,584
HEI (*SE*)	39.67 (1.95)		40.32 (1.72)		41.87 (7.59)		49.04 (3.72)		44.28 (2.83)		42.43 (1.08)	
Race/Ethnicity [b]												
White	40	921,377	34	1,405,839	25	1,592,351	15	881,696	10	603,228	124	5,404,491
HEI (*SE*)	41.09 (2.10)		40.36 (1.88)		42.27 (2.95)		47.81 (6.58)		43.74 (3.31)		42.48 (1.46)	
Other	102	1,541,412	97	1,024,545	42	625,553	39	684,688	52	1,050,393	332	4,926,591
HEI (*SE*)	39.21 (2.00)		41.90 (2.02)		43.90 (2.30)		47.92 (2.86)		43.18 (2.13)		42.77 (0.94)	
Total	**142**	**2,462,789**	**131**	**2,430,384**	**67**	**2,217,904**	**54**	**1,566,384**	**62**	**1,653,621**	**456**	**10,331,082**
HEI (*SE*)	**40.38 (1.43)**		**41.01 (1.66)**		**42.50 (2.30)**		**47.85 (3.89)**		**43.39 (2.49)**		**42.60 (1.03)**	

Notes. [a]Age is in years. [b]The race/ethnicity categories used by NHANES (Mexican-American, Other Hispanic, Non-Hispanic Black, and Other Race including Multi-Racial) have been collapsed into the category "other." The maximum HEI-2010 score is 100. Data from NHANES 2003-2012 Demographic and Day 1 Total Nutrient Intakes Files

4.4). Total mean energy intake was at least 150 kcals less in 2009-2010 than in other years, and the breakdown of specific dietary component scores is presented in Table 4.5.

Table 4.5. *Comparison of Average Individual HEI-2010 Scores for Children Age 6-19 years Who Consumed Items from Vending Machines by NHANES Cycle.*

HEI-2010 Dietary Component (max score)	2003 2004	2005 2006	2007 2008	2009 2010	2011 2012
Total kcals	2678	2290	2402	1975	2126
Total vegs (5)	2.23	2.38	2.43	2.40	1.69
Greens & beans (5)	0.34	0.56	0.63	0.98	0.27
Total fruit (5)	1.93	1.96	1.81	2.51	1.30
Whole fruit (5)	1.24	1.38	1.50	1.61	0.98
Whole grains (10)	0.85	1.16	1.53	1.83	2.60
Dairy (10)	5.46	5.78	6.10	6.25	7.01
Total protein foods (5)	3.62	3.61	3.43	3.41	3.41
Seafood & plant protein (5)	1.37	0.92	1.12	1.30	1.61
Fatty acids (10)	4.71	4.24	4.25	5.07	4.14
Sodium (10)	5.70	5.38	4.82	5.17	4.18
Refined grains (10)	4.78	4.99	5.27	4.80	3.97
Empty calories (20)	6.63	8.53	9.07	11.40	11.34
Total HEI-2010 Score	**38.86**	**40.89**	**41.95**	**46.75**	**42.50**

Note: HEI-2010 possible scores are 0-100. HEI-2010 scores calculated for individuals. Data from NHANES 2003-2012 Demographic and Day 1 Total Nutrient Intakes Files.

Results of statistical analysis for Question Two

A multiple linear regression was calculated using PROC SURVEYREG to predict mean HEI-2010 scores of children who reported consuming items from vending machines based on gender, dichotomized age group (6-11 years or 12-19 years), and dichotomized race/ethnicity of either white or other. The overall regression model was not significant [F (3,452) = 0.37, p = 0.7721], with an R^2 of .004 accounting for less than 1% of the model's variability; none of the predictors had a significant value.

Research Question Three: Mean HEI-2010 Scores between Users and Non-Users

Descriptive characteristics of NHANES participants included in study

Table 4.6. *Demographic Characteristics of NHANES 2003-2012 Participants, Age 6-19 years, with Day 1 Reliable Diets, Unweighted and Weighted Frequencies*

	Unweighted		*Weighted*	
	n	*%*	*n*	*%*
Gender				
Males	6,660	50	145,439,280	51
Females	6,523	50	141,798,748	49
Age Group [a]				
6-11	5,333	41	123,114,735	42
12-19	7,850	59	164,123,293	58
Race/Ethnicity [b]				
White	3,682	28	171,280,658	60
Other	9,502	72	115,957,370	40
NHANES Cycle				
2003-2004	3,062	23	56,963,252	20
2005-2006	3,127	24	56,974,125	20
2007-2008	2,277	17	57,357,133	20
2009-2010	2,419	18	57,450,306	20
2011-2012	2,298	18	58,493,211	20
Total	13,184	100	287,238,028	100

Notes. [a] Age is in years. [b] The race/ethnicity categories used by NHANES (Mexican-American, Other Hispanic, Non-Hispanic Black, and Other Race including Multi-Racial) have been collapsed into the category "non-White." Data from NHANES 2003-2012 Demographic Files.

Results of statistical analysis for Question Three

Mean HEI-2010 scores for non-users were higher than for users of vending machines, and the HEI-2010 scores increased with each cycle progression. Because the subpopulation of vending users was small after 2007, it was necessary to combine several cycles of NHANES data to properly execute the statistical analysis using the aforementioned codes.

Table 4.7. *Weighted HEI-2010 scores using NCI Population Method for NHANES 2003-2012 Day 1, Children Age 6-19 years with Reliable Diets, Complex Survey Design*

	Did Not Use Vending				
		HEI-2010		95% CI	
Cycle	*n*	*M*	*SE*	*Lower*	*Upper*
2003-2004	2920	45.00	.93	43.14	46.83
2005-2006	2996	46.82	.62	45.59	48.06
2003-2006	5916	45.90	.55	44.80	46.98
2007-2012	6811	50.82	.57	49.70	51.92
2003-2012*	12,727	48.81	.42	47.97	49.62
	Used Vending				
		HEI-2010		95% CI	
Cycle	*n*	*M*	*SE*	*Lower*	*Upper*
2003-2004	142	43.61	1.71	40.47	47.13
2005-2006	131	42.99	2.16	39.15	47.67
2003-2006	273	43.27	1.34	40.72	46.01
2007-2012	183	47.15	2.30	42.58	51.62
2003-2012*	456	45.15	1.32	42.54	47.78

Note. The maximum HEI-2010 score is 100. Data from NHANES 2003-2012 Demographic and Day 1 Total Nutrient Intakes Files.

Non-user and vending user mean HEI-2010 scores did not differ significantly between each other for the first 4 time periods listed in Table 4.7. However, in a comparison for the entire period of 2003-2012 between users and non-users, non-user scores were 3.66 points higher than user scores; this was a significant difference as observed by the non-overlapping 95% confidence intervals.

Table 4.8 presents the breakdown of the 12 dietary component scores and difference in kcals between vending machine users and non-users. Vending users consumed an average of 233 kcals more than their counterparts, and scored significantly lower in the following individual dietary component scores: total fruit, whole fruit and sodium.

Table 4.8. *Mean Kcals and HEI-2010 Total and Component Scores for Children Age 6-19 Years During 2003-2012*

HEI-2010 Dietary Component (maximum score)	Vending Machine Users (n=456)	Non-Users (n=12,727)
	Mean Score (SE) [95% CI]	
Total kcals	2,349	2,116
Total vegetables (5)	2.20 (0.13) [1.95 – 2.46]	2.23 (0.03) [2.16 – 2.29]
Greens and beans (5)	0.41 (0.11) [0.20 – 0.63]	0.59 (0.04) [0.50 – 0.67]
Total fruit (5)*	2.18 (0.20) [1.79 – 2.59]	2.98 (0.08) [2.81 – 3.14]
Whole fruit (5)*	1.98 (0.22) [1.55 – 2.43]	3.47 (0.12) [3.22 – 3.71]
Whole grains (10)	1.50 (0.24) [1.03 – 1.96]	1.81 (0.05) [1.71 – 1.91]
Dairy (10)	7.34 (0.37) [6.63 – 8.09]	7.91 (0.11) [7.70 – 8.12]
Total protein foods (5)	4.37 (0.21) [3.97 – 4.79]	4.67 (0.06) [4.55 – 4.78]
Seafood and plant proteins (5)	2.96 (0.37) [2.24 – 3.67]	2.89 (0.10) [2.69 – 3.10]
Fatty acids (10)	3.96 (0.30) [3.38 – 4.56]	3.38 (0.08) [3.23 – 3.54]
Sodium (10)*	5.49 (0.24) [5.02 – 5.95]	4.65 (0.10) [4.46 – 4.85]
Refined grains (10)	3.90 (0.51) [2.92 – 4.92]	4.49 (0.11) [4.27 – 4.69]
Empty calories (20)	8.85 (0.47) [7.91 – 9.76]	9.75 (0.14) [9.48 – 10.02]
Total HEI score (100)*	**45.15 (1.32) [42.53 – 47.78]**	**48.81 (0.42) [47.97 – 49.62]**

Note: HEI-2010 score calculated using the population ratio method. Data from NHANES 2003-2012 Demographic and Day 1 Total Nutrient Intakes Files. *Significantly different 95% confidence intervals.

Chapter 5

Discussion

Summary of Study

The principal aim of this study was to explore the contribution of vended foods and beverages to the overall dietary quality of vending machine users between the age of 6 - 19 years using dietary intake data collected through the National Health and Nutrition Examination Survey (NHANES) What We Eat in America dietary interview. The second aim of this study was to determine if vending machine selections had improved over the span of 10 years from 2003 - 2012 relative to dietary quality. The third aim was to see if a difference in overall diet quality existed between school-aged users and non-users of vending machines, and among different demographic sub-groups within the group of school-aged children who used vending machines.

Research Question One Discussion

The null hypothesis that there was no difference among mean HEI-2010 scores of food and beverage selections made from vending machines across the 5 biennial NHANES cycles between 2003 and 2012 was not rejected as Tukey post-hoc comparisons confirmed no statistical differences among HEI-2010 scores. Additional ANOVA testing omitting HEI-2010 scores for water further justified a failure to reject the null hypothesis with non-significant differences. However, a final analysis substituting kcals as the dependent variable instead of the HEI-2010 score yielded significant results, indicating that mean energy in kcals from vended foods and beverages decreased over time for all NHANES cycles.

Decrease in frequency of vended items

The frequency of vending machine use as a source of foods or beverages steadily decreased from 2003 through 2012, both in the raw data presented on Table 4.1 on page 36 and when weighted as in Figure 5.1. The sharpest drop of nearly 40% occurred during the 2009-2010 NHANES cycle – well after implementation of the first School Wellness Policy was required during the fall semester of the 2006-2007 school year for schools participating in federal child nutrition programs.

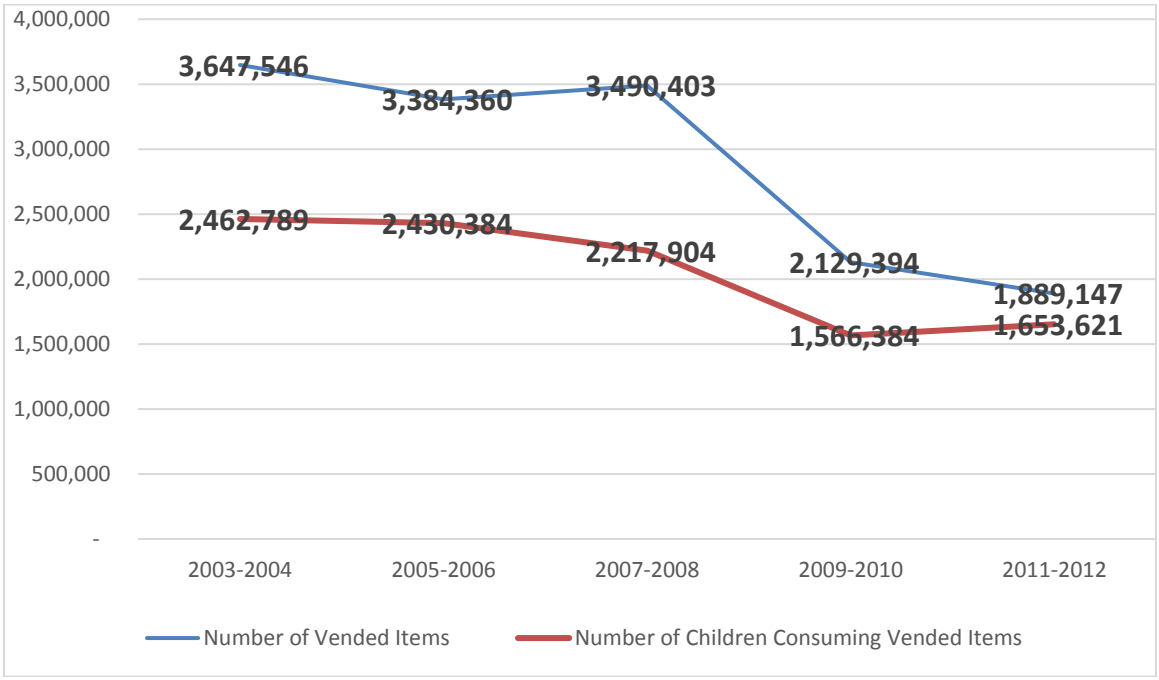

Figure 5.1. Number of vended items consumed by children age 6-19 years in day 1 NHANES individual dietary intake files, weighted data, US census nationally representative estimate.

The drop in vending machine use by children may be attributed to decreased access in the school environment. A sharp decrease in student exposure to vending machines on school campuses was noted by several authors, beginning with a slight decrease in 2004 and becoming more pronounced beyond 2008 (Kubik et al., 2015; Phillips et al., 2011; Turner and Chaloupka, 2011; Terry-McElrath, O'Malley, and Johnston, 2011). Figure 5.1 shows similar trends as the number of children using vending machines and the amount of vended items they consumed decreased sharply between 2008 and 2009. The ratio of vended items consumed by children

decreased from an average 1.5 items in 2003-2004 to 1.1 items in 2011-2012, reducing the amount of mostly empty kcals that children obtained from vending machines.

Changes in beverage consumption

More water and less sugary beverages were selected by children with the progression of each cycle during this same period, most likely due to decreased access to sugary beverages and increased access to bottled water in vending machines (Figure 5.2). This is consistent with research conducted by Turner and Chaloupka who noted a significant decrease in access to beverages not allowed by national guidelines from elementary school vending machines between the 2006 -2007 and the 2008 - 2009 school years (2011). Research conducted in orthodontic patients between January 2010 and March 2013 found that water, considered a "healthy item" by the study authors, was frequently reported by these child patients as being more accessible in school vending machines and school stores than sodas (Cisse-Egbuonye et al., 2016).

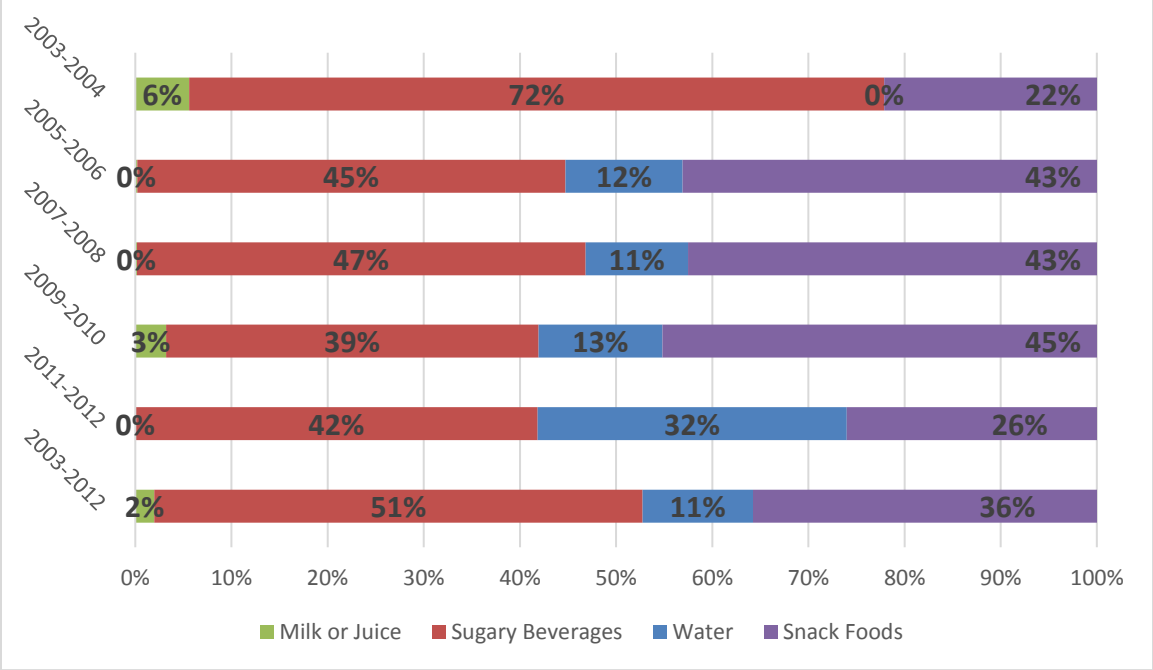

Figure 5.2. Weighted percentages and type of vended items consumed by children age 6-19 years in NHANES day 1 individual dietary intake files.

This change in beverage selections was claimed as an accomplishment by the American Beverage Association (ABA) in its *Alliance School Beverage Guidelines Final Progress Report* (2010). The Alliance for a Healthier Generation was able to secure the commitment of major soft drink manufacturers and the ABA to voluntarily comply with its beverage guidelines designed to reduce both portion sizes and kcals of beverages sold in schools. Among the accomplishments claimed by the ABA in the report:

- an 88% decrease in kcals shipped to schools between 2004 and 2009;
- a shift away from full calorie soft drinks to "healthier" beverages such as 100% juice, sports drinks and waters;
- and nearly 99% compliance to voluntary beverage guidelines in assessed schools (ABA, 2010).

Although the sugary beverage industry took the credit in this report for the drastic change in beverage mix in the school food environment, the reality is that SWPs addressing competitive food venues were required to be in place by the fall of 2006 because of the 2004 Child Nutrition and Special Supplemental Nutrition Program for Women, Infants and Children (WIC) Reauthorization Act. The voluntary agreement may have helped facilitate that change, but was done most likely to preserve the interests of beverage manufacturers by allowing them to gradually make changes through different beverage lines that would meet stricter guidelines and thus be able to remain as part of the school food environment.

Offering water to drink more often than other beverages containing empty calories is a recommended strategy to lower consumption of sugary beverages by agencies such as the CDC, USDA and the US DHHS. Water consumption is strongly encouraged by the 2015-2020 US Dietary Guidelines, which note that beverages accounted for nearly 20% of the average kcals

consumed in the US –the largest source coming from empty kcals in sugary beverages (US DHHS & USDA, 2015a). The shift to water in school vending machines follows those recommendations and has resulted in a lower mean kcal intake by children who use them.

Changes in mean HEI-2010 scores of vended foods and beverages

Statistical testing comparing HEI-2010 scores for all vended items resulted in non-significant results due to large 95% confidence intervals. This could be attributed to small sample sizes and large standard errors caused by large variations in HEI-2010 scores due to water scores equaling zero. However, the second ANOVA excluding water scores was not significant because excluding the water scores increased the mean HEI-2010 scores enough to bring them closer together, reducing the difference among means (Figure 5.3).

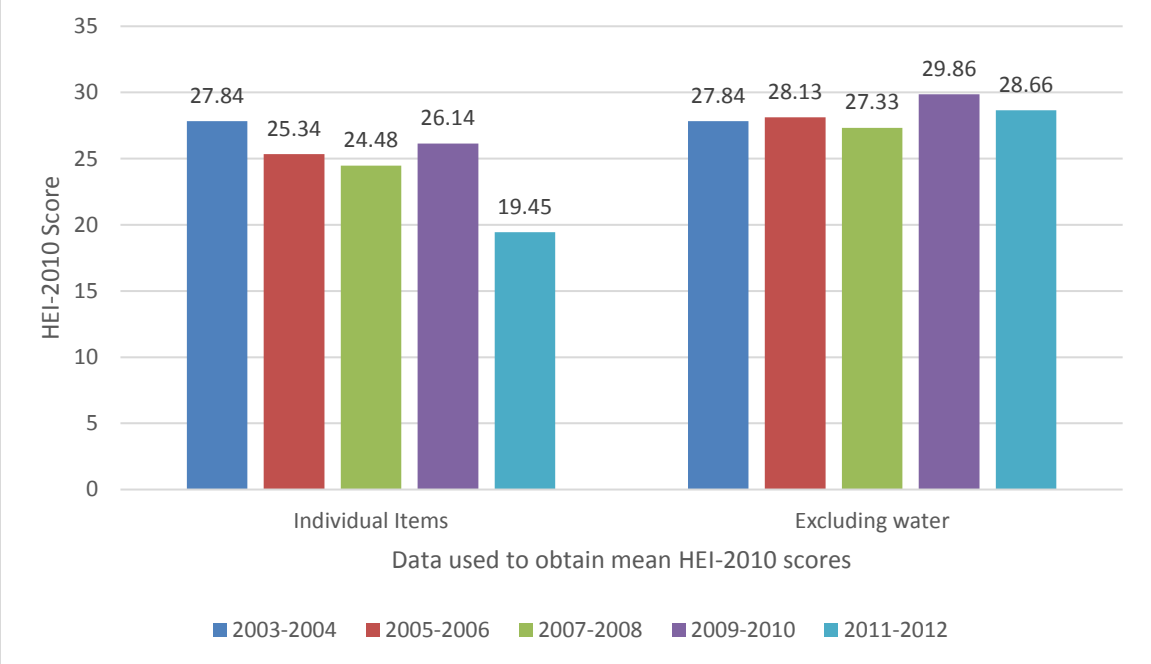

Figure 5.3. HEI-2010 scores for vended foods consumed by children, age 6-19 years, using NHANES day 1 individual dietary intake files.

The HEI-2010 tool is meant to assess total diet, not individual foods or beverages. It has been successfully used to measure the quality of a food environment, but researchers had to

modify the tool to measure all of the foods and beverages available in the assessed environment pooled together, not by single item (Reedy, Krebs-Smith, and Bosire, 2010). In retrospect, the HEI-2010 does not appear to be an appropriate tool to examine the dietary contribution of individual foods or beverages, nor has the tool been validated for use in that manner.

Changes in mean kcal consumption

Mean kcal consumption from vended items decreased between 2003 and 2012. Although manufacturers made formulation changes to their snack products in order to improve nutrition profiles through the use of different types and amounts of fats and oils, reductions in sodium, and the incorporation of more whole grains, it appeared that the greatest change to vending items resulted from a decrease in mean kcals (Figure 4.1, page 39), most notably because water consumption became more prevalent. Decreased access likely played a role as well, and it is unlikely that less energy dense food offerings played a large part in reducing the total mean kcals as HEI-2010 scores did not change drastically among NHANES cycles.

The observation that zero kcals beverages were consumed in greater proportions from vending machines with each NHANES cycle, combined with the problems encountered from the individually derived HEI-2010 scores placing a low value on their results prompted a third ANOVA using kcals as a dependent variable instead of the HEI-2010 score. Since sugary beverages and snack foods had made up such a large proportion of the vended items consumed by children in 2003-2004, their gradual reduction and replacement with non-caloric waters consequentially reduced the mean energy value for each NHANES cycle.

Research Question Two Discussion

The null hypothesis that there was no relation to explain or predict mean HEI-2010 scores among the demographic variables of gender, age group or race/ethnicity among school-aged

children between the age of 6-19 years that used vending machines was not rejected since the variability in the multiple regression model was not explained by any of these predictors.

Demographic data

Raw data shown side by side with weighted data on Table 4.5, page 41, showed that 73% of the non-white children as compared to 27% of the white children reported using vending machines on day 1 of their dietary intake interview during the 2003-2012 NHANES cycles. Although this is disproportionately high, it is important to understand that specific populations were oversampled to ensure more accurate estimates related to health conditions of interest. For example, during the period from 2007-2010, certain ethnic and racial groups over the age of 80 years and those with an income less than 130% of the federal poverty rate were oversampled, as well as Hispanics that were not Mexican (Mirel et al., 2013). When the NHANES sample for this study is weighted, 48% of the vending machine users are non-white and 52% are white. Children that consumed items from vending machines more often came from the older age group of 12-19 years which tend to represent children in middle or high school, often referred to as secondary school. This is consistent with studies including different age groups as they show that older children and those in secondary school have higher exposure to vending machines than younger children or elementary school students (Park et al., 2003; Terry-McElrath et al., 2014; O'Hara & Haynes-Maslow, 2015). Gender was distributed fairly equally, while race/ethnicity varied widely among the different NHANES cycles.

Use of demographic data to predict HEI-2010 scores

The literature review cited the existence of disparities in the use of vending machines due to race/ethnicity (Thompson et al., 2010; Wiecha et al., 2006), among other non-demographic characteristics having to do with type or location of school (Nanney et al., 2013; Adachi-Mejia,

2013). Thus, research question two used a multiple regression analysis to determine if gender, age group, or race/ethnicity had a linear relationship with HEI-2010 scores and could be used to predict dietary quality. Although a great deal of variability existed in the regression model, it was not explained by the three independent variables which accounted for less than 1% of the model's variability. Gender has been shown to make a difference in the diet quality of adults, and females tend to score higher in adherence to the dietary guidelines recommendations than males (Lutz et al., 2013), however gender did not make a difference in this group of children.

Overall dietary quality did not appear to be affected by demographic variables and may be due to other factors not examined in this study. This finding may be an indication that changes to the food environment may help blur the distinction between higher and lower dietary quality scores among children of different genders, races/ethnicities, or age groups by mitigating disparities related to healthy food environment. Comparably, disparities in weight status among students who received subsidized school meals and students who did not were greatly reduced in states with strict nutrition standards (Taber et al., 2013). Thus to not be able to predict HEI-2010 scores using demographic variables could be viewed as a positive effect of school wellness policies and child nutrition program regulations.

Research Question Three Discussion

The null hypothesis that there was no difference in total diet quality (mean HEI scores) between vending machine users and non-users age 6-19 years was not rejected when mean scores were compared between the 2003-2006 and 2007-2012 NHANES cycles. Small sample sizes for vending machine users required aggregating NHANES cycles, so the original comparison among the 5 individual NHANES cycles was not possible. When the entire NHANES cycle period from

2003-2012 was aggregated, there was a significant difference between mean HEI-2010 scores of vending machine users and non-users.

Less than 3% of the 13,184 child participants, or 456 children, reported eating or drinking foods and/or beverages from vending machines in the 2003-2012 NHANES. When examining demographic data weighted to represent US census population figures, this percentage increased slightly to represent nearly 4% of the national population age 6-19 years. Of note is that 456 children consumed 638 vended items, an average of 1.4 vended items per consumer, because many children consumed more than one item from a vending machine. Drewnoski and Rehm determined that less than 1% of the energy in the average American diet came from vending machines (2013a), and as such would seem an inconsequential source of kcals or nutrients for most people in the United States. However, the average energy content of vended foods in the 2003-2012 NHANES sample was 158 kcals, and multiplied by 1.4 becomes 221 mostly empty kcals that contribute little nutritional value to the overall diet.

Difference in HEI-2010 scores between vending machine users and non-users

Question three inquired whether a difference existed in HEI-2010 scores over time between children who used vending machines and children who did not. Both groups reported diets that resulted in higher HEI-2010 scores between the comparison periods of 2003-2006 and 2007-2012, with non-user HEI-2010 scores experiencing a gain of 4.92 points and vending machine users showing an improvement of 3.88 points. Despite this difference, the 95% confidence intervals between mean HEI-2010 scores for users and non-users overlapped, indicating they were not significantly different from each other for those comparison periods.

A problem with the vending machine user data was that it consisted of a small sample making it impossible to properly calculate the HEI-2010 scores using the population ratio

method. To overcome this problem, the sample size was increased by combining NHANES cycles instead of comparing them individually as originally intended. The two cycles from 2003-2006 were combined along with the three cycles from 2007-2012 (Figure 5.4). These years were selected for comparison periods as policy changes in federal child nutrition programs did not require the implementation of school wellness policies until after the 2005-2006 school year. Thus, school vending machine offerings were unlikely to be noticeably different in nutrient quality until the policy implementation incited their change.

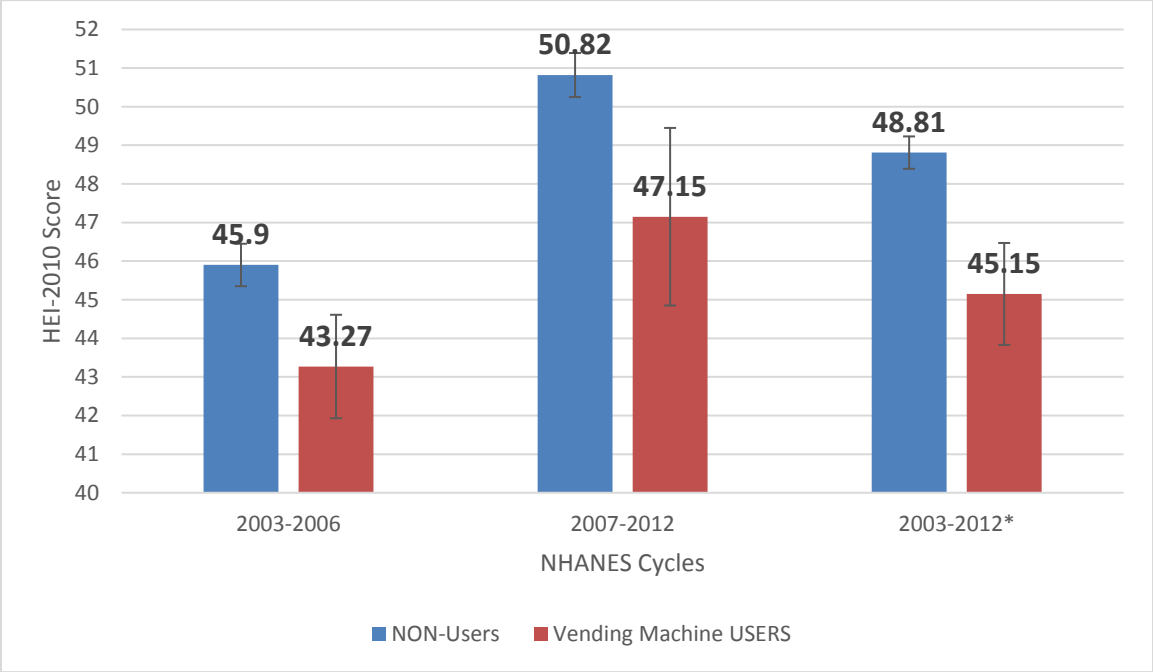

Figure 5.4. HEI-2010 scores for children, age 6-19 years, 2003-2012 NHANES demographic and day 1 total nutrient intakes files. HEI-2010 score calculated using the population ratio method.

While mean HEI-2010 scores between vending machine users and non-users were not statistically different, vending machine user scores were consistently lower than non-users. The larger standard errors and confidence intervals for vending machine users increased the probability of a type I error, and larger sample sizes could help reduce this problem. Both of these observations prompted a comparison of the HEI-2010 scores for users and non-users over

the entire NHANES period between 2003 and 2012. The increase in vending machine user sample size helped decrease variability and reduce the standard error, yielding smaller confidence intervals and improving the overall accuracy of the estimate. The tighter confidence intervals were such that when the means were compared between users and non-users for the entire period between 2003 and 2012, the difference of 3.66 points was significant.

Differences in specific dietary components and kcals

A visual inspection of Table 4.9 on page 45 showing the individual HEI-2010 dietary components provides specific clues as to why children who used vending machine had a significantly lower HEI-2010 score than children who did not use vending machines. Firstly, they consumed an average of 233 kcals more than their counterparts. As stated previously, the average amount of energy consumed from vending machines per user was 221 kcals, so it is plausible that the higher mean kcals is related to the use of vending machines. This could have also been the reason that the empty calories HEI-2010 dietary component score was significantly lower in vending machine users. Vending machines have consistently been sources of low nutrient energy dense foods, as documented in the literature (Phillips et al., 2010; Rovner et al., 2011; Pasch et al., 2011), hence children's diets are almost certain to be negatively impacted by most foods and beverages dispensed out of vending machines.

Secondly, the total fruit and the whole fruit dietary components were significantly lower in the vending machine users' scores, and this is consistent with findings by Kubik at al. that fruit intake was negatively associated with vending machine use in teens (2003). Most of the fruit scores for vended items in this study came from processed fruits with longer shelf lives, not whole fruits or vegetables as they are perishable items. One-hundred percent fruit juice in 8 oz. portions for elementary schools and 12 oz. portions for secondary schools is permitted by the

USDA's Smart Snacks regulation, and is often included in meals and snacks served as part of the federal child nutrition program both during and after school (USDA, 2016b). Despite being considered a "healthy" beverage, juice typically does not contain all of the beneficial nutrients found in its whole counterparts such as fiber, and it is a source of concentrated sugar and kcals which are easily consumed, quickly impact blood sugar levels, and are detrimental to oral health. As such, the American Academy of Pediatrics has recommended limiting 100% juice intake to no more than half of the overall fruit intake recommendation – for children 7-18 years of age that is no more than 8-12 ounces per day (2017).

The sodium dietary component was significantly higher in children who used vending machines than in children who did not, indicating a more favorable sodium to kcals ratio. This is most likely due to the higher amount of mean kcals consumed since the HEI-2010 tool uses density ratios based on total kcal intake. But it could also be a reflection of the commitment that snack food manufacturers have made to lower sodium in salty snacks often found in vending machines. For example, Frito Lay lowered the sodium in their flavored chips by an average of 25% (Frito-Lay, 2017). This effort by the snack food industry is an important one as it positions its snack foods as a mainstay in the school food environment by allowing their snacks to meet Smart Snack standards for sodium, currently set at $\leq$ 200 mg per snack item (USDA, 2016b).

Discussion Summary

In summary, though vended foods and beverages are only consumed by about 4% of the population between the age of 6 - 19 years on any given day, their consumption is associated with a significantly lower diet quality as measured by the HEI-2010. The consumption of these foods decreased substantially between 2003 and 2012, during a time when access to vending machines in the school food environment decreased according to other studies. This decrease

coincided with the implementation of school wellness policies that were required by the Healthy Hunger Free Kids Act legislation for federal child nutrition programs. Total kcals consumed from vending machines also decreased significantly, most likely due to increased water consumption, as water replaced sugary beverages due to policy requirements and industry cooperation and commitment to reduce kcals shipped to schools. Child vending consumers overwhelmingly belonged to the secondary school-age group between 12-19 years, and had a near equal representation of both genders as well as white and non-white children.

Implications

This study set out to reveal the effects of a national food policy on food environment and population health risk factors by asking three research questions having to do with diet and food environment. The most important findings include the following:

- vended food and beverage consumption in children decreased by 48% between 2003 and 2012
- vended water became a larger proportion of vended items, experiencing a 1.5 fold increase between 2009 and 2012
- mean kcal consumption from vended items decreased by 57% between 2003 and 2012
- gender, race/ethnicity, and age group did not predict dietary quality as measured by HEI-2010 scores among vending machine users
- HEI-2010 scores improved across the NHANES cycles for all children, and
- children who used vending machines had significantly lower HEI-2010 scores than children who did not use them.

These findings should help show that national food policy can effectively be used to shape food environment and population level health behaviors such as diet. Though one cannot directly attribute the change in vending consumption to federal food policy, a reasonable assumption may be made that the two are related, given the present and supporting research consistently demonstrating that policy has been used successfully to decrease access to vending machines in schools, among other health-promoting changes. The effects of policy on the food environment are easy to measure with physical inventories or assessments at a local level, but these methods are resource intensive and the food environment so vast, that measurement of food environment at the national level requires the use of creative alternative methods.

The use of the HEI-2010 tool to measure the dietary quality of children who consume foods out of vending machines provides an indirect method of assessing the impact of food policy on dietary behavior. Changes in population diet over time should be detectable using national food consumption data, and paired with related research findings and statistics may help assess policy effectiveness. A successful food policy or intervention should be able to show an impact on dietary, and eventually population health, however long range effects on health may not be seen for years or even decades.

Federal child nutrition program regulations are the implementing rules of federal legislation and have a wide reach and potential to mold food environments into healthier ones, especially in our nation's schools where children spend a good third of their day. These policies affect the neediest children the most, but the HHFKA expanded that reach to the entire student body by mandating changes in the availability and nutrient content of all foods and beverages offered in all school food venues during the entire school day. The HHFKA illustrates an intervention designed to influence population health by working on the first two levels at the

base of the Health Impact Pyramid: socioeconomic factors such as access to food, and changing the context to make the healthy choice the easy choice.

Food and beverage manufacturers also responded to policy by making favorable changes to the nutrient profile of their products or by proactively making commitments to self-regulate. Whether those changes were spurred by updated consumer norms, government health recommendations, industry integrity, program regulations, or national food policy, the result has been improved dietary intake, and the end result may be improved population health. It is imperative to give policy a chance to manifest positive results when those improvements are ones that take a lot of time and are multi-faceted. Such is the case with the HHFKA which seeks to "*reduce childhood obesity and improve the diets of children*". With continued implementation of the current nutrition guidelines, one may expect to see changes in childhood obesity levels which take a long time to become evident at the population level. This study shows however, that dietary quality has improved among children over the years, and reinforces the importance of policy and industry cooperation to help make positive changes to the food environment.

Limitations

This research is subject to limitations related to recall bias, affecting the quality of food recall data by adding the potential to inaccurately report food consumption due to the inability to remember all foods and beverages consumed. NHANES is a cross-sectional study, and only one day of dietary interviews was used for this study, providing only a single point of reference which may not be reflective of an individual's usual food intake. To minimize the effect of recall bias, NHANES employs a standardized dietary interview technique known as the Automated Multiple-Pass Method. Additionally, the SAS software code provided by the NCI to calculate the HEI-2010 score using the population ratio method, takes into account the complex survey design

of NHANES to help improve the tool's ability to provide nationally representative estimates of dietary quality.

The HEI-2010 tool was used to measure dietary quality at the individual vending item level – a method not validated nor recommended by any of the prior research. Although the mean kcals and frequency data was useful, the value of the HEI-2010 scores themselves may be debatable. This method was only used for research question one, and no two mean HEI-2010 scores were significantly different from each other in the ANOVA testing so the findings may err on the conservative side. But because research is a way to convey methods that often result from trial and error, it was deemed important to share the method and results with all of their limitations rather than omit the question altogether.

Water consumption was recommended in the 2010 guidelines (US DHHS & USDA, 2010), however water was not included as a dietary component nor considered in the algorithm for the HEI-2010 tool. This is a limitation of the HEI-2010 tool's application for this study as water was increasingly consumed by the children who participated in NHANES. Since consumption of water is encouraged as a strategy to keep consumption of empty kcals within individual kcal needs, it would be beneficial to find a way to acknowledge its consumption as part of the HEI score in the future. The release of an updated tool designed to align with the recently updated 2015-2020 US Dietary Guidelines is expected soon, although it is not known if water consumption will be accounted for in the updated tool.

Conclusion

The purpose of this study was to explore how food and/or beverages obtained from vending machines impact dietary quality among the NHANES subpopulation of vending machine users. It showed that kcal consumption has decreased and diet quality has modestly

improved over the years among children who use vending machines, though vending machine use is negatively associated with dietary quality among children. This research indirectly supports the affirmation that national policy to improve dietary intake in children through modification of the food environment has been successful, and its author recommends that current school food nutrition regulations with respect to nutrition guidelines continue so improved dietary behaviors and health may be seen in the next generation of children.

Appendix 1: Data Required to Compute Healthy Eating Index (HEI) Scores

Data Required to Compute Healthy Eating Index (HEI) Scores

Data Source	File Name(s)	Format	Estimated Size
CDC NCHS NHANES 2011-2012	Demographic Variables & Sample Weights	SAS	3.6 MB
	Dietary Interview, Individual Foods, Day 1		82 MB
	Dietary Interview, Total Nutrient Intakes, Day 1		11.8 MB
CDC NCHS NHANES 2009-2010	Demographic Variables & Sample Weights	SAS	3.5 MB
	Dietary Interview, Individual Foods, Day 1		97.9 MB
	Dietary Interview, Total Nutrient Intakes, Day 1		13 MB
CDC NCHS NHANES 2007-2008	Demographic Variables & Sample Weights	SAS	3.3 MB
	Dietary Interview, Individual Foods, Day 1		94.5 MB
	Dietary Interview, Total Nutrient Intakes, Day 1		12.2 MB
CDC NCHS NHANES 2005-2006	Demographic Variables & Sample Weights	SAS	3.4 MB
	Dietary Interview, Individual Foods, Day 1		93.1 MB
	Dietary Interview, Total Nutrient Intakes, Day 1		12.2 MB
CDC NCHS NHANES 2003-2004	Demographic Variables & Sample Weights	SAS	3.4 MB
	Dietary Interview, Individual Foods, Day 1		82.1 MB
	Dietary Interview, Total Nutrient Intakes, Day 1		11.8 MB
USDA ARS FPED 2011-2012	Food Patterns equivalents for foods in the WWEIA, NHANES 2011-12 Day 1	SAS	
USDA ARS FPED 2009-2010	Food Patterns equivalents for foods in the WWEIA, NHANES 2009-10 Day 1	SAS	
USDA ARS FPED 2007-2008	Food Patterns equivalents for foods in the WWEIA, NHANES 2007-08 Day 1	SAS	
USDA ARS FPED 2005-2006	Food Patterns equivalents for foods in the WWEIA, NHANES 2005-06 Day 1	SAS	
USDA ARS MPED 2.0	MyPyramid equivalents for foods in the WWEIA, NHANES 2003-04	SAS	67 MB

Appendix 2: UNLV Biomedical IRB – Administrative Review

UNLV

UNLV Biomedical IRB - Administrative Review
Notice of Excluded Activity

DATE:	November 7, 2016
TO:	Timothy Bungum, DrPH
FROM:	UNLV Biomedical IRB
PROTOCOL TITLE:	[978883-1] Are vending machine selections healthier? Trends in dietary quality of vending machine food and beverage selections among NHANES participants aged 6-19 years.
SUBMISSION TYPE:	New Project
ACTION:	EXCLUDED - NOT HUMAN SUBJECTS RESEARCH
REVIEW DATE:	November 7, 2016
REVIEW TYPE:	Administrative Review

Thank you for your submission of New Project materials for this protocol. This memorandum is notification that the protocol referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46.

The UNLV Biomedical IRB has determined this protocol does not meet the definition of human subjects research under the purview of the IRB according to federal regulations. It is not in need of further review or approval by the IRB.

We will retain a copy of this correspondence with our records.

Any changes to the excluded activity may cause this protocol to require a different level of IRB review. Should any changes need to be made, please submit a Modification Form.

If you have questions, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 702-895-2794. Please include your protocol title and IRBNet ID in all correspondence.

Office of Research Integrity - Human Subjects
4505 Maryland Parkway . Box 451047 . Las Vegas, Nevada 89154-1047
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Curriculum Vitae

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Education

PhD Candidate, University of Nevada, Las Vegas, 2017.
Major: Public Health, Social & Behavioral Health Concentration
Dissertation Title: Are vending machine selections healthier? Trends in dietary quality of vending machine food & beverage selections among NHANES participants age 6-19 years between 2003-2012.

MS, University of Nevada, Las Vegas, 2008.
Major: Exercise Physiology
Thesis Title: Knowledge of Personal Energy Requirements in College Students

BS, University of Nevada, Las Vegas, 2005.
Major: Nutrition Science
Supporting Areas of Emphasis: Minor in Psychology

Professional Licenses and Certifications

Licensed Dietitian, Nevada Division of Public and Behavioral Health Dietitian Licensing Unit. (May 31, 2013).

Physical Activity in Public Health Specialist Certification, ACSM/National Physical Activity Society. (November 11, 2008).

Registered Dietitian Nutritionist, Commission on Dietetic Registration. (August 4, 2006).

Exercise Physiologist Certification, American College of Sports Medicine. (November 10, 2005).

Honors and Awards

Outstanding Dietitian of the Year, Nevada Dietetic Association. (2015).

Jessie C. Obert Memorial Scholarship, Academy of Nutrition and Dietetics Foundation. (2013).

Emerging Dietetics Leader Award, Nevada Dietetic Association. (2012).

Outstanding Dietetic Intern of the Year, Nevada Dietetic Association. (2006).

Work Experience

Military

Aerospace Ground Equipment Mechanic / SSGT (E5), United States Air Force. (January 7, 1985 - January 6, 1995).

Professional

Group Fitness Instructor, Clark County Parks & Recreation. (January 2004 - Present).

Health Educator II, Southern Nevada Health District. (November 2008 - March 31, 2016).

Nutrition Education Contractor, Southern Nevada Health District. (January 2008 – October 2008).

Nutrition Educator, Family to Family Connection ISD#13. (June 2005 – December 2005).

Nutrition Education Facilitator, Health Plan of Nevada, Health, Education & Wellness Division. (May 2005 – March 2006).

Teaching Experience

NUTR 121 Part Time Instructor, University of Nevada, Las Vegas. (August 2006 - May 2010).

Oral Presentations

Buffington, A. M., Meacham, M., Reichert, A., National CACFP Sponsors Association Conference, "Improving Community Health through Policy, Systems and Environmental Change in Southern Nevada," Child, Flamingo Las Vegas, Las Vegas, NV. (April 22, 2015).

Buffington, A. M., Go Red Por Tu Corazon Luncheon, "El Trio Que Rompe Corazones," American Heart Association, Aliante Casino and Hotel, Las Vegas, NV. (February 28, 2015).

Buffington, A. M., Meacham, M., Ahlo, M., NRPS Annual Conference, "Public Health Partnerships That Enhance Current Programming," Nevada Recreation & Park Society, Whitney Ranch Recreation Center, Las Vegas, NV. (April 16, 2014).

Buffington, A. M., Earney, R., WIC Staff Professional Development, "Meal Planning Tools for Diabetes Management," Nevada Health Centers, WIC North Las Vegas, North Las Vegas, NV. (April 11, 2014).

Buffington, A. M., NRPS South Chapter Meeting, "Resolutions to Reality…Get Healthy with the 10 in 10 Challenge," Nevada Recreation & Park Society, Paradise Recreation Center, Las Vegas, NV. (January 29, 2014).

Buffington, A. M., Olivares, L., Food and Nutrition Conference and Expo, "Recruitment and Retention - Lessons from the Field," Academy of Nutrition and Dietetics, George R. Brown Convention Center, Houston, TX. (October 20, 2013).

Buffington, A. M., 4th Annual Salud America! Scientific Summit, "Change-Makers Tell Their Stories," Robert Wood Johnson Foundation & IHPR UT Health Science Center, San Antonio Marriott Riverwalk, San Antonio, TX. (May 16, 2013).

Buffington, A. M., Earney, R., NRPS South Chapter Meeting, "Taking Care of Your Heart," Nevada Recreation & Park Society, Paradise Recreation Center, Las Vegas, NV. (February 28, 2013).

Buffington, A. M., Kessler, L. (Presenter Only), Food and Nutrition Conference and Expo, "Missing: Minorities in the Nutrition Profession, Using Mentoring to Retain Latino Students," Academy of Nutrition and Dietetics, Pennsylvania Convention Center, Philadelphia, PA. (October 9, 2012).

Buffington, A. M., NPHA Annual Conference: Blazing New Trails in Nevada's Public Health, "Lessons from Nevada's First SNAP/EBT project at the Las Vegas Farmers' Markets," Nevada Public Health Association, UNLV, Las Vegas, NV, United States. (October 4, 2012).

Buffington, A. M., NDA Annual Conference, "Locally Grown: Public Health Nutrition at Work in Southern Nevada," Nevada Dietetic Association, UNLV Stan Fulton Bldg., Las Vegas, NV. (April 27, 2012).

Buffington, A. M., Quarterly Chapter Meeting, "The Role of Nutrition in Health Promotion and Disease Prevention," Southern Nevada Chapter NPHA, UNLV BHS, Las Vegas, NV. (March 16, 2012).

Buffington, A. M., Nevada Diabetes Council Professional Education Conference: Fundamentals in Diabetes, "Meal Planning Tools for Diabetes Management," Nevada Diabetes Council, UNCE Clark County, Las Vegas, NV. (February 23, 2012).

Buffington, A. M., Social Justice: Narrowing Nevada's Health Equity Gap, "Making Fruits and Vegetables Fun in the Classroom," Nevada Public Health Association, UNLV Stan Fulton Bldg., Las Vegas, NV, United States. (October 1, 2010).

Poster Presentations

Buffington, A. M. (Presenter & Author), Bungum, N. (Author Only), NPHA Annual Conference, "Farm Fresh Out of the Desert: A Farmers Market SNAP/EBT Expansion Program," Nevada Public Health Association, Springs Preserve, Las Vegas, NV, United States. (September 22, 2016).

Buffington, A. M. (Presenter & Author), Jones, D. (Author Only), Bungum, N. (Author Only), NPHA Annual Conference, "Collaborating with Parks & Recreation to Transform Snack & Beverage Vending Machine Selections," Nevada Public Health Association, UNLV Student Union, Las Vegas, NV, United States. (September 25, 2014).

Buffington, A. M. (Presenter & Author), Udomwattawee, P. (Author Only), Reichert, A. (Author Only), NPHA Annual Conference, "From Paper Tracker to Smart Phone App: Using technology to track sugar sweetened beverage consumption," Nevada Public Health Association, UNLV Student Union, Las Vegas, NV, United States. (September 25, 2014).

Buffington, A. M. (Presenter & Author), Tandy, R., Kruskall, L. (2008). Southwest Chapter ACSM Annual Meeting, "Knowledge of personal energy requirements in college students," Southwest Chapter of the American College of Sports Medicine, San Diego, CA. (October 2008).

Grants

Buffington, Aurora M, "Team Nutrition Grant Sub Award", Sponsored by Nevada Department of Agriculture, Federal, $140524.68. (September 30, 2016 - September 30, 2019).

Buffington, Aurora M (Co-Principal), Lednicky, Susan (Co-Principal), "Pick a Better Snack (Chefs for Kids)", Sponsored by USDA FNS SNAP-Ed, Federal, $226430.00. (October 1, 2016 - September 30, 2017).