FRUIT AND VEGETABLE INTAKE OF YOUTH IN LOW-INCOME COMMUNITIES

by

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Abstract

The objectives of the study were to assess fruit and vegetable intake of 6th to 8th grade youth in low-income areas, assess their food environment, and determine factors that influenced fruit and vegetable consumption.

Sixth to eighth grade youth from two low-income communities in each of the three states of South Dakota, Kansas and Ohio were involved in the study. Fruit and vegetable intake was measured using the National Cancer Institute (NCI) fruit and vegetable screener tool. The food environment was measured using the Nutrition Environment Measures Survey for Restaurants (NEMS-R) and the Nutrition Environment Measures Survey for Stores (NEMS-S) tools. A generalized linear mixed model in PROC GLIMMIX was used to assess possible predictors of fruit and vegetable intake.

Average daily fruit and vegetable consumption for males and females was 3.8 cups (95%CI= 2.4-6.0) and 3.1 cups (95%CI=2.0-4.9) respectively. Grade, gender, ethnicity, community, and state of residence did not influence fruit and vegetable consumption, while fruit and vegetable availability at home influenced intake. Youth had a favorable view of their food environment, contrary to the findings of objective measures.

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To Yeshua, who is the source of wisdom and knowledge, and without whom, this work would not be possible.

Chapter 1- Introduction

Between 2011 and 2012, 8.1% of infants and toddlers were reported to have high weight for recumbent length; 16.9% of youth, and about 35% of adults older than 20 years in the U.S. were obese (Ogden et al., 2014). The obesity epidemic continues to be an issue of Public Health concern in this country. Although obesity is conventionally attributed to various individual causes including genetic, metabolic and behavioral factors, its etiology is closely linked to environmental factors (Boehmer et al., 2007; Hill, 1999). Previously, interventions have primarily focused on individual nutrition education, dietary and behavioral modification, and other individual psychological and social factors. However, research indicates that focus on physiological and social factors has not been effective in mitigating obesity, given that prevalence is still on the increase (Cummins & Macintyre 2006; French et al., 2001; Garner & Wooley, 1991; and Glanz et al., 2005).

The immediate causes of obesity are understood to be excessive energy intake coupled with inadequate physical activity, however the factors that lead to increased energy intake and reduced physical activity are more complex and less understood. According to Glanz et al. (2005), individual-level social parallels of diet and physical activity behaviors inadequately explain obesity. Many who subscribe to this school of thought argue that the food environment has a much bigger role to play in shaping dietary behaviors (and therefore is a significant predictor of obesity) than previously presented

(French et al., 2001; Glanz et al., 2005). Hill & Peter, (1998); Nestle & Jacobson (2000); Diex-Roux (2003); and Hill et al. (2003) have posited that the environment plays a crucial role in obesity development through its promotion of excessive energy intake and reduced physical activity. However, research on the mechanisms by which the food environment exerts influence on obesity, is only in its infancy.

Research shows that disparities across neighborhoods, with regard to access to healthy foods, put certain communities at higher risk for chronic conditions like obesity, than others (Lewis et al., 2005). Numerous research findings have shown a link between ecological factors and other chronic conditions including type 2 diabetes, cardiovascular diseases and some types of cancers (Hill et al., 1998; Lewis et al., 2005; Stokols, 1992). Glanz et al. (2007) posited that social and built environments influence access to affordable healthy food. The food and or nutrition environment is broadly defined as a complex multi-level entity with sub-environments including community, organization, consumer and information nutrition environments (Glanz et al., 2005; Holstein et al., 2007). According to Glanz et al. (2005), the community and consumer environments have the most significant impact on obesity and overweight. Glanz et al. (2005) and Mckinnon et al. (2009) further describe the food environment as encompassing the home, community, media and information environments, food stores (including grocery stores, supermarkets, farmers markets and food pantries), restaurants (such as fast food and full service restaurants), schools, and worksites. They defined the general community environment as the number, type, location and accessibility of food outlets in an area. It is assessed by using either proximity (distance between food outlet and residence) or density (number of food outlets in a given area of residence) measures of food outlets. Food outlets comprise both restaurants (full service and limited service restaurants) and food stores (grocery stores, supermarkets, convenience stores) (Holstein et al., 2007).

Moorland et al. (2002) delineated the important role played by presence of food stores and supermarkets in rural and low-income communities. The availability of food stores/supermarkets with healthy food options (including fruits and vegetables) has been shown to be an important determinant of access to healthy foods and consequently healthy eating patterns among residents of low-income communities. Morland et al. (2002) and Zenk et al. (2005) have documented racial and ethnic disparities in access to food stores and supermarkets, which revealed that African Americans' consumption of fruits and vegetables was higher for those in close proximity to supermarkets and food stores. Availability of one supermarket was associated with 32% increase in fruit and vegetable consumption among African Americans. Morland & Filomena's (2007) findings also revealed that predominantly white neighborhoods had greater supermarket access compared to racially mixed areas, and a lower proportion of food stores in predominantly African American neighborhoods carried fresh produce compared to white and racially mixed neighborhoods. In fact, supermarkets were four times more likely to be found in predominantly white neighborhoods than in predominantly black neighborhoods. Furthermore, predominantly black neighborhoods also generally had fewer healthy foods compared to areas with fewer African American residents (Lewis et al., 2011).

Despite compelling evidence for the significant role played by environmental factors in the etiology of obesity and the inadequacies of individual-based intervention approaches, there are limited research studies focused on measuring the food environment. There are still many constraints to measuring the food environment. These include: the psychometric standards to which measurement tools assessing the food environment should be held (such as validity and reliability); how the food environment can be assessed in the broader context of an ecological model; and the choice of the best study designs for assessing the importance of environmental factors (Lytle, 2002). Commonly used data collection methods for assessing the location and description of food outlets include direct observation, and assessment of commercial or organizational business listings**;** and both methods measure food outlet location and density**.**

Measurement of the consumer nutrition environment is focused on food availability, shelf space, placement of items within food outlets, in-store advertising and signage, and price. There are two measures used to capture the components of the community and consumer nutrition environment, these include the Nutrition Environment Measures Survey (NEMS) index and the Checklist of Health Promotion Environments at Worksites (CHEW) (Glanz et al., 2008; Kelly et al., 2011; and Saelens et al., 2007). According to

Glanz et al. (2007) and Saelens et al. (2007), the NEMS tools were developed to assess consumer and community nutrition environments within food outlets (NEMS-S) and restaurants (NEMS-R).

Based on the Socio-Ecological theoretical framework, the objectives of this study were threefold: assess fruit and vegetable intake of youth in the 6^{th} to 8^{th} grade; and objectively assess their physical (food environment) and intrapersonal factors (individual perception of their food environment). The third objective was to examine the impact of intrapersonal factors (gender, ethnicity and grade), interpersonal factors (fruit and vegetable availability at home) and community factors (community of residence; fruit and vegetable availability at school and at the store) on youth fruit and vegetable intake. The study had two hypotheses. The first was that fruit and vegetable consumption of youth in low-income areas would be lower than USDA recommendations. The second was that grade, gender, ethnicity, community of residence and consumption of unhealthy foods would predict fruit and vegetable intake.

Chapter 2- Literature review

A review of literature was conducted to better understand the impact of community nutrition and consumer nutrition environments on the consumption of healthy foods, in particular, fruits and vegetables. In the review, obesity prevalence and its relationship to fruit and vegetable consumption, the Socio-Ecological Model, objective methods for measuring the community nutrition environment, and the impact of individual perception of environment, on total fruit and vegetable consumption; are addressed.

Overweight and obesity in the U.S

Physiologically, overweight and obesity result from excess energy consumption, which is not matched with appropriate energy expenditure. However, obesity etiology is also linked to complex interactions between genetic, metabolic, behavioral and environmental factors (Hill and Peters, 1998; Poston & Foreyt, 1999). The Socio-Ecological theory of health behavior proposes that physical and social environments influence obesity through their effect on diet and physical activity behaviors. Obesogenic environments common in western countries such as the U.S. promote inactivity and over-eating at a population level (Franklin, 2001; and Swinburn et al., 1999). As a result, in the U.S., 8.4% of infants and toddlers have high weight for recumbent length; 16.9% of youth and 35% of adults are obese (Ogden et al., (2014). Furthermore, Wang and colleagues (2008) reported that overweight and obesity prevalence has increased steadily among US populations groups, however the increase is much higher among minority groups, specifically, black women and Mexican-

American men. They further predict that by 2030, 86.3% of American adults will be overweight or obese, and 51% will be obese.

The consequences of high obesity prevalence in the American population are reflected in the rising healthcare costs, costs incurred to treat chronic conditions such as stroke, cardiovascular diseases, type 2 diabetes, and various forms of cancers among other lifestyle-induced conditions. In fact, Wang and colleagues (2008) reported that overweight and obesity accounted for about 9.1% (78.5 billion US dollars) of total US healthcare expenditures in 1998. They further predicted a rise in health care costs to the tune of 860.7 to 956.9 billion US dollars by 2030, (which would reflect 16-18% of U.S. healthcare costs) hence the need for more potent interventions and policies in place. In addition to health and economic effects, obesity has social and psychological consequences; it is associated with depression, anxiety, eating disorders, negative body image and low self-esteem (Greeneberg et al., 2005; Russel-Mayhew et al., 2012).

Relationship between Fruit and vegetable consumption and obesity

The USDA (2015) dietary guidelines recommend that Americans two years and older follow a balanced diet, with plenty of whole grains, at least 2 servings of fruits and 2.5 servings of vegetables per day; in addition to low intake of saturated fat and cholesterol (Casagrande et al., 2007). A plethora of studies show positive correlations between consumption of fruits and vegetables and lower risk of chronic diseases such as cardiovascular diseases, obesity, stroke, hypertension, type 2 diabetes and certain cancers among others (Bazzano et al., 2002; Bazzano, 2006; and Josiphura et al., 2001). Tohill and colleagues' (2004) reviewed literature revealed that consumption of fruits and vegetables also plays a key role in weight management and prevention of obesity. Shintani and colleagues' (2001) study also explored the effects of a traditional native Hawaiian diet rich in fruits and vegetables, on body weights of overweight Hawaiians. Their findings revealed that over the course of the three-week study period, subjects on the Hawaiian diet had reduced daily energy intake and lost an average weight of 7.8kg. However, despite the reduction in energy intake, subjects reported the traditional Hawaiian diet to be adequately satiating. In the twelve-year follow up to the Nurses' Health cohort study, He et al. (2004) reported an inverse association between intake of fruits and vegetables and risk of overweight and obesity among middle-aged women. They reported a 24% and 28% reduction in obesity risk and risk of gaining weight, respectively, associated with increase in fruit and vegetable consumption. Although data directly relating fruit and vegetable consumption to risk of obesity and long-term weight gain are limited, the Nurses' Health study provides evidence for the need to advocate for more fruits and vegetables consumption as a strategy in combating overweight and obesity.

The Socio-Ecological Model

Ecological models provide frameworks for understanding the multiple and interacting determinants of health behaviors, such as fruit and vegetable consumption. The principal concept of the Ecological Model, according to Sallis and colleagues (2008) is that behavior including health behavior, has multiple levels of influence including:

intrapersonal (biological and psychological), interpersonal (social and cultural), organizational, community, physical environment, and policy. These influences on behaviors interact across the different levels, and therefore multi-level interventions are necessary and more effective in changing behavior. This study sought to examine both the physical environment (food environment) and intra personal factors (perception of the food environment) of youth living in low-income areas. In addition, the study also examined the impact of intrapersonal factors (gender, ethnicity and grade), interpersonal factors (fruit and vegetable availability at home), and community factors (fruit and vegetable availability at school and at the store; and community of residence) on fruit and vegetable intake of youth.

Low-income communities in the US

According to the United States Department of Health and Human Services (HHS), individuals who are financially constrained have higher mortality and morbidity rates compared to the general population; and they are more likely to belong to a minority ethnic group (HHS, 2003). Individuals with limited income and more often minority groups, have a lifelong exposure to excessive environmental and physical stress levels that predispose them to chronic diseases such as obesity, heart disease, type 2 diabetes among others (Cubbin et al., 2001; Deaton & Lubotsky, 2003; Friedrich, 2000; and Veenema, 2001). These disparities in health are also significantly correlated with residential segregation and neighborhood deprivation (Gee & payne-Sturges, 2004). Research also shows that poor and minority neighborhoods tend to be more exposed to unhealthy advertisements for alcohol, tobacco and unhealthy food, in addition to having fewer supermarkets and fewer pharmacies. The few supermarkets and food stores available in these neighborhoods also generally have limited availability of healthy foods, which renders such neighborhoods “food deserts” (Morland et al., 2002 Morrison et al., 2000).

There is lack of consensus on the definition of food deserts and on the appropriate measures required to identify them. As such, various researchers define them differently. For example, according to availability and number of food stores or according to the type and quality of foods they avail to their clients (Walker et al., 2010). Cummins & Macintyre (2002) defined food deserts as “poor urban areas in which residents do not have access to affordable healthy food.” Conversely, Hendrickson and colleagues (2006) defined food deserts as “urban areas with ten or fewer food stores that have more than twenty employees.” One of the theories put forward to explain the formation of food deserts alludes to both the development and closure of stores. That is, growth and expansion of large chain supermarkets and stores, which in turn outcompete and eventually force smaller neighborhood grocery stores to close. As a result, people in these neighborhoods are left with transportation constraints in accessing affordable healthy foods, which are only available at large chain stores or supermarkets. To access large chain stores, low-income individuals are required to have cars or be able to meet public transportation costs (Alwitt & Donley, 1997; Furey et al., 2001; and Guy et al., 2004). There is another theory, which suggests that food deserts resulted from changes in demographics in larger U.S. cities. Bianchi and colleagues (1986) posited that the period between 1970 and 1988 was characterized by increased economic segregation and emigration of the affluent from inner cities to suburban areas. This in turn caused a significant proportion of inner city stores to close (Alwitt & Donley, 1997).

Social and physical environments of low-income individuals influence their diets and their ability to acquire healthy food. Morland and associates (2007) suggested that Low-income individuals that live in food deserts are inadvertently exposed to high-energy dense food from both stores and restaurants within their neighborhoods. Food deserts are also significantly correlated with low fruit and vegetable intake, and consequently obesity (Laraia et al., 2004; Morland et al., 2002; and Pearson et al., 2005). Moreover, individuals that regularly shop at small food stores have also been shown to have a lower consumption of fruits and vegetables and on a less regular basis (Zenk et al., 2005). This is partly attributed to the fact that larger sized food stores, which are usually not available in food deserts, are more likely to stock healthier foods and offer these foods at a lower cost compared to smaller stores. Studies done by Cheadle et al. (1991) and Fisher & Strogatz (1999), confirm the significant relationship between food cost, availability of healthy foods in stores, diet quality, and health status of individuals that live in food deserts.

Ogden and colleagues (2006) reported that the prevalence of obesity is much higher among minority ethnic groups including African Americans and Hispanics, than among white populations. Similarly, Diez-Roux and associates (1999) revealed that obesity related complications such as atherosclerosis, diabetes, and cancer, are also more common among minority low-income populations. Ward and colleagues (2004) in their study examining cancer disparities by race and social economic status, revealed that residents of poorer neighborhoods had higher rates of cancer, coupled with lower five-year survival rates. Moreover, they were also more likely to be either African American, American Indian or Hispanics. Giger and associates (2007) define health disparities as "differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific populations groups in the United States." Previously, health disparities have also been tied to racial categories and variations in genetic composition (Williams, 2002). Giger and colleagues (2007) also reported that health disparities between Caucasian and ethnically and racially diverse and underserved groups, still exist despite various Federal, State and local initiatives geared towards their elimination.

Impact of food environment on consumption of healthy foods in low-income communities

Story and colleagues (2008) define the environment as everything outside the individual in contrast to individual or personal variables. They further postulated that for individuals to make healthy food and lifestyle choices, they require a supportive environment with accessible and affordable wholesome (healthy) foods. Several factors within the home are associated with healthy dietary habits, and these include availability (presence of healthy foods in the home) and accessibility of healthy foods, frequency of family meals, in addition to parental food habits and practices.

Numerous research findings have shown a link between ecological factors and chronic conditions such as type 2 diabetes, cardiovascular diseases and some types of cancers (Hill et al., 1998; Lewis et al., 2005; and Stokols, 1992). According to Glanz et al. (2005), individual-level social parallels of diet and physical activity behaviors inadequately explain obesity. Research also shows that disparities across neighborhoods with regard to access to healthy foods put certain communities at higher risk for chronic conditions than others (Lewis et al., 2005).

Story et al. (2008) defined environmental interventions as strategies that involve altering the physical surroundings, social climate, information availability and organizational systems to promote behavior change. Glanz and associates (2007) further postulate that social and built environments influence access to affordable healthy food. They subdivide the nutrition environment into two: the community nutrition environment (CNE) and the consumer nutrition environment (CONE). The CNE is defined as the number, type, location and accessibility of food outlets including grocery stores. The CONE on the other is what consumers encounter in and around places where they buy food, including availability, cost, and quality of healthy foods. Caspi and colleagues (2012) explored Pechansky & Thomas' (1981) five dimensions of food access, which included availability, accessibility, affordability, accommodation and acceptability; which considerably impact the food environment.

Penchansky & Thomas (1981) defined food availability as adequate supply of healthy food (for example presence of certain types of restaurants and places where produce can be purchased). Accessibility on the other hand denotes the location of the food supply and ease of getting to it. Time required to get to such a location in addition to the distance covered act as measures of accessibility. Alwitt & Donley (1997) showed that the poor usually have to travel longer distances to access the same resources (such as healthy food) as their non-poor counterparts. Moreover, poor residents usually lack transportation to chain stores that have more varied and healthy food options (Coterill & Franklin, 1995). Affordability relates to food prices and individuals' perceptions of worth in relation to cost. Affordability is measured by store audits of specific healthy foods. Acceptability refers to attitudes towards tributes of individuals' local food environment and the extent to which food supply meets personal standards. Garasky et al. (2004) findings revealed that residents of rural and low-income communities perceived their food environment as having a less than adequate number of supermarkets or food stores. In addition, Hendrickson et al. (2006) also revealed that foods within food deserts were of less than adequate quality than those in non-food desert areas. Lastly, accommodation designates how well the local food sources accept and adjust to local residents' needs, for example, food store acceptance of SNAP checks.

Moorland et al. (2002) elucidates the importance of the availability of food stores and supermarkets in rural and low-income communities. The availability of food stores/supermarkets with healthy food options (including fruits and vegetables) has been shown to be an important determining factor of access to healthy foods and consequently healthy eating patterns among residents of low-income communities. Morland et al. (2002) and Zenk et al. (2005) have documented racial and ethnic disparities in access to food stores and supermarkets which revealed that African Americans' consumption of fruits and vegetables was higher for those in close proximity to supermarkets and food stores. Availability of one supermarket was associated with 32% increase in fruit and vegetable consumption among African Americans. Morland & Filomena's (2007) findings also revealed that predominantly white neighborhoods had greater supermarket access compared to racially mixed areas, and a lower proportion of food stores in predominantly African American neighborhoods carried fresh produce compared to white and racially mixed neighborhoods. In fact, supermarkets were four times more likely to be found in predominantly white neighborhoods than in black neighborhoods. Predominantly black neighborhoods also had fewer healthy food options compared to areas with fewer African American residents (Lewis et al., 2005).

Foley & Pollard (1998) and Mackeras (1997) argued that cost is the most significant predictor of dietary choices and thus healthy eating habits are difficult for the poor. This is in tandem with the findings of Morland et al. (2002) which revealed that locations of food stores and other food service places were associated with the wealth and social make-up of the neighborhoods in which they were situated. This may be a more important predictor of healthy eating habits than personal dietary habits or attitudes. Their findings revealed disproportionate distribution of supermarkets in four states (North Carolina, Maryland, Minnesota and Mississippi) with a ratio of supermarkets to residents being 1: 23,582 and 1: 3816 for people in predominantly African American and predominantly white neighborhoods respectively (Morland et al., 2002).

Their findings supported research studies, which revealed disproportionately high rates of morbidity, mortality, and adverse health conditions among racial minority neighborhoods in U.S. states (Cubbin et al., 2001; Deaton & Lubotsky, 2003). These neighborhoods also have increased exposure to unhealthy advertising for tobacco and alcohol and fewer drugs in the few pharmacies and supermarkets available. Block et al. (2004) also points out that predominantly African American neighborhoods had six times more fast food restaurants than predominantly white neighborhoods.

Food Environment Perceptions

To fully appreciate environmental determinants of obesity, both objective neighborhood-level measures (for example on-site in-store audits) and subjective perceptions about the food environment (which influence food purchasing habits and shopping frequency), need to be considered (Gustafson et al., 2011). Perception-based measures are beneficial in detecting variation in availability and quality of healthy food, which may not be possible with more objective measures (Moore et al., 2008).

A cross-sectional study done by Sharkey and associates (2010) revealed that perceptions of community and household food resources were consistently negatively correlated with fruit and vegetable intake, among seniors residing in rural areas. Jilcott et al. (2009) examined low to moderate income midlife women's perceptions of their community food environment, and reported differences in perception of the environment between urban and rural dwelling women. Rural women reported having fewer supermarkets and restaurants, while those living in urban areas reported fewer produce stands. Inglis & Crawford (2008) carried out a cross-sectional study to evaluate the contribution of perceived environmental factors to mediating socioeconomic variations in women's fruit, vegetables and fast food consumption, in Australia. Their findings revealed that socioeconomic variations in diet were contingent on perceptions of food availability, accessibility and affordability, and when perceived environmental variables were controlled for, associations between socioeconomic status and diet were weak and not significant. Interventions targeting reduction of socioeconomic and health disparities should therefore aim at identifying household, neighborhood and community facilitators and barriers to healthy food choices.

Measuring the Food Environment

Measurement tools used for assessing the local food environment need to adhere to psychometric standards in order for researchers and public health specialists to understand the correlation between these environments and health. This is important for developing relevant interventions to improve access and availability of healthy food to the population. Food and nutrition environments comprise all potential determinants of what people eat, and are measured differently from individual factors such as food habits. Measurement of the food environment is a relatively new concept, and as such, research on the various methods of measurement is new and not widely available. According to Glanz et al. (2005) and Mckinnon et al. (2009), the food environment includes the home, community, media and information environments, food stores (including grocery stores, supermarkets farmers' markets and food pantries), restaurants (such as fast food and full service restaurants), schools and worksites. They define food stores and restaurants as places one travels to purchase food; while worksites and schools and schools are places where individuals spend a big chunk of their time and also happen to provide food (in form of vending machines and cafeterias) Lytle (2009) adumbrated the potential constraints to measuring the food environment. These include: the psychometric standards to which measurement tools assessing the food environment should be held (such as validity and reliability); how the food environment can be assessed in the broader context of an ecological model; and the choice of the best study designs for assessing the importance of environmental factors. McKinnon and his colleagues' (2009) review of literature on the tools and methods used to measure the food environment revealed that all the measures could be either categorized as instruments or methodologies. They defined instruments as standardized assessment tools used to assess observed or perceived food environments; and these were in form of checklists (based on pre-determined lists of foods), market baskets (based on pre-determined lists of foods meant to represent total diet), inventory (reporting all foods) or interview/questionnaires (predetermined list of questions pertaining the food environment). The checklist and market basket tools may both be used to collect information on food availability, price and quality. However, the difference lies in the fact that checklists include all indicator foods preselected or predetermined while a market basket represents foods that make an adequate diet (and therefore may include both healthy and unhealthy frequently consumed food options among the population). Therefore, market baskets are usually limited to food stores while checklists may be used in food stores as well as restaurants, schools and worksites. According to Moore & Diez-Roux (2006), local food environments act as independent predictors of individual food choices and diet quality, especially where there's pronounced segregation by income and ethnicity. Kelly et al. (2011) subdivided the food environment into three to include: the community nutrition environment, the consumer nutrition environment and the organizational nutrition environment.

Measuring the community nutrition environment

According to Kelly et al. (2011), the community nutrition environment involves proximity of food outlets to residences, and their concentration in a given area. Commonly used data collection methods used to assess the location and describe food outlets include: direct observation, and assessment of commercial or organizational business listings**.** Both methods measured food outlet location and density**.** Direct observation involves scanning areas by walking through neighborhoods or settings and taking note of identified food outlets.

This method has a higher validity due to its ability to identify smaller stalls, vending machines and even street vendors (most of these would otherwise not be identified or listed as commercial businesses). However, it is time, labor and resource intensive. Assessment of commercial and or business listings involves using data from registered food businesses. Even though this method has low validity (resulting from documentation errors and incomplete information), its more practical due to the ease of access of freely available data (Kelly et al., 2011; Spence et al., 2009).

Measuring the consumer nutrition environment

Measurement of the consumer nutrition environment is focused on food availability, shelf space, placement of items within food outlets, in-store advertising in addition to signage and price. That is, measuring the consumer nutrition environment involves measuring the “4P’s of marketing; price, product, place and promotion. The method primarily used to measure the consumer nutrition environment assesses physical measurements of shelf-space, food availability, accessibility and prominence. The linear length of shelf-space allotted to foodstuffs including “end-of-aisle” baskets and bins is also assessed. In addition, items displayed in baskets/bins, depth and width are measured to reflect what the customer is able to see. The validity of this method is quite high, mostly because standard measuring instruments are used; and the reliability (in form of inter rater reliability and repeatability) was also found to be high. However, with regard to large stores or samples, the method is time intensive (hence reduced practicality).

Components of the consumer nutrition environment are captured by using the Nutrition Environment Measures Study (NEMS) index and the Checklist of Health Promotion Environments for Worksites (CHEW)**.** However, both tools may be modified to collect information from other food outlet settings (Glanz et al., 2008; Kelly et al., 2011; and Saelens et al., 2007).

The Nutrition Environment Measures Survey (NEMS) tools

The NEMS tools are observational measures that evaluate consumer nutrition environments in food outlets mostly stores and restaurants. While the NEMS index collects information on retail environments within communities, the CHEW instrument collects information from worksites (that is, structural features of worksites including availability of healthy food at cafeterias and vending machines). It collects information on fruit, salads, low fat dairy, low fat/sugar snacks, diet drinks, water and juice in addition to information on vending machines and canteens. The reliability (inter-rater reliability) of CHEW as an instrument is high; however, practicality is not as high. The NEMS tool is used to evaluate stores (NEMS-S), restaurants (NEMS-R), vending machines (NEMS-V) and more recently perceived nutrition environment (NEMS-P). The NEMS-S index has a composite score for food stores based on availability, quality and price of healthier options for ten indicator foods which include milk, fruit, vegetables, baked goods, frozen meals, processed meat, beverages, bread, cereal and chips. Two points are awarded to stores for each indicator food for the availability of healthier options (availability score); two points for lower priced healthier options (price score) and up to three points for having more produce of acceptable quality (the quality score).

As a result, the NEMS-S tool has found use as a comparative tool for store types in various geographic areas.

The NEMS-R tool is used to assess nutrition environments at restaurants by evaluating eight types of food indicators namely: healthy main dish choices (low fat, low calorie, healthy main dish options), availability of fruits and vegetables without added sauce, whole grain bread and baked chips, beverages, children's menus, signage and promotions, facilitators and barriers to healthy eating, pricing and accessibility. For menu items without nutritional information, conservative criteria regarding inclusion of high calorie and high fat ingredients are used. The tool evaluates healthy entrees and main dish salads; healthy entrees are defined as less than or equal to 800 calories (which represents two fifth of the FDA food label standard), less than or equal to 30% calories from fat and less than or equal to 10% calories from saturated fat. Main dish salads are defined as healthy if relevant nutritional information was indicated on the menu; or if a low fat or fat free dressing is available. Facilitators of healthy eating include: availability of nutrition information on the menu, labeling of entrees as being healthier, availability of reduced size portions on the menu, allowance for special requests to modify entrees (for example substitution of vegetables for French fries), and availability of a salad bar. Barriers to healthy eating assessed include: encouragement of larger portion sizes through price discounts, the menu encourages over eating for example unlimited refills (excluding beverages), prohibition of special requests and substitutions, promotion of low carbohydrates, and availability of the "all you can eat" or “unlimited” portions option on the menu. Saelens and colleagues (2007) developed the tool and tested its inter-rater and test-retest reliability which was found to be high with most kappa values greater than 0.80 (Franco et al., 2008; Glanz et al., 2008; Kelly et al., 2011; Saelens et al., 2007; and story et al., 2008).

Voss and colleagues (2012) developed the NEMS-V tool to evaluate the vending machine environment, by assessing availability of healthier food and beverage options in vending machines located in schools, business premises and communities. They also developed a website with a tutorial on how to use the tool along with a healthy choices calculator. A completed NEMS-V assessment includes: (1) visual depiction of each vending machine displaying green, yellow or red coded foods and beverages. These are based on the Health and Sustainable Guidelines (HHS) for Federal concessions and vending operations. (2) Provision of certificates for each machine and its location as a whole for example gold awards for machines that have at least 50% of the food or 75% of their beverages in the yellow or green, without any unhealthy advertisements. (3) Generation of report cards for each machine and location with a checklist of action steps needed to make healthier choices. The tool’s developers also rated its inter-rater reliability and inter test-retest reliability, and these were found to be sufficiently high. They anticipated the tool would be beneficial to public health professionals implementing policy and environmental change initiatives. In addition, the authors report that the vending machine project will support a policy calling for state facilities to provide a minimum of less than 30% of foods and beverages in their vending machines as healthy options, based on the NEMS-V criteria, which will be used as a model for other businesses (Voss et al., 2012).

Green & Glanz (2015) developed the NEMS-P tool using a multiphase system measurement development process to comprehensively evaluate the main scopes of perceived food environments including the community nutrition environment, the consumer nutrition environment and the home food environment. Its development involved five steps: (1) the development of a conceptual model and inventory of items; (2) expert review; (3) pilot testing and cognitive interviews; (4) revising the survey; and (5) administration of the revised survey to participants in neighborhoods of high and low social economic status on two occasions in order to evaluate neighborhood differences and test-retest reliability. The final survey tool comprised of 118 items with 53 recommended items for measuring the key constructs of perceived food environments. Supplementary survey items also addressed psychosocial factors, health behaviors, socio-demographic factors, shopping behaviors and eating behaviors. The tool's test-retest reliability for core constructs of perceived nutrition environments was found to be between moderate and good for majority of the measured constructs. The tool was also able to show that "residents of higher socioeconomic status neighborhoods reported higher scores in stores, stronger agreement that healthy options were available in nearby restaurants, and higher scores for accessibility of healthy foods in their homes." Therefore, the tool was able to distinguish between perceptions of nutrition environments between residents of higher socioeconomic status neighborhoods and those living in low socioeconomic status neighborhoods (Green & Glanz, 2015).

Chapter 3- Manuscript

Abstract: Fruit and Vegetable intake of youth in low-income communities

Objectives: Assess fruit and vegetable intake of 6th to 8th grade youth in low-income areas, assess their food environment, and determine factors that influenced their fruit and vegetable consumption.

Design: The design was a cross-sectional study conducted as part of a larger, five-year tristate community–based participatory research (CBPR) project titled "Ignite: Sparking youth to create Healthy communities.

Setting: Two low-income communities in each of the three states of South Dakota, Kansas and Ohio.

Participants: 6th to 8th grade youth.

Variables measured Fruit and vegetable intake, food environment, perception of food environment and factors influencing fruit and vegetable consumption.

Analysis: A generalized linear mixed model in PROC GLIMMIX was used to determine possible predictors of fruit and vegetable intake.

Results: Average daily fruit and vegetable consumption for males and females was 3.8 cups (95%CI= 2.4-6.0) and 3.1 cups (95%CI=2.0-4.9) respectively. Grade, gender, ethnicity, community, and state of residence did not influence fruit and vegetable consumption, while fruit and vegetable availability at home influenced intake. Youth had a favorable view of their food environment, contrary to the findings of objective measures.

Fruit and vegetable intake of adolescents in low-communities

Introduction

Between 2011 and 2012, 8.1% of infants and toddlers were reported to have high weight for recumbent length; 16.9% of youth, and about 35% of adults older than 20 years in the U.S. were obese (Ogden et al., 2014). The obesity epidemic continues to be an issue of public health concern in this country. Although obesity is conventionally attributed to various individual causes including genetic, metabolic and behavioral factors, its etiology is now being linked to environmental factors (Boehmer et al., 2007; and Hill, 1998). Previously, interventions have also mainly focused on individual nutrition education, dietary and behavioral modification, and other individual psychological and social factors. However, research now shows that these have been ineffective in mitigating the obesity epidemic given the prevalence of the epidemic keeps snowballing (Cummins & Macintyre 2006; French et al., 2001; Garner and Wooley, 1991; Glanz et al., 2005).

Many of those opposed to the over-emphasis on individual intervention factors opine that the food environment has a much bigger role to play in shaping dietary behaviors (and therefore is a significant predictor of obesity) than previously shown (French et al., 2001; Glanz et al., 2005). The immediate causes of obesity are understood to be excessive energy intake coupled with inadequate physical activity, however the factors that lead to increased energy intake and reduced physical activity are more complex and less understood. According to Glanz et al. (2005), individual-level social parallels of diet and physical activity behaviors inadequately explain overweight and obesity. Hill & peter, (1998); Diex-Roux (2003); Nestle & Jacobson (2000); and Hill et al., (2003) posited that the environment plays a crucial role in obesity development through its promotion of excessive energy intake and reduced physical activity. Howbeit, research on the mechanisms by which the built environment exerts influence on obesity, is only in its infancy.

Papas et al. (2007) defined the “built environment” as one that incorporates aspects of an individual’s surroundings including those that are man-made or modified. The food and / nutrition environment is defined as a complex multi-level entity with sub environments including community, organization, consumer and information nutrition environments (Glanz et al., 2005; Holsten et al., 2009). According to Glanz et al. (2005), the community and consumer environments have the most significant impact. The general community environment encompasses the number, type, location and accessibility of food outlets in an area. It is assessed by using either proximity (distance between food outlet and residence) or density (number of food outlets in a given area of residence) measures of food outlets. Food outlets comprise of both restaurants (full service and limited service restaurants) and food stores (grocery stores, supermarkets, convenience stores) (Holstein et al., 2007).

Research shows that disparities across neighborhoods, with regard to access to healthy foods put certain communities at higher risk for chronic conditions than others (Lewis et al., 2005). Numerous research findings have shown a link between ecological factors and chronic conditions such as type 2 diabetes, cardiovascular diseases and some types of cancers (Hill et al., 1998; Stokols, 1992; and Lewis et al., 2005). Story et al. (2008) defined environmental interventions as strategies that involve altering the physical surroundings, social climate, information availability and organizational systems to promote behavior change. Glanz et al. (2007) further posited that social and built environments influenced access to affordable healthy food. Glanz et al. (2005) and Mckinnon et al. (2009) described the food environment as including the home, community, media and information environments, food stores (including grocery stores, supermarkets farmers markets and food pantries), restaurants (such as fast food and full service restaurants), schools and worksites. They defined food stores and restaurants as places one travels to purchase food; while worksites and schools and schools are places where individuals spend a big chunk of their time and also happen to provide food (in form of vending machines and cafeterias).

Moorland et al. (2002) delineated the important role played by presence of food stores and supermarkets in rural communities. The availability of food stores/supermarkets with healthy food options (including fruits and vegetables) has been shown to be an important determining factor of access to healthy foods and consequently healthy eating patterns among residents of rural communities. Zenk et al. (2005) and Morland et al., (2002) have documented racial and ethnic disparities in access to food stores and supermarkets which revealed that African Americans' consumption of fruits and vegetables was higher for those in close proximity to supermarkets and food stores. Availability of one supermarket was associated with 32% increase in fruit and vegetable consumption among African Americans. Morland & Filomena's (2007) findings also revealed that predominantly white neighborhoods had greater supermarket access compared to racially mixed areas, and a lower proportion of food stores in predominantly African American neighborhoods carried fresh produce compared to white and racially mixed neighborhoods. In fact, supermarkets were four times more likely to be found in predominantly white neighborhoods than in predominantly black neighborhoods. Predominantly black neighborhoods also had fewer healthy food options compared to areas with fewer African American residents (Lewis et al., 2011).

Despite compelling evidence for the significant role played by environmental factors in the etiology of obesity and the inadequacies of individual intervention approaches, there's not a whole lot of research studies focused on measuring the environment. There are still many constraints to measuring the food environment. These include: the psychometric standards to which measurement tools assessing the food environment should be held (such as validity and reliability); how the food environment can be assessed in the broader context of an ecological model; and the choice of the best study designs for assessing the importance of environmental factors (Lytle, 2002). McKinnon and his colleagues (2009) review of literature on the tools and methods used to measure the food environment concluded that all the measures were categorized as either instruments or methodologies. Commonly used data collection methods used to assess the location and describe food outlets included: direct observation; and assessment of commercial or organizational business listings**.** Both methods measured food outlet location and density**.** Direct observation involved scanning areas by walking through neighborhoods or settings and taking note of identified food outlets (Kelly et al., 2011).

Measurement of the consumer nutrition environment is focused on food availability, shelf space, placement of items within food outlets, in-store advertising and signage and price. In other words, measuring the consumer nutrition environment involves measuring the "4P's of marketing (price, product, place and promotion). There are two measures used to capture the components of the community and consumer nutrition environment, these include the Nutrition Environment Measures Survey (NEMS) index and the Checklist of Health Promotion Environments for Worksites (CHEW). However, either of the tools may be modified to collect information from other food outlet settings (Glanz et al., 2008; Kelly et al., 2011; and Saelens et al., 2007).

According to Glanz et al. (2007) and Saelens et al. (2007), the NEMS tools were developed to assess consumer and community nutrition environments within food outlets (NEMS-S) and restaurants (NEMS-R). Sturm & Datar (2005) report that elementary school children's increase in BMI was more positively related to price estimates of fruits and vegetables than to overall restaurant or restaurant type. Based on the Socio-Ecological Model theoretical framework, the objectives of the study included: assessment of fruit and vegetable intake of youth between the 6th and 8th grade, assessment of their physical environment (food environment) and intrapersonal factors (perception of the food environment). In addition, the study also sought to examine the impact of intrapersonal factors (gender, ethnicity and grade), interpersonal factors (fruit and vegetable availability at home), and community factors (community of residence; fruit and vegetable availability at school and at the store) on youth fruit and vegetable intake. The first hypothesis was fruit and vegetable intakes of youth living in low-income areas would be lower than the amounts recommended by the USDA for their respective age groups and gender. The second hypothesis was that intrapersonal factors (gender, ethnicity and grade), interpersonal factors (fruit and vegetable availability at home) and community factors (community of residence; fruit and vegetable availability at school and at the store) would all predict youth fruit and vegetable intake.

Methodology

Study Design

The design was a cross-sectional study conducted as part of a larger, five-year tristate Community–Based Participatory Research (CBPR) project titled "Ignite: Sparking youth to create healthy communities." Ignite targets both urban and rural communities in South Dakota (SD), Kansas (KS) and Ohio (OH); however, this study was limited to two low-income communities in each of the three states. Institutional Review Board (IRB) approval and subject consent were sought and obtained in compliance with the policy statements of the Human Subjects Committees at South Dakota State, Ohio State and Kansas State Universities.

Communities and Participants

Study communities were selected based on the following criteria: researchers from the three states developed and distributed a request for proposals via the Cooperative Extension network within each state; those interested in participating in the project had to submit an application for funding to their corresponding state's project researcher. To be considered, communities had to meet "low income" and "minority" definitions, which had been established by the research team (Kidd et al., 2016). Research personnel randomly selected the communities, and consenting sixth to eighth grade youth were recruited from their respective schools within each community in each state, as study participants.

Nutrition Assessment

Research personnel that received training prior to conducting the assessment did nutrition assessment. Fruit and vegetable intakes were measured using the ten-item National Cancer Institute (NCI) all-day fruit and vegetable screener. The NCI screener uses ten questions to measure both frequency and quantity estimates of fruit and vegetables consumed per day. Questions pertain to consumption of: 100% fruit juice, fruit consumption, lettuce salad, Fried potatoes, other white potatoes, dried beans, other vegetables (including raw, cooked and frozen), tomato sauce, vegetable soups and mixtures that include vegetables. Scoring algorithms were utilized to generate estimates for daily fruit and vegetable consumption. Consumption of unhealthy foods was measured using questions 11 and 13 (appendix 1), which probed about consumption of sugary beverages and “junk” food (Kidd et al., 2016).

Environmental assessment

The Nutrition environment was assessed using the Nutrition Environment Measures Survey for Restaurants (NEMS-R) and the Nutrition Environment Survey for Stores (NEMS-S) tools. Glanz et al. (2007) and Saelens et al. (2007) designed both tools. The NEMS-S tool was developed to audit the quality (of fresh produce like fruits and vegetables), availability and pricing of different foods in the community environment. Total point assignments are based on selections of canned, frozen and fresh fruits and vegetables, whole wheat bread, low fat milk, lean beef and healthier snacks, beverages, baked goods and frozen meal options. Twenty-three grocery and convenience stores in the three states were audited using the validated NEMS-S tool. Standard NEMS-S scoring methodology was applied, and stores with the highest availability and quality of healthier options scored the highest points (with the highest score being 58). Stores that did not meet NEMS-S parameters were excluded from the study.

The NEMS-R tool evaluates availability of healthy food items in various menu categories which include entrees, main -dish salads, side dishes (such as fruits, non-fried vegetables) and beverages. Healthy entrees are defined as less than 800 calories with less than 30% calories from fat and less than 10% calories from saturated fat. The tool is used to audit different types of restaurants including sit down restaurants, fast-casual restaurants and fast food restaurants. It is also able to identify barriers to healthy eating (such as super-sized items, all-you-can-eat promotions), facilitators to healthy eating (such as healthy entrée options, offering reduced portions), pricing (if for example healthy foods are pricier than their unhealthy counterparts) and marketing or promotion of healthy or unhealthy foods. Items rated to determine a total score of each restaurant included number of main-dishes and salads, number of healthy options, salad dressing, fruit and non-fried vegetables, facilitators and barriers, differentials in pricing and availability of kids' menus. Forty-nine restaurants from the three states were identified for audit using the NEMS-R tool, and thirty-one were assessed. Among these were 10, 6 and 15 sit down, fast food and other restaurants, respectively. Restaurants that were not open to the public and those that catered to patrons older than twenty-one, were excluded. Restaurants were scored against a modified rubric with the highest score being 87. Prior to this baseline survey, particular communities in each state had been designated as control and intervention communities, with the latter being the community that would actually receive nutrition intervention in the future. Therefore, restaurants and stores surveyed were from both the control and intervention communities within each state.

Assessment of youth perception of their environment

The self-efficacy of youth with regard to fruit and vegetable consumption was assessed with three questions adapted from previously validated tools (Neumark-Sztainer et al., 2002; Neumark-Sztainer et al., 2002). Prior to use in the study, the questions in the tool were cognitively pre-tested for content, organization, and comprehension with non-study participant youth in the same age and grade-range (6^{th} to 8^{th} grade). After a few modifications, the final questions were administered to consenting. The question on perception of self -efficacy was: if you wanted to, how sure are you that you could eat healthy foods when you are 1) hungry after school; 2) with your friends; 3) at a fast food restaurant; 4) eating dinner with my family. Possible responses included “do not agree,” “slightly agree,” “somewhat agree,” “moderately agree,” and “strongly agree.” (Neumark-Sztainer et al., 2002; Neumark-Sztainer et al., 2002; and Neumark-Sztainer et al., 2003). Youth perception of their food environment was assessed by probing about how often the following six questions were true: 1) fruits and vegetables are available in my home. 2) Healthy foods are available in my home. 3) Fruits and vegetables are available in my school. 4) Healthy foods are available in my school. 5) Healthy foods are available at local grocery stores in my community. 6) There are low cost healthy foods available in my community. Possible responses were “never,” “rarely,” “sometimes,” “often,” or “always,” with 1 corresponding to “never” and 5 corresponding to “always.”

Statistical Analysis

Scoring algorithms from the National Cancer Institute website were utilized to generate estimates for daily fruit and vegetable consumption. Each reported frequency was converted to a daily average by standardizing the midpoint of each frequency category to the number of times consumed per day. Due to the large number of outliers brought on by respondents' overestimation of their daily 100% juice intake, total fruit and vegetable consumption estimates were calculated with the exclusion of juice, as well. PROC FREQ and PROC TABULATE (SAS version 9.4; SAS institute Inc., 2013) were utilized in preliminary investigation to generate means and confidence intervals. An analysis was used to assess the impact of grade, gender and race; and fruit and vegetable availability (at home, school and community) on the consumption of fruits and vegetables. The treatment structure was a three-way factorial with grade (3 levels for 6th, 7th and 8th grade), by gender (2 levels for male and female) by ethnicity (5 levels for American Indian, white, black, Hispanic and other). Blocking factors of state and community were collapsed together to form a new variable of CommunityAndState (six levels with two communities per state) due to issues of non-estimable covariance parameters. Grade was the whole plot factor with an experimental unit of class (grade* CommunityAndstate). The whole plot experimental unit of class was a blocking factor for the split plot factors of gender and ethnicity with an experimental unit on the level of observation (individuals nested within state, community, grade, gender and ethnicity). Preliminary analyses using Proc Mixed assumed normality of the residuals; however, clear rightward skewness of the residuals indicated a necessary transformation to better fit the data. A generalized linear mixed model with a lognormal distribution and identity link function was specified with the aforementioned design and treatment structure using the GLIMMIX procedure of SAS. F-tests were calculated for the main effects (grade, gender, ethnicity and state and community) and interactions. A significance level of $\alpha = 0.05$ was used for all tests. Additional comparisons amongst communities within states were performed utilizing Best Linear Unbiased Predictors (BLUPs) and a Bonferroni adjustment for multiple comparisons. Statistical tests were based on lognormal distribution and later back transformed to original scale for presentation. Further investigation was done to assess the impacts of additional covariates of FruitAndVegetable availability (Home, School, and Community; with 3 levels for not often, often, and always) and the consumption of Sugary Beverages and Junk Food (4 levels for never, rarely, often, and regularly). A final model included the overall design/treatment structure (described before) along with additional covariates for FruitAndVegetable Availability at Home, interaction of FruitAndVegetable Availability at Home by Grade, and Consumption of Sugary Beverages.

Results

The study had more female participants (56.1%) than male participants. Majority were in the 6th grade (35.6%) and 8th grade (32.9%), Hispanic (39.8%) and from the state of Kansas (62.7%). Their average age was 12.8 (SD=1.1) (Table 1).

Average daily fruit and vegetable consumption estimates

Due to the large number of outliers brought on by respondents' possible overestimation of their daily 100% juice intake (table 6), daily fruit and vegetable consumption estimates were calculated without the inclusion of juice as well (table 2). As shown in Figure 1, the average daily consumption estimates of both fruits and vegetables ranged from 2.9 cups (95% CI=1.03, 4.83) (South Dakota Intervention community) to 5.1 cups (95% CI=3.40, 6.78) (South Dakota Control community). There were no significant differences in daily fruit and vegetable consumption estimates across the six communities. Sixth grade youth had the highest median consumption of fruits and vegetables (4.2 cups; 95% CI= 2.6, 6.7) while 8th grade youth had the lowest median consumption (2.5 cups; 95% CI=1.6, 4.06) (Figure 2). With regard to gender, males had higher median consumption (3.8 cups; 95% CI=2.4, 6.0) than females (3.1 cups; 95% CI= 1.9, 4.9) (Figure 2). White youth had the highest median consumption (4.2 cups; 95% CI=2.6, 6.8) while American Indian and African American youth had the lowest median consumption (2.7 cups; 95%CI=1.4, 5.3 and 2.9 cups; 95% CI= 1.8, 4.8, respectively) (Figure 2).

Environmental Assessment

Total NEMS-S and total NEMS-R complete menu (from NEMS-R main menu and NEMS-R kids' menu) scores are presented in table 7. Average NEMS-S scores ranged between 14.7% (Ohio intervention community) and 34% (South Dakota intervention community) of the ideal requirement. Average NEMS-R scores ranged between 7.3% (Kansas intervention community) and 28.4% (South Dakota intervention community) of the ideal requirement. There were no significant differences in the NEMS-S and NEMS-R main menu, NEMS-R kids' menu and NEMS-R complete menu scores, across the six communities.

Perception of food environment and self-efficacy

Four hundred and ten participants from three states (whose average ages were 13.1± 1.0, 12.3± 0.9, and 12.3± 1.2 in Kansas, South Dakota and Ohio, respectively) participated in the perception survey questions. Youth environmental perception and self-efficacy scores are presented in table 8. Majority (over 55%) of the youth reported that fruits and vegetables were always available in their homes. A significant number (73%) of youth also reported that fruits and vegetables were always available at their schools, while 82% reported healthy foods as always available at their local grocery stores. There were no significant differences in participants' perception of their environment across the six communities.

Determination of factors influencing fruit and vegetable consumption

The original model comprised of grade, gender and ethnicity as the main factors with frequency of consumption of unhealthy food (junk food and sugary beverages) and fruit and vegetable availability (at home, school and community) as covariates. For purposes of analysis, frequency responses for both junk food and sugary beverages were scaled down from ten to four levels (never, low, medium and high), and responses for fruit and vegetable availability at home were scaled down from five to three (not often, often and always available). Both covariates were treated as ordinal variables. Preliminary investigation into incorporation of sugary beverages and junk food into the model revealed that individually they had a significant impact on fruit and vegetable consumption; however, when added together, there were issues of multicollinearity, which necessitated removal of junk food from the model. The third iteration involved incorporating availability of fruits and vegetables (at home, school and the community). Fruit and vegetable availability in the home was found to play a dominant role in influencing fruit and vegetable consumption (table 4), with fruit and vegetable availability at school showing marginal level of significance. In addition, the interaction between fruit and vegetable availability at home and being in the 8th grade was also found to be significant (p-value< 0.05) (table 5). The final model therefore comprised the original design and incorporated fruit and vegetable availability at home and the interaction between fruit and vegetable availability at home with grade. Table 4 shows the factors, covariates and the interactions that were used for both models (one with juice component and the other without).

Impact of Grade, Gender and ethnicity, on fruit and vegetable consumption

There were no significant differences in fruit and vegetable consumption related to gender, grade, ethnicity, and state/community. As shown in table 4, all the p-values of the F-tests were higher than 0.05 and therefore implied that gender, grade, ethnicity, state and community did not significantly influence fruit and vegetable consumption.

Impact of fruit and vegetable availability and consumption of unhealthy food on fruit and vegetable consumption

Availability of fruits and vegetables at home was found to significantly influence fruit and vegetable consumption (table 4). In addition, the interaction between fruit and vegetable availability in the home and grade of respondent was also found to be significant (table 4). With regard to unhealthy food, only the sugary beverages' component was added to the model. Frequency of consumption of sugary beverages was found to significantly (p-value<0.05) (table 4) influence fruit and vegetable consumption.

Discussion

The key findings from this study are: (1) fruit and vegetable consumption estimates of youth were lower than USDA recommendations; (2) the food environment with regard to the quality of foods available at food stores and restaurants, met less than 50% of predetermined requirements; (3) youth in these communities had a positive view of their food environment; (4) intrapersonal factors like grade, gender and ethnicity were not significant predictors of fruit and vegetable intake; and (5) fruit and vegetable availability at home and frequency of consumption of sugary beverages were both found to influence fruit and vegetable consumption.

For this study, youth fruit and vegetable consumption estimates were assessed alongside objective measures of their nutrition environment in each of the six communities. The USDA (2016) recommends that boys between the ages of 9 and 13 years should consume 2.5 cups and 1.5 cups of vegetables and fruit a day, respectively, which is equivalent to 4 cups of fruits and vegetables per day. Girls within the same age group are recommended to consume at least 3.5 cups of fruits and vegetables daily (2 cups of vegetables and 1.5 cups of fruit). Study results show that median estimates for both genders were below these gender-specific recommendations, although boys had slightly higher consumption. Although grade was not a significant predictor of intake, there was a noticeable trend line in median consumption values across the three grade levels. That is, 8th grade youth had median values lower than those of their 6th and 7th grade counterparts. This may reflect reduced intake, as youth get older. Kong et al. (2016), Lytle et al. (2000), and Minaker & Hammond (2016), also documented this decline in intake as youth got older, and they attributed it to increased independence in making food choices and the increase in exposure to unhealthy foods. This calls for early intervention during childhood before youth become more autonomous in making food choices.

Ethnicity was also not a significant predictor of fruit and vegetable intake; however, there were apparent differences in median estimates between Native Americans/ African Americans and whites/Hispanics that amounted to more than a cup. Ethnic disparities have been well documented (Dubowitz et al., 2008; Glover et al., 2009; Guerrero & Chung, 2016; Haughton et al., 2016; Larson et al., 2015; and Whitt-Kirkpatrick et al., 2012) and correlated with disparities in fruit and vegetable consumption.

Study results also showed that community of residence did not influence fruit and vegetable consumption. However, an apparent trend line clearly showed only the control communities had mean estimates above 3.5 cups of fruits and vegetables. All three of the communities slated to receive intervention had average daily consumption estimates below 3.5 cups. Although, the communities were randomly assigned as control and intervention, the differences could be attributed to respondent bias given that prior to the study; focus group discussions had been conducted in schools within the intervention communities. Some of the study respondents may have been part of these focus group discussions and therefore privy to the intentions of the study process.

There is growing evidence of a correlation between fruit and vegetable consumption and weight management in relation to overweight and obesity (He et al., 2004; Shitani, 2001). The community and consumer nutrition in turn, influence fruit and vegetable consumption (Glanz et al., 2005; Holstein et al., 200; Moorland et al., 2002; and Tohill et al., 2004). The average NEMS-S scores ranged between 14.7% and 34% of the requirements based on availability and quality of healthy food options. This is in tandem with studies that show that low-income communities not only have fewer grocery stores, but the available stores are not adequately stocked with quality healthy foods for their residents (Morland et al., 2002; Zenk et al., 2005; Morland and Filomena, 2007). In this study, 10 sit-down, 6 fast food and 15 other restaurants from the 3 states were audited; and their NEMS scores ranged between 7.3% and 28.4% of the total possible ideal restaurant score. That is, the best preforming restaurants had a score that only met 28% of the stipulated requirements with regard to signage, promotion of healthy food items, availability, quality and price of meals provided. Other studies have also reported low-income and rural areas as having more energy dense and unhealthy foods readily available and more accessible to them in comparison to higher income areas (Block et al., 2004; Glanz et al., 2005; Larson et al., 2009; Morland et al., 2002).

Although, this study only assessed the physical environment with regard to restaurants and food stores, the findings point to the interconnectivity between the food environment (which was poor in this case) and fruit and vegetable consumption (which was also poor), depicted by the Socio-ecological model.

Despite the findings of the objective food environment measures, youth subjective responses reflected a positive view of their nutrition environment. When probed about their perception of their school, home and restaurant environments with regard to how often healthy foods including fruits and vegetables were available, majority (more than 50%), of the youth responded with “often true.” When asked how sure they were that they could eat healthy foods at school, fast food restaurants and at home, majority responded with “moderately agree,” somewhat agree” and “strongly agree” respectively. A cross sectional study done by Williams and colleagues (2011) comparing the objective food environment with perceptions of the food environment also revealed a mismatch between objective and subjective findings. They determined that this mismatch highlighted the flaws in using subjective measures such as perceptions of the food environment as a proxy for more objective measures of the food environment. They further reported that socioeconomic status had minimum impact on the relationship between perceived and objective food/nutrition environments. Kirtland and colleagues (2003) explained the discrepancy as due to differences in lifestyle behaviors, personal beliefs and cultural values. On the other hand, Mesch & Manor (1998) remarked that the mismatch was reflective of how people judged their environments, that is, in accordance with individual desires and expectations.

The study findings also revealed that factors including grade, gender, ethnicity, state and community of residence did not significantly predict fruit and vegetable consumption. A study done by Drapeau et al. (2016) also showed that gender did not influence fruit and vegetable consumption. Contrarily, Harris and colleagues' (2015) study which assessed changes in dietary intake during puberty, reported changes in trends of dietary intake of fruits and vegetables as being sex-specific. In fact, they went as far as recommending sex-specific dietary interventions for children. Dubowitz et al. (2008) and Holubcikova et al. (2016) also explored the impact of gender on eating behaviors and reported gender related differences in consumption of both unhealthy and healthy foods including fruits and vegetables. Further investigation might give conclusive results regarding the relationship between gender and youth fruit and vegetable consumption. Kirkpatrick et al. (2012) and Dubowitz et al. (2008) reported ethnicity as being significantly related to fruit and vegetable consumption. Although in this study, ethnicity did not significantly influence fruit and vegetable consumption, median fruit and vegetable estimates of African/black and Native American youth were more than one cup lower than the median intake estimates of White and Hispanic youth. Dubowitz and colleagues (2008) reported that the impact of ethnicity was modified by neighborhood social economic status, and once social economic status was adjusted for, the coefficients for individual characteristics such as gender and ethnicity did not change significantly. Interestingly they also reported that the interaction between ethnicity and neighborhood social economic status seemed to influence fruit and vegetable consumption differently for different ethnicities. Specifically, the impact of social economic status created greater disparity in fruit and vegetable consumption among African Americans versus whites than between Hispanic Americans versus whites.

This study did not find significant differences in fruit and vegetable consumption due to state and community of residence, unlike other studies by Ellaway & Macintyre, 1996; Diez-Roux et al. 1999; and Shahaimi et al. 2014. However, Diez-Roux et al. (1999) qualified their findings by stating that individual level income was a much better predictor regardless of area of residence. This may imply that the relationship between fruit and vegetable intake and community of residence is mediated by socioeconomic status of residents. Given that this study's respondents were youth, information about their parents' socioeconomic status was not collected.

The positive impact of fruit and vegetable availability at home, on fruit and vegetable consumption among children and youth has also been reported in previous studies (Lederer et al., 2015; Trofholz et al., 2016). The significant interaction between fruit and vegetable availability at home and grade was also interesting. As the children got older (8^{th} grade), their consumption of fruits and vegetables was more significantly influenced by their availability at home. This finding is informative and further research would be necessary to investigate the strength of this relationship in order to come up with relevant policies and interventions. Jarman et al. (2012) and Ohly et al. (2013) explored the influence of parental involvement on children's intakes of fruits and vegetables, and their results showed strong correlations between parental involvement and consumption of fruits and vegetables.

Lastly, this study also found a positive relationship between frequency of consumption of sugary beverages and intake of fruits and vegetables. This was both perplexing and contrary to what we expected. However, we speculate that high consumers of sugary beverages were also generally high consumers of all foods including fruits and vegetables.

Limitations of the study

The study had some limitations, among them, the inability to generalize the results to all youth because only 6th to 8th grade youth were included in the study. In addition, the data values were self-reported and therefore it was not possible to verify accuracy of the data, although the tool used to collect the data had been previously validated and used in other studies.

Conclusion

The physical environment (food environment) of youth that were part of the study was inadequately furnished to promote healthy food choices, albeit youth had a favorable opinion of their environment. Multi-level factors (as demonstrated by the Socio-ecological Model) influenced behavior. Study results showed the interaction between an interpersonal-level factor (fruit and vegetable availability at home) and the intrapersonal factor of grade, and their positive effect on youth fruit and vegetable intake. This is informative to policy makers, specifically, that fruit and vegetable intake of youth in higher grade, is dependent on their home environment. This may also imply that the low median fruit and vegetable estimates of 8th grade youth were more reflective of their home environments than their subjective responses. Therefore, despite the mismatch between objective and subjective environmental measures, objective measures may have captured the truer picture of these students' food environment, and may explain the generally low levels of fruit and vegetable intake. Given the multilevel nature of factors influencing behavior (fruit and vegetable intake) as predicted by the Socio-Ecological Model, multilevel interventions are required to address barriers to adoption of healthy behaviors.

Table 1: Demographic characteristics of participants (N=410)

Characteristic	N (%)
Overall n=410	
State	
Ohio	95(23.2)
South Dakota	58(14.1)
Kansas	257(62.7)
Gender	
Female	230(56.1)
Male	176(42.9)
Grade	
6	146(35.6)
7	122(29.8)
8	135(32.9)
9	2(0.5)
Ethnicity	
"American Indian And Alaska Native"	33(8.0)
Black African American	66(16.1)
Hispanic. Latino or Spanish	163(39.8)
White	90(22.2
Other[1]	53(12.9)

(1) Other includes Asian, native Hawaiian, multiple ethnicities and other groups.

Table 2: Daily mean consumption of fruits and vegetables and unhealthy food (in cups) [1]

State and Community	OH intervention	OH Control	S.D Intervention	S.D Control	KS intervention	KS Control
Juice	1.7 (0.85-2.55)	2.16 (1.10-3.23)	1.14 (0.17-2.12	2.41 (1.54-3.28)	1.34 (0.91-1.77)	1.58 (1.25-1.91)
Fruit	0.98 (0.71-1.26)	1.53 (0.83-2.23)	0.73 (0.23-1.22)	0.91 (0.48-1.34)	1.04 (0.67-1.41)	1.15 (0.94-1.36)
Lettuce	0.36 (0.16-0.57	0.64 (0.18-1.10)	0.24 (0.06-0.42)	0.69 (0.27-1.12)	0.15 (0.09-0.21)	0.39 (0.26-0.53)
French fries	0.36 (0.18-0.55)	0.31 (0.14-0.48)	0.11 (0.03-0.18)	0.48 (0.10-0.86)	0.13 (0.08-0.19)	0.12 (0.08-0.15)
White potatoes	0.25 (0.10-0.39)	0.48 (-0.00-0.96)	0.29 (0.03-0.55)	0.57 (0.17-0.97)	0.24 (0.11-0.37)	0.27 (0.20-0.34)
Dried beans	0.18 (0.02-0.35)	0.22 (0.09-0.35)	0.06 (0.01-0.10)	0.53 (0.22-0.85)	0.49 (0.29-0.69)	0.49 (0.34-0.65)
Other vegetables	0.45 (0.26-0.64)	0.75 (0.34-1.16)	1.31 (-0.11-2.72)	0.74 (0.43-1.06)	0.58 (0.31-0.84)	0.85 (0.0.63-1.08)
Tomato sauce	0.33 (0.17-0.49)	0.33 (-0.02-0.68)	0.17 (0.05-0.29)	0.58 (0.24-0.91)	0.23 (0.08-0.39)	0.23 (0.16-0.30)
Vegetable soup	0.36 (0.10-0.61)	0.55 (0.04-1.07)	0.05 (0.02-0.08)	0.65 (0.3-1.00)	0.15 (0.10-0.20)	0.25 (0.16-0.33)
Daily fruit and vegetable estimates[2]	4.73 (3.39-6.07)	6.26 (4.068.45)	4.08 (1.29-6.86)	7.5 (5.17-9.84)	4.29 (3.23-5.35)	5.26 (4.456.07)
Daily fruit and vegetable estimates without juice component	3.17 (2.30-4.04)	4.42 (2.80-6.04)	2.93 (1.03-4.83)	5.09 (3.40-6.78)	2.99 (2.21-3.78)	3.73 (3.10-4.36)
Unhealthy food						
Sugary beverages	3.38 (2.13-4.63)	2.11 (1.15-3.06)	1.09 (0.34-1.84)	1.51 (0.90-2.12)	1.96 (1.27-2.66)	1.58 (1.24-1.92)
Junk food[3]	5.18 (5.0)	4.50 (5.0)	3.16 (3.0)	3.85 (3.0)	3.27 (3.0)	3.39 (3.0)

Values in parenthesis are 95% confidence intervals
(1) Higher scores are better for sub-scores, daily fruit, and vegetable estimates
(2) Daily fruit and vegetables estimate = juice + solid fruit + lettuce + French fries + white potatoes + dried beans + other vegetables + tomato sauce + vegetable soups.

(3) Values for junk food correspond to frequency of consumption (with median values in parenthesis) and not average consumption.

Table 3: Median fruit and vegetable consumption by grade, gender and ethnicity

Grade	median	95% Confidence Interval
6	4.2	2.6- 6.7
7	3.8	2.3- 6.1
8	2.5	1.6- 4.1
Gender		
Males	3.8	2.4- 6.0
Females	3.1	2.0- 4.9
Ethnicity		
American Indian	2.7	1.4- 5.3
Black/African	2.9	1.8- 4.8
Hispanic	4.0	2.4- 7.0
White	4.2	2.6-6.8
Other[1]	3.5	2.2-5.5

(1) Other includes Asian, native Hawaiian, multiple ethnicities and other groups.

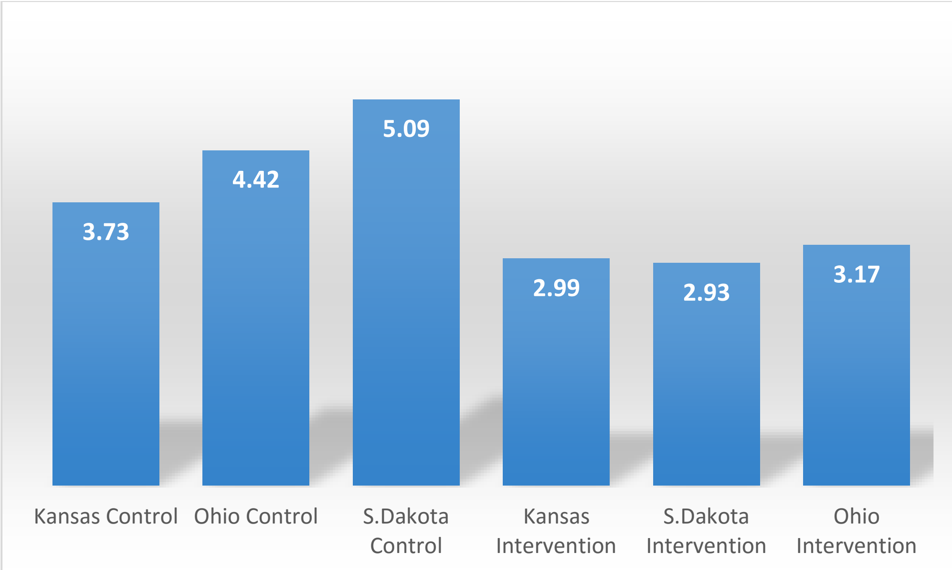

Figure 1: Average daily fruit and vegetable estimates by community

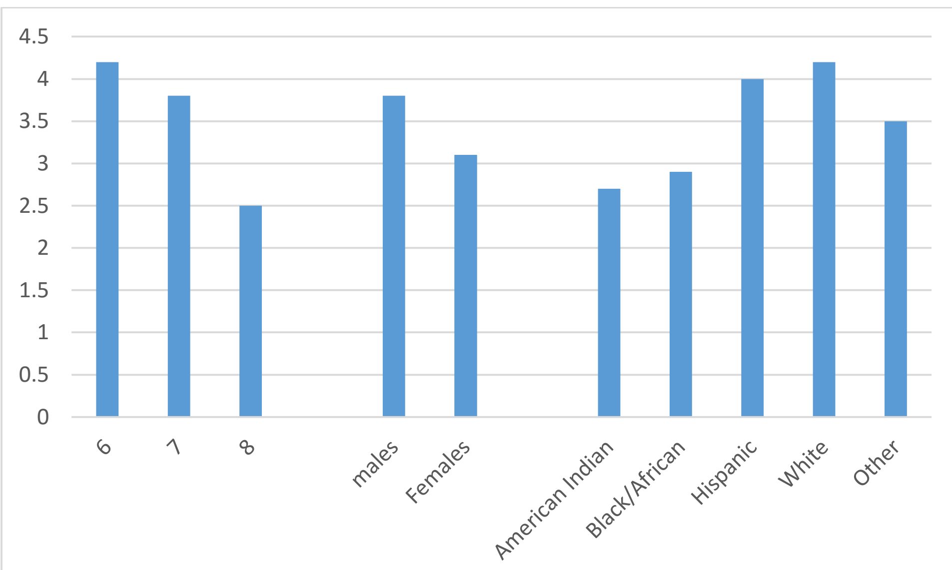

Figure 2: Median daily fruit and vegetable consumption by grade, gender and ethnicity

Table 4: Type III tests of fixed effects for factors and covariates in the final model[1]

	With Juice		Without Juice	
Effect	***F Value***	***Pr > F***	***F Value***	***Pr > F***
Grade	3.91	0.1193	2.61	0.2177
Gender	3.34	0.0685	3.44	0.0644
Grade*Gender	1.58	0.2080	0.97	0.3814
Ethnicity	1.86	0.1226	0.67	0.6131
Grade*Ethnicity	0.17	0.9939	0.31	0.9578
Gender*Ethnicity	1.05	0.3830	1.07	0.3715
Grade*Gender*Ethnicity	0.68	0.7073	0.92	0.4970
Fruit and vegetable availability at home	2.88	0.0576	3.85	0.0222
Grade*Fruit and vegetable availability at home	1.90	0.1093	2.73	0.0290
Sugary beverage consumption frequency	14.42	<.0001	11.91	<.0001

(1) $\alpha=0.05$

Table 5: Test of Slice effects/slice differences of grade*fruit and vegetable availability at home by grade[1]

		Fruit and vegetable availability at home		
Grade	**P-value**	***Not often***	***Often***	***Always***
6	0.8321	4.26^{a}	3.89^{a}	4.32^{a}
7	0.2150	4.43^{a}	2.99^{a}	4.08^{a}
8	0.0047*	1.74^{b}	2.70^{ab}	3.52^{a}

*value is statistically significant, $\alpha=0.05$

(1) Values with different superscript letters indicate statistically significant differences in median fruit and vegetable consumption across fruit and vegetable availability levels at home per grade

Table 6: High consumers per food category in relation to daily fruit and vegetable consumption estimates (N)

Level of consumption	Juice	fruit	Lettuce salad	French fries	White potatoes	Dried beans	Other vegetables	Tomato sauce	Vegetable soup	total
Low (0-4.5 cups)	3	0	0	0	0	0	0	0	0	257
Medium (4.5-9 cups)	25	7	1	0	0	1	3	0	0	82
High (>9 cups)	48	19	9	2	6	11	17	4	8	71
TOTAL	76	26	10	2	6	12	20	4	8	410

Table 7: Mean NEMS- R and NEMS-S scores[1, 2]

Community	OH Intervention	OH Control	SD Intervention	SD Control	KS Intervention	KS Control
NEMS_S[3]	UA	8.50 (4.0)	19.50 (18.00)	15.75 (5.00)	11.50 (8.50)	16.14 (5.00)
NEMS-R Main Menu	17.00 (7.15)	UA	19.50 (11.40)	13.13 (6.33)	8.33 (0.67)	6.5 (2.08)
NEMS-R Kids Menu	4.29 (2.77)	UA	5.25 (5.25)	3.75 (2.60)	-2.00 (1.00)	5.00 (2.06)
NEMS-R Complete Menu[4]	21.29 (9.83)	UA	24.75 (16.57)	16.88 (8.70)	6.33 (2.52)	11.22 (3.35)

Values in parenthesis are standard errors
UA= unavailable
(1) No significant differences were found across the six communities at $p \leq 0.05$
(2) Higher scores are better for NEMS-S, sub-scores and NEMS-R complete menu
(3) Highest possible score was 58
(4) Highest possible score was 87

Table 8: Mean scores of youth environmental perception

Community	OH intervention	OH control	SD intervention	SD control	KS intervention	KS control
Question 1: I find it easy to choose low fat foods.[1]	2.7 (1.06)	2.7 (1.3)	3.0 (1.2)	3.1 (1.0)	2.7 (1.01	3.0 (1.0)
Question 2: I find it easy to eat at least 1.5 to 2 cups of fruit each day[1]	4.0 (1.15)	3.7 (1.2)	3.9 (1.2)	3.6 (1.3)	3.5 (1.2)	3.9 (1.2)
Question 3: I find it easy to eat at least 2 to 3 cups of vegetables each day[1]	3.1 (1.16)	3.3 (1.4)	2.6 (1.2)	3.0 (1.3)	2.7 (1.20)	3.1 (1.21)
Question 4: if you wanted to, how sure are you that you could eat healthy foods when you are hungry after school[2]	3.7 (1.25)	3.2 (1.3)	3.8 (1.4)	3.3 (1.3)	3.0 (1.1)	3.5 (1.1)
Question 5: if you wanted to, how sure are you that you could eat healthy foods when you are with your friends[2]	3.4 (1.36)	3.2 (1.3)	3.5 (1.4)	3.3 (1.3)	2.7 (1.2)	3.0 (1.2)
Question 6: if you wanted to, how sure are you that you could eat healthy foods when you are at a fast food restaurant[2]	2.6 (1.35)	2.7 (1.3)	2.4 (1.4)	2.5 (1.3)	2.3 (1.2)	2.4 (1.2)

Question 7: if you wanted to, how sure are you that you could eat healthy foods when you are eating dinner with your family[2]	3.8 (1.1)	4.2 (1.1)	4.2 (1.1)	4.2 (1.0)	3.6 (1.1)	3.9 (1.1)
Question 8: fruits and vegetables are available in my home.[3]	4.4 (0.8)	4.3 (0.2)	4.4 (1.0)	3.9 (1.3)	4.3 (0.9)	4.5 (0.8)
Question 9: healthy foods are available in my home.[3]	4.3 (0.8)	4.2 (1.1)	4.5 (0.9)	4.1 (1.2)	4.4 (0.8)	4.4 (0.8)
Question 10: fruits and vegetables are available in my school[3]	4.8 (0.5)	4.2 (0.9)	4.7 (0.8)	4.6 (0.9)	4.7 (0.7)	4.5 (0.9)
Question 11: healthy foods are available in my school[3]	4.7 (0.8)	4.3 (1.0)	4.6 (0.7)	4.6 (1.0)	4.4 (0.9)	4.4 (1.1)
Question 12: healthy foods are available at local grocery stores In my community[3]	4.9 (0.2)	4.5 (0.8)	4.7 (1.0)	4.4 (1.1)	4.7 (0.7)	4.7 (0.7)
Question 13: there are low cost healthy foods available in my community[3]	4.0 (1.1)	3.8 (1.1)	3.7 (1.1)	3.5 (1.2)	3.7 (1.0)	3.9 (1.0)
Question 14: there are healthy choices in vending machines at school[3]	2.9 (1.5)	2.8 (1.6)	2.2 (0.9)	3.2 (1.6)	2.8 (1.2)	2.6 (1.2)

Values in parenthesis are standard deviations
(1) Students were asked: “please respond to how much you agree with the following statements on healthy eating and food choices.” Possible responses include 0=not at all agree, 1= slightly agree, 2= somewhat agree, 3= moderately agree, 4= strongly agree. Higher scores indicate greater agreement.
(2) Possible responses: 0= not at all sure, 1= slightly sure, 2= fairly sure, 3=quite sure, 4= extremely sure
(3) Students were asked: “how often are the following true?” possible responses are 0=never, 1= rarely, 3= sometimes, 3= often, 4= always.

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Appendix

Appendix A: Nutrition Environment Measures Survey for Restaurants (NEMS-R) data collection tool

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES--DATA COLLECTION

38906

Restaurant ID: ______ Rater ID: ____ Date: __ / __ / __ (Month / Day / Year)

1) Type of Restaurant: Code # __ __

2) Data Sources:

Site Visit/Observation	Take-Away Menu	Internet	Interview
○ yes ○ no	○ yes ○ no	○ yes ○ no	○ yes ○ no

3) Site Visit Information:

- Take-away Menu ○ yes ○ no
- Nutrition Information ○ yes ○ no
- Other: ○ yes ○ no

Comments: ____________

4) Take-Away Menu Features:

- Nutrition Information ○ yes ○ no
- Identification of healthier menu items ○ yes ○ no
- Other: ○ yes ○ no

Comments: ____________

5) Internet Site Features:

- Menu ○ yes ○ no
- Nutrition Information ○ yes ○ no
- Identification of healthier menu items ○ yes ○ no
- Other: ○ yes ○ no

Website URL ____________

Comments: ____________

6) Interview Information:

- Menu options ○ yes ○ no
- Pricing ○ yes ○ no
- Other: ○ yes ○ no

Comments (describe items above) ____________

7) Hours of operation: **Data Source:** ○ Site ○ Menu ○ Web

○ Open 24 Hours *(If 24-hr, leave Hours of Operation section blank)*

Sunday ○ Open ○ Closed	**Thursday** ○ Open ○ Closed	**Friday** ○ Open ○ Closed	**Saturday** ○ Open ○ Closed
○ B: 6:00 - 11:00am	○ B: 6:00 - 11:00am	○ B: 6:00 - 11:00am	○ B: 6:00 - 11:00am
○ L: 11:00 am - 3:00 pm	○ L: 11:00 am - 3:00 pm	○ L: 11:00 am - 3:00 pm	○ L: 11:00 am - 3:00 pm
○ D: 5:00 pm to Close	○ D: 5:00 pm to Close	○ D: 5:00 pm to Close	○ D: 5:00 pm to Close
__ : __ ○ AM ○ PM	__ : __ ○ AM ○ PM	__ : __ ○ AM ○ PM	__ : __ ○ AM ○ PM

8) Access: **Drive-thru window** ○ yes ○ no **Parking onsite** ○ yes ○ no

Comments: ____________

9) Size of Restaurant: ○ Seating capacity = ___ **OR** ○ Number of tables = ___

Comments: ____________

Page 1

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES--DATA COLLECTION

36805

Restaurant ID: ______ Rater ID: __ __

Site visit (Observation)	Select One		Comments
10) Restaurant has a salad bar	○ yes	○ no	______
11) Signage/Promotions a. Is nutrition information posted near point-of-purchase, or available in a brochure?	○ yes	○ no	______
b. Do signs/table tents/displays highlight healthy menu options?	○ yes	○ no	______
c. Do signs/table tents/displays encourage healthy eating?	○ yes	○ no	______
d. Do signs/table tents/displays encourage unhealthy eating?	○ yes	○ no	______
e. Do signs/table tents/displays encourage overeating (e.g., all-you-can-eat, super-size, jumbo, grande, supreme, king size, feast descriptors on menu or signage)?	○ yes	○ no	______
f. Does this restaurant have a low-carb promotion?	○ yes	○ no	______
g. Other? ______	○ yes	○ no	
Menu Review/Site visit			
12) a. Chips	○ yes	○ no	______
b. Baked chips	○ yes	○ no	______
13) a. Bread	○ yes	○ no	______
b. 100% wheat or whole grain bread	○ yes	○ no	______
14) 100% fruit juice	○ yes	○ no	______
15) 1% Low-fat, skim, or non-fat milk	○ yes	○ no	______

Page 2

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES--DATA COLLECTION

36805

Restaurant ID: ______ Rater ID: __ __

Menu Review	Select One	Choices (#)	Comments
16) Main Dishes/Entrees: a. Total # Main Dishes/Entrees	○ yes ○ no	#	
b. Healthy options	○ yes ○ no	#	
17) Main dish salads: a. Total # Main dish	○ yes ○ no	#	
b. Healthy options	○ yes ○ no	#	
c. Low-fat or fat free salad dressings	○ yes ○ no	#	
18) Fruit (w/out added sugar)	○ yes ○ no	#	
19) Non-fried vegetables (w/out added sauce)	○ yes ○ no	#	
20) Diet soda	○ yes ○ no		
21) Other healthy or low calorie beverage? ______	○ yes ○ no		

Page 3

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES--DATA COLLECTION

38805

Restaurant ID: ______ Rater ID: ___

Menu Review/Site Visit

22) Facilitators & Supports

	Select One	Comments
a. Nutrition information on menu (paper or posted menu)	O yes O no	
b. Healthy entrees identified on menu	O yes O no	
c. Reduced-size portions offered on menu	O yes O no O standard	
d. Menu notations that encourage healthy requests	O yes O no	
e. Other? ______	O yes O no	

23) Barriers

	Select One	Comments
a. Large portion sizes encouraged? (e.g., Super-size items on menu)	O yes O no	
b. Menu notations that discourage special requests (e.g., No substitutions or charge for substitutions)	O yes O no	

Page 4

Restaurant ID: ______ Rater ID: ______

36905

23) Barriers (Cont.)	Select One	Comments
c. All-you-can-eat or "unlimited trips"	O yes O no	
d. Other? ______	O yes O no	

24) Pricing	Select One	Comments
a. Sum of individual items compared to combo meal	O more O less O same O NA	
b. Healthy entrees compared to regular ones	O more O less O same O NA	
c. Charge for shared entree?	O yes O no	
d. Smaller portion compared to regular portion (if 22c is No or Standard then mark N/A)	O more O less O same O NA	
e. Other? ______	O more O less O same O NA	

36905

Restaurant ID: ______ Rater ID: ______

Menu Review	Select One	Comments
25) Kid's menu?	○ yes ○ no	
a. Age limit	○ 10 and Under ○ 12 and under ○ Other ○ NA	
b. Any healthy entrees?	○ yes ○ no ○ NA	
c. 100% fruit juice	○ yes ○ no ○ NA	
d. 1% low-fat, skim or non-fat milk	○ yes ○ no ○ NA	
e. Are there free refills on unhealthy drinks?	○ yes ○ no ○ NA	
f. Are there any healthy side items (either assigned or to choose)?	○ yes ○ no ○ NA	
g. Can you substitute a healthy side for an assigned unhealthy one?	○ yes ○ no ○ NA	
h. Do any entrees that have assigned sides include an assigned healthy side?	○ yes ○ no ○ NA	
i. Is an unhealthy dessert automatically included in a kid's meal?	○ yes ○ no ○ NA	
j. Are there any healthy desserts (either free or at additional cost)?	○ yes ○ no ○ NA	
k. Is nutrition information (e.g., calories or fat) provided on the kid's menu?	○ yes ○ no ○ NA	
l. Other unhealthful eating promotion?	○ yes ○ no ○ NA	
m. Other healthful eating promotion?	○ yes ○ no ○ NA	

Appendix B- Nutrition Environment Measures for Stores (NEMS-S) Data Collection Tool.

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #1: MILK

Store ID: ____________   Rater ID: ☐☐

Marking Instructions		
Please use a pencil or blue or black ink.	Correct ●	Incorrect ⊘ ⊙ ⊖ ⊛

1. Is there milk available in this store? ○ Yes ○ No Comments: ____________

If yes, continue. If no, move on to the next measure.

A. Availability

Comments:

2. a. Is low-fat (skim or 1%) available? ○ Yes ○ No ____________
   b. If not, is 2% available? ○ Yes ○ No ○ NA ____________

Reference brand

3. Store brand (preferred) ○ Yes ○ No

4. Alternate Brand Name: ____________

Comments: ____________

5. **Shelf space:** (measure only if low-fat or 2% milk is available)

Type	Pint	Quart	Half gallon	Gallon
a. Lowest fat milk available ○ Skim ○ 1% ○ 2%	☐☐	☐☐	☐☐	☐☐
b. Whole	☐☐	☐☐	☐☐	☐☐

B. Pricing All items should be same brand

	Price	Comments:
1. Whole milk, quart	$☐.☐☐	____________
2. Whole milk, half-gallon	$☐.☐☐	____________
3. Lowest fat milk available, quart	$☐.☐☐	____________
4. Lowest fat milk available, half-gallon	$☐.☐☐	____________

33408

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #2: FRUIT

Store ID: ____________ Rater ID: ☐☐

Does this store sell any fresh fruit? Yes ○ No ○ Comments: ____________

If yes, continue. If no, move on to the next measure.

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Bananas**		○	○	$☐.☐☐	☐	○	○	○	○	____
2. **Apples**	○ Red delicious ○ ____	○	○	$☐.☐☐	☐	○	○	○	○	____
3. **Oranges**	○ Navel ○ ____	○	○	$☐.☐☐	☐	○	○	○	○	____
4. **Grapes**	○ Red seedless ○ ____	○	○	$☐.☐☐	☐	○	○	○	○	____
5. **Cantaloupe**		○	○	$☐.☐☐	☐	○	○	○	○	____
6. **Peaches**		○	○	$☐.☐☐	☐	○	○	○	○	____
7. **Strawberries**		○	○	$☐.☐☐	☐	○	○	○	○	____
8. **Honeydew Melon**		○	○	$☐.☐☐	☐	○	○	○	○	____
9. **Watermelon**	○ Seedless ○ ____	○	○	$☐.☐☐	☐	○	○	○	○	____
10. **Pears**	○ Anjou ○ ____	○	○	$☐.☐☐	☐	○	○	○	○	____

11. **Total Types**: (Count # of yes responses) ☐☐

32528

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #3: VEGETABLES

Store ID: ______ Rater ID: ☐☐

Does this store sell any fresh vegetables? Yes ○ No ○ Comments: ______

If yes, continue. If no, move on to the next measure.

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Carrots**	○ 1 lb bag ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
2. **Tomatoes**	○ Loose ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
3. **Sweet Peppers**	○ Green bell peppers ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
4. **Broccoli**	○ Bunch ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
5. **Lettuce**	○ Green leaf ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
6. **Corn**		○	○	$☐.☐☐	☐	○	○	○	○	______
7. **Celery**		○	○	$☐.☐☐	☐	○	○	○	○	______
8. **Cucumbers**	○ Regular ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
9. **Cabbage**	○ Head - Green ○ ______	○	○	$☐.☐☐	☐	○	○	○	○	______
10. **Cauliflower**		○	○	$☐.☐☐	☐	○	○	○	○	______

11. **Total Types**: (Count # of yes responses) ☐☐

38744

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #4: GROUND BEEF

Store ID: ______________ Rater ID: ☐☐

Does this store sell any beef? Yes ○ No ○ Comments: ______________

If yes, continue. If no, move on to the next measure.

Availability and Price

Item	Available Yes	Available No	Available N/A	Price/lb.	Comments
Healthier option:					
1. Lean ground beef, **90% lean, 10% fat** (Ground Sirloin)	○	○		$☐.☐☐	
Alternate Items:					
2. Lean ground beef, (<10% fat) ☐☐ **% fat**	○	○	○	$☐.☐☐	
3. Ground Turkey, (≤10% fat) ☐☐ **% fat**	○	○	○	$☐.☐☐	

4. # of varieties of lean ground beef (≤10% fat) ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

Item	Available Yes	Available No	Available N/A	Price/lb.	Comments
Regular option:					
5. Standard ground beef, **80% lean, 20% fat** (Ground Chuck)	○	○		$☐.☐☐	
Alternate Item:					
6. Standard alternate ground beef, if above is not available ☐☐ **% fat**	○	○	○	$☐.☐☐	

26746

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #5: HOT DOG

Store ID: ______ Rater ID: ☐☐

Does this store sell any hot dogs? Yes ○ No ○ Comments: ______

If yes, continue. If no, move on to the next measure.

Availability and Price

Item	Available Yes	No	N/A	Price/pkg.	Comments
Healthier option:					
1. Oscar Mayer 98% Fat-free Wieners (turkey/beef) ≤1g fat	○	○		$☐.☐☐	______
Alternate Item: (≤ 9g fat)					
2. Other: Brand name and type *e.g., Ball Park Fat Free Beef Franks* ______	○	○	○	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg ______
Regular option:					
7. Oscar Mayer Wieners (turkey/pork/chicken)-regular 12g fat	○	○		$☐.☐☐	______
Alternate Item: (> 9g fat)					
9. Other: Brand name and type *e.g., Ball Park Beef Franks* ______	○	○	○	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg ______

17407

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #6: FROZEN DINNERS

Store ID: ____________ Rater ID: ☐☐

Does this store sell any frozen dinners? Yes ○ No ○ Comments: ____________

If yes, continue. If no, move on to the next measure.

A. Reference Brand

1. Stouffer's brand (preferred) ○ Yes ○ No
2. Alternate brand (with reduced-fat dinners available) Brand Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Comments: ____________

B. Availability

1. Are reduced-fat frozen dinners available? (≤9g fat/8-11 oz.) ○ Yes ○ No ____________

Shelf space (measure only if reduced-fat frozen dinners are available)

2. Reduced-fat dinners/regular dinners: Proportion ○ < = 10% ○ 11-33% ○ 34-50% ○ 51%+

C. Pricing (All items must be same brand)

Reduced-Fat Dinner	Price/ Pkg	Regular Dinner	Price/ Pkg	Comments
1. Lean Cuisine **Lasagna** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Lasagna** ☐☐ oz.	$☐☐.☐☐	
2. Lean Cuisine **Roasted Turkey Breast** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Roasted Turkey Breast** ☐☐ oz.	$☐☐.☐☐	
3. Lean Cuisine **Meatloaf** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Meatloaf** ☐☐ oz.	$☐☐.☐☐	

Reduced-Fat Alternate (≤ 9g fat)	Price/ Pkg	Regular Alternate (≥ 10g fat)	Price/ Pkg	Comments
4. Other ____ ☐☐ oz. ☐☐☐ Kcal ☐☐ g fat	$☐☐.☐☐	Other ____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
5. Other ____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Other ____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
5. Other ____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Other ____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	

29844

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #7: BAKED GOODS

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐

Does this store sell baked goods? Yes ○ No ○

Comments: ________

If yes, continue. If no, move on to the next measure.

Availability & Price

Low-fat baked goods ≤3g fat/serving

Item	Available Yes No	Amt. per package	g fat/ per item	kcal/ per item	Price	Comments
Healthier option:						
1. Bagel Single	○ ○		☐☐	☐☐☐	$☐.☐☐	________
	Yes No N/A					
Package	○ ○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________
Alternate Items:	Yes No N/A					
2. English muffin	○ ○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________
3 a. Low-fat muffin ☐☐☐☐☐☐☐☐☐☐	○ ○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________
b. #varieties of low fat muffins	○ 0 ○ 1 ○ 2 ○ 3+					

Regular option (≥4g fat/serving or 400 Kcal/serving):

Item	Available	Amt. per package	g fat/ per item	kcal/ per item	Price	Comments
4. Regular muffin	○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________
Alternate Items:	Yes No N/A					
5. Regular Danish	○ ○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________
6. Other	○ ○ ○	☐☐	☐☐	☐☐☐	$☐.☐☐	________

54166

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #8-CS: BEVERAGE

Store ID: ________ Rater ID: ☐☐

Does this store sell beverages? Yes ○ No ○ Comments: ________

If yes, continue. If no, move on to the next measure.

Availability & Price

Healthier option:

Item	Size	Available: Yes	No	N/A	Price	Comments
1. Diet Coke	12 oz.	○	○		$☐.☐☐	________
	20 oz.	○	○		$☐.☐☐	________
2. Alternate brand of diet soda ________	12 oz.	○	○	○	$☐.☐☐	________
________	20 oz.	○	○	○	$☐.☐☐	________

Regular option:

Item	Size	Yes	No	N/A	Price	Comments
3. Coke	12 oz.	○	○		$☐.☐☐	________
	20 oz.	○	○		$☐.☐☐	________
4. Alternate brand of sugared soda ________	12 oz.	○	○	○	$☐.☐☐	________
________	20 oz.	○	○	○	$☐.☐☐	________

Healthier option:

Item	Available: Yes	No	N/A	Price	Comments
5. **100% juice, 15.2 oz.** ○ Minute Maid ○ Tropicana ○ Other	○	○		$☐.☐☐	________
Alternate Item: 6. **100% juice** ____ oz. ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐	________

Regular option:

Item	Yes	No	N/A	Price	Comments
8. **Juice Drink, 15.2 oz** ○ Minute Maid ○ Tropicana ○ Other	○	○		$☐.☐☐	________
Alternate Items: 10. **Juice Drink** ____ oz. ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐	________

20070

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #8-GS: BEVERAGE

Store ID: ____________ Rater ID: ☐☐

Does this store sell any beverages? Yes ○ No ○ Comments: ____________

If yes, continue. If no, move on to the next measure.

Availability & Price

Healthier option:	**Available size**	**Available** Yes	No	N/A	**Price**	**Comments**
1. Diet Coke	12 pack 12 oz.	○	○		$☐.☐☐	____
Alternate Item: ____	○ 12 pack 12 oz. ○ 6 pack 12 oz.	○	○	○	$☐.☐☐	____

Regular option:		Yes	No	N/A		
3. Coke	12 pack 12 oz.	○	○		$☐.☐☐	____
Alternate Item: ____	○ 12 pack 12 oz. ○ 6 pack 12 oz.	○	○	○	$☐.☐☐	____

Healthier option:	Yes	No	N/A		
5. Minute Maid 100% juice, (64 oz., half gallon)	○	○		$☐.☐☐	____
Alternate Items:					
6. Tropicana 100% juice, (64 oz., half gallon)	○	○	○	$☐.☐☐	____
7. Other: ____	○	○	○	$☐.☐☐	____

Regular option:	Yes	No	N/A		
8. Minute Maid juice drink, (64 oz., half gallon)	○	○		$☐.☐☐	____
Alternate Items:					
9. Tropicana juice drink, (64 oz., half gallon)	○	○	○	$☐.☐☐	____
10. Other: ____	○	○	○	$☐.☐☐	____

362

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #9: BREAD

Store ID: ______ Rater ID: ☐☐

Does this store sell any bread? Yes ○ No ○ Comments: ______

If yes, continue. If no, move on to the next measure.

Availability & Price

Item	Available Yes	No	N/A	Loaf size (ounces)	Price/loaf	Comments
Healthier Option: Whole grain bread (100% whole wheat bread and whole grain bread)						
1. Nature's Own 100% Whole Wheat Bread	○	○		☐☐	$☐.☐☐	______
Alternate Items:						
2. Sara Lee Classic 100% Whole Wheat Bread	○	○	○	☐☐	$☐.☐☐	______
3. Other: ______	○	○	○	☐☐	$☐.☐☐	______
4. # of varieties of 100% whole wheat bread and whole grain (all brands)	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+					
Regular Option: White bread (Bread made with refined flour)						
5. Nature's Own Butter Bread	○	○		☐☐	$☐.☐☐	______
Alternate Items:						
6. Sara Lee Classic White Bread	○	○	○	☐☐	$☐.☐☐	______
7. Other: ______	○	○	○	☐☐	$☐.☐☐	______

54990

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #10: CHIPS

Store ID: ____________ Rater ID: ☐☐

Does this store sell chips? Yes ○ No ○ Comments: ____________

If yes, continue. If no, move on to the next measure.

Availability & Price

Low-fat chips ≤3g fat/1 oz. serving

Item	Size	Available	Price	Comments
Healthier Option:		Yes No		
1. Baked Lays Potato Chips	☐☐ oz.	○ ○	$☐.☐☐	____________
Alternate Item:		Yes No N/A		
2. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	○ ○ ○	$☐.☐☐	____________

3. # of varieties of low-fat chips (any brand) ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

Regular Option (select most comparable size to healthier option available):

Item	Size	Available	Price	Comments
		Yes No		
4. Lays Potato Chips Classic	☐☐ oz.	○ ○	$☐.☐☐	____________
Alternate Item:		Yes No N/A		
5. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	○ ○ ○	$☐.☐☐	____________

51552

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #11: CEREAL

Store ID: ____________ Rater ID: ☐☐

Does this store sell any cereal? Yes ○ No ○ Comments: ____________

If yes, continue. If no, move on to the next measure.

Availability & Price

Healthier cereals < 7 g sugar per serving

Item	Available Yes	No	N/A	Size (ounces)	Price	Comments
Healthier Option:						
1. Cheerios (Plain)	○	○		☐☐	$☐.☐☐	________
Alternate Item:	Yes	No	N/A			
2. Other ________	○	○	○	☐☐	$☐.☐☐	________
3. # of varieties of healthier cereals	○0	○1	○2	○3+		
Regular Option (>7g of sugar per serving):						
4. Cheerios (Flavored) ________	○	○		☐☐	$☐.☐☐	________
Alternate Item:	Yes	No	N/A			
5. Other ________	○	○	○	☐☐	$☐.☐☐	________