PROMOTING THE POSITIVE: CHILDREN'S NUTRIENT INTAKE FROM FRUIT IS SIMILAR TO THEIR NUTRIENT INTAKE FROM VEGETABLES

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AUTHORIZATION TO SUBMIT THESIS

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ABSTRACT

Preferences for fruit and vegetables are established in childhood and persist into adulthood, demonstrating a need for further investigation of young children's fruit and vegetable consumption. The objectives of this study were to 1) describe the amount, frequency, and average nutrient intake from young children's fruit consumption and vegetable consumption; and 2) determine whether there are significant differences in children's fruit consumption and vegetable consumption by age, gender, body-mass index (BMI), ethnicity, and socioeconomic status (SES). Fruit consumption and vegetable consumption of young children, two to five years of age (n=821), was identified using the 2009-2010 National Health and Nutrition Examination Survey dietary data from a 24 hour recall. Mean, standard error, and multiple comparisons using p-values from a Tukey's HSD post-hoc test were completed using "R" software. Children consumed approximately three times as many fruit servings as vegetable servings regardless of age, gender, BMI, ethnicity, and SES. Potato products and fruit juice were consumed most frequently and in the greatest amounts. Children obtained more fiber, vitamin C, folate, magnesium, and potassium from fruit than from vegetables; and more vitamin A and E from vegetables than from fruit. Children's nutrient intake from fruit indicates that while caregivers should continue to offer and encourage vegetables, they can be informed that children's fruit consumption may provide similar nutrients as vegetables to meet the recommended dietary allowance.

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LIST OF ABBREVIATIONS

AI	Adequate Intake
ARS	Agricultural Research Services
BMI	Body Mass Index
CACFP	Child and Adult Care Food Program
CDC	Centers for Disease Control
DRI	Dietary Reference Intakes
EAR	Estimated Average Requirement
FNDDS	Food and Nutrient Database for Dietary Studies
FNS	Food and Nutrition Services
FSRG	Food Surveys Research Group
FVC	Fruit and Vegetable Consumption
FV	Fruit and Vegetables
SES	Socioeconomic Status
PIR	Poverty Index Ratio
USDA	United States Department of Agriculture
WHO	World Health Organization

Chapter One

Introduction

Fruit and vegetable consumption yields many health benefits: increased immune function and decreased risk of cardiovascular disease, hypertension, obesity, and some forms of cancer (Ford & Mokdad, 2001; Lampe, 1999; Miller, Moore, & Kral, 2011; Moore et al., 2005; United States Department of Agriculture [USDA], 2012a; World Cancer Research Fund, 1997; World Health Organization [WHO], 2002). Six of the nine major risk factors for developing atherosclerotic heart disease, the leading cause of death in the Western nations, may be reduced by eating a healthy diet including fiber from fresh produce (Anderson, 2003). An estimated 2.7 million lives could be saved each year if fruit and vegetable consumption was sufficiently increased (WHO, 2002). Global and national recommendations encourage the consumption of both fruit and vegetables as part of a healthy diet (USDA, 2012a; WHO & Food and Agriculture Organization (FAO), 2005).

Although fruit and vegetables provide many health benefits, few adults or children consume the recommended amount of fruit and vegetables (Fox, Condon, Briefel, Reidy, & Deming, 2010; Lorson, Melgar-Quinones, & Taylor, 2009; Matheson, Spranger, & Saxe, 2002). Adults' low fruit and vegetable consumption may be a result of their low fruit and vegetable consumption in childhood, since many habits of food intake are developed in early childhood and persist into adulthood (Pearson, Timperio, Salmon, Crawford, & Biddle, 2009). One of the most formative times for the development of fruit and vegetable preference is during early childhood (Fox et al., 2010).

Many factors influence a child's consumption of fruit and vegetables including taste preference, food neophobia, previous exposure to fruit and vegetables, and parenting

techniques (Birch, 1999; Branen & Fletcher, 1999; Dovey, Staples, Gibson, & Halford, 2008; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Sullivan & Birch, 1990). Children have an innate preference for sweet or salty foods over bitter and sour foods (Birch, 1999), and they experience the greatest food neophobia, or unwillingness to try new foods, during the ages of two to six (Dovey et al., 2008). One way to increase preference is by giving children multiple exposures to a particular food, such as a fruit or vegetable (Sullivan & Birch, 1990). However, forcing or coercing a child to consume food, such as fruit and/or vegetables, is counterproductive and may lead to less intake of that food in the long term (Fisher et al., 2002; Branen & Fletcher, 1999).

Since preferences for fruit and vegetables are established in childhood and persist into adulthood, there is a need for further investigation of young children's fruit and vegetable consumption. While the majority of research has focused on both fruit and vegetable consumption, few studies have investigated young children's fruit consumption and vegetable consumption separately, or their nutrient intake from fruit and vegetables.

Statement of Purpose

The purpose of this study was to determine the amount of fruit and vegetables consumed by children ages two to five years, the nutrient content from the fruit and vegetables consumed, and the types of fruit and vegetables consumed most frequently and in the highest amount. Fruit consumption and vegetable consumption of young children was identified using the 2009-2010 National Health and Nutrition Examination Survey (NHANES) dietary data from a 24 hour recall. Results from this research will allow professionals and dietitians to identify current patterns in young children's fruit consumption

and vegetable consumption, and inform parents and caregivers on amounts of key nutrients contained in frequently consumed fruit and vegetables.

Research Objectives

The objectives of this study were to 1) describe the amount, frequency, and average nutrient intake from young children's fruit consumption and vegetable consumption; and 2) determine whether there are significant differences in children's fruit consumption and vegetable consumption by age, gender, body-mass index (BMI), ethnicity, and socioeconomic status (SES).

Limitations

A few limitations have been recognized in this study. Food intake of young children varies from day to day (Birch, Johnson, Andersen, Peters, & Schulte, 1991). A greater number of recorded days may provide a more accurate representation of children's average food or nutrient intake. However, a large sample size accounts for some of this variation by taking into consideration the individual differences across the population (Rockett & Colditz, 1997).

The child's food intake in NHANES was reported by the primary caregiver rather than the child; as a result, some reporting bias may have occurred (CDC, 2012a). Measures were taken by NHANES interviewers to ensure quality data collection, including in-person interviews for the first day of the food recall, and provision of portion size references for the parent.

The food group definitions of the Food Surveys Research Group (FSRG) were used for this research (Ahuja et al., 2012). Mixed dishes that were primarily fruit or vegetables were included in the fruit and vegetable categories. Fruit and vegetables in other mixed

dishes that were mainly grain or meat were excluded from these categories; therefore, some fruit and vegetables from these mixed dishes were not accounted for. Fruit and vegetable content from these mixed dishes were marginal and likely had no significant impact on nutrient intake.

Definition of Terms

Accessibility:

> A condition in which food is available within reach and ready to be eaten (Bere & Klepp, 2005). In application, accessibility means that food, such as fruit and vegetables, have been prepared (i.e. washed, sliced, and peeled) for consumption and have been placed in an area where children can easily pick them up and eat them (Goldman, Radnitz, McGrath, 2012).

Authoritative parenting:

> A cooperative parenting style in which the adult is responsive to the child's needs and individuality while setting firm boundaries. In feeding, there is a shared responsibility where the adult chooses what food and when it will be presented and the child chooses how much and whether to eat (Baumrind, 1971; Fletcher, Branen, & Lawrence, 1997).

Authoritarian parenting:

> A parenting style in which the adult shapes, controls, and evaluates a child's behaviors and attitudes based on a set of standards. In feeding, the parent controls all aspects of the food environment including what, when, and how much their child will consume (Baumrind, 1971; Fletcher et al., 1997).

Availability:

Availability is the term used to describe when a food is on hand in the immediate food environment, such as home, work, school, or preschool (Timperio et al., 2008). Availability of food, including fruit and vegetables, is typically determined by the parent or caregiver of young children (Goldman et al., 2012).

Fruit items:

Food in which the majority of the item is a fruit: citrus fruit and juices, dried fruit, other fruit (berries and mixtures), fruit juices and nectars excluding citrus, and baby food consisting of fruit and juices (Ahuja et al., 2012).

Fruit juice:

Any juice item that is not labeled as 100% fruit juice in the NHANES dataset, as defined by the USDA's Agricultural Research Service (Ahuja et al., 2012).

Food neophobia:

An unwillingness to try new foods (Wardle, Carnell, & Cooke, 2005).

Instrumental eating:

The consumption of a particular food item (i.e. vegetables) as a 'means' to an 'end' reward: praise, dessert, or a special privilege (Birch, Marlin, & Rotter, 1984).

Permissive parenting:

A parenting style in which the parent uses little punishment, does not clearly define rules, and avoids asserting his or her authority. In feeding, the child controls the eating environment including what, when, and how much he/she will consume (Baumrind, 1971; Fletcher et al., 1997).

Potato products:

White potatoes and Puerto Rican starchy vegetables including: white potatoes (baked, boiled, chips, creamed, fried, mashed, or stuffed), potato salad, potato recipes, potato soups, plantain, or cassava/yucca (Ahuja et al., 2012).

Taste:

Sensations arising only from the taste system, which includes the basic tastes of sweet, salty, sour, and bitter; as opposed to flavor, which is a term used to describe a more complex sensation arising from a combination of olfactory, taste, and touch systems (Birch, 1999).

Vegetable items:

Food in which the majority of the item is a vegetable: white potatoes and Puerto Rican starchy vegetables, dark-green vegetables, deep-yellow vegetables, tomatoes and tomato mixtures, other vegetables (relishes, soups, etc.), baby food consisting of vegetables, vegetables with meat, poultry, or fish, and mixtures that are mostly vegetables without meat, poultry, or fish (Ahuja et al., 2012).

Summary

Chapter one includes an introduction of the health benefits of fruit and vegetable consumption and explains the importance of early childhood in the development of food preferences, specifically preferences for fruit and vegetables. This chapter also states the purpose, research objectives, and definitions of terms related to this research. Chapter two is a review of the literature with greater detail of health benefits and nutrients contained in fruit and vegetables, current consumption of fruit and vegetables by young children, and factors related to children's fruit and vegetable consumption. Chapter three contains the

methodology, results, discussion, and conclusion. Since it is written in journal article format, some information from chapters one and two is repeated in chapter three.

Chapter Two

Review of the Literature

Fruit and vegetable consumption is related to many health benefits, such as a decreased risk for obesity and chronic diseases (Ford & Mokdad, 2001; Miller et al., 2011; Moore et al., 2005; WHO, 2002; World Cancer Research Fund, 1997). However, few individuals meet the recommendations for fruit and vegetable consumption, despite the recorded health benefits (Fox et al., 2010; Lorson et al., 2009; Matheson et al., 2002). Since habits of food intake, specifically fruit and vegetable consumption, are developed in childhood and persist into adulthood (Pearson et al., 2009), further research on children's intake of fruit and vegetables is warranted. Understanding the factors and current recommendations related to children's fruit and vegetable consumption provides the background for this study.

This literature review begins by outlining the importance of fruit and vegetable consumption due to numerous health benefits and includes a description of nutrients contained in fruit and vegetables. Then, government recommendation for fruit and vegetable consumption and children's current consumption are outlined. Factors related to children's fruit and vegetable consumption, including taste preference, food neophobia, early exposure to fruit and vegetables, parental modeling of fruit and vegetable consumption, availability and accessibility, children's physical and emotional development, and various parenting styles are discussed. Considerations for feeding young children are presented, followed by a summary of this chapter.

Global Burden of Chronic Diseases

Chronic diseases such as obesity, diabetes, cardiovascular disease, hypertension, and cancer have become a global burden, claiming millions of lives and costing billions of dollars in healthcare (Druss et al., 2001; Hayat, Howlader, Reichman, & Edwards, 2006; Kearney et al., 2005; WHO, 2013). Worldwide, obesity has doubled since 1980, affecting 1.4 billion adults in 2008 and 40 million children under the age of five in 2010 (WHO, 2013a). Obesity is a risk factor for type two diabetes, which currently affects 312 million individuals worldwide including an increasing number of children (WHO, 2013b). In addition, the World Health Organization reported that cardiovascular disease, the leading cause of worldwide death and disability, accounted for 17.3 million deaths in 2008 and is estimated to increase to 23.6 million deaths by 2030 (WHO, 2013c). The same trend can be seen with regards to hypertension: 26.4% of the worldwide adult population, or 972 million individuals, had hypertension in 2000 and researchers expect a 60% increase in this number by 2025 (Kearney et al., 2005). Cancer, another major chronic disease, claimed 7.6 million lives in 2008, an estimated 30% of which could have been prevented (WHO, 2013d). Based on the rates of cancer in the United States from 2001-2003, the likelihood of developing cancer during a person's lifetime is approximately one in two for men and one in three for women (Hayat et al., 2006). Chronic diseases have a major impact on the world population and their effects are expected to rise (Druss et al., 2001).

Fruit and Vegetables Decrease the Risk of Chronic Diseases

Many chronic disease states can be alleviated or reversed with increased fruit and vegetable consumption (Anderson, 2003; Bazzano et al., 2002; WHO, 2002). The 2002 *World Health Report* indicated that low fruit and vegetable consumption is estimated to

cause approximately 31% of ischemic heart disease and 11% of strokes worldwide (WHO, 2002). Six of the nine major risk factors for developing atherosclerotic heart disease, the leading cause of death in the Western nations, may be reduced by eating a healthy diet including fiber from fresh produce (Anderson, 2003). The intake of fiber and other nutrients from fresh fruit and vegetables may slow the development of hypertension, decrease blood pressure in hypertensive individuals, lower LDL-cholesterol, and increase HDL-cholesterol. An estimated 2.7 million lives could be saved each year if fruit and vegetable consumption was sufficiently increased (WHO, 2002).

Nutrients in Fruit and Vegetables Contribute to Health Benefits

Fruit and vegetables are rich sources of many nutrients, including vitamins, minerals, fiber, and other biologically active compounds (Lampe, 1999). These nutrients contribute to health benefits through several possible mechanisms including: modulation of detoxification enzymes, stimulation of the immune system, reduction of platelet aggregation, modulation of cholesterol synthesis and hormone metabolism, reduction of blood pressure, and antioxidant effects. While these mechanisms may decrease the risk of chronic diseases, they also contribute to less DNA damage, a slower aging processes, and greater overall health (Lampe, 1999; McGuire & Beerman, 2007).

A number of vitamins are contained in fruit and vegetables including vitamins A, C, E and folate. Vitamin A assists with growth, reproduction, and the maintenance of a strong immune system (McGuire & Beerman, 2007). Acute vision is maintained by vitamin A, which helps preserve the outermost layer of the eye**,** and assists rod and cone cells with signal transduction of images to the brain. Vitamin C is known for its influence on the immune system and also plays a role in the cardiovascular, neurological, and endocrine

systems. It is needed to produce collagen, a connective substance that holds cells together, and maintains blood vessels, bones, cartilage, and teeth. Vitamin C and other antioxidants reduce the oxidation of cholesterol in the arteries, leading to less risk of heart disease (Van Duyn & Pivonka, 2000). Vitamin E, another antioxidant, helps stabilize cell membranes, preserve fatty acids, and reduce free radicals in the body (Dietz & Stern, 1999). This vitamin is important in the formation of blood cells, muscles, and other tissues. Folate, a vitamin found in fruit and vegetables, is involved with single transfer carbon reactions in the construction of various amino acids. Folate is central in the process of creating purines and pyrimadines, two nucleic acids that are components of RNA and DNA. In addition, folate might act at the molecular level to protect against the development of cancer (Van Duyn & Pivonka, 2000).

Magnesium and potassium are among several minerals found in fruit and vegetables that are required for energy metabolism and other processes (Bear, Conners, & Paradiso, 2007; Ford & Mokdad, 2001; McGuire & Beerman, 2007). Magnesium has been shown to reduce the incidence of diabetes through its relationship to insulin actions (Ford & Mokdad, 2001). Potassium helps lower blood pressure in some individuals through the regulation of fluid balance (McGuire & Beerman, 2007) and assists with nerve function (Bear et al., 2007). This mineral sends action potentials during neurophysiological responses, and it plays a critical role in the contractions of the heart tissue.

Dietary fiber found in fresh fruit and vegetables lowers the risk of obesity, diabetes, hypertension, and hypercholesterolemia (Ford & Mokdad, 2001; McGuire & Beerman, 2007; USDA, 2011). Fiber increases satiety following ingestion (McGuire & Beerman, 2007) which can decrease the risk of obesity (USDA, 2011). Fiber also assists in the management

of diabetes by blunting the postprandial rise in blood glucose, thereby improving glucose regulation and peripheral insulin sensitivity (Ford & Mokdad, 2001).

Several of the nutrients contained in fruit and vegetables work together and have synergistic effects (Miller et al., 2000). For example, vitamins A, C, E, and folate are natural antioxidants that sequester free radicals within the body, thereby preventing damage of DNA and cell membranes (Kaur & Kapoor, 2001). Both potassium and magnesium are required for the proper functioning of certain enzymes (McGuire & Beerman, 2007). Folic acid and vitamins B12 and B6 help lower homocysteine, which is a known risk factor for cardiovascular disease (Van Duyn & Pivonka, 2000). These vitamins and minerals, found in fruit and vegetables, support optimal health, and can help alleviate chronic diseases (Kaur & Kapoor, 2001).

Children Benefit from Fruit and Vegetable Consumption

Although most of the research in chronic diseases has focused on adults, children also experience several health benefits from greater fruit and vegetable consumption including maintenance of a healthy body weight (Miller et al., 2011) and a lower trajectory of age-related increase in systolic blood pressure throughout childhood and early adolescence (Moore et al., 2005). Miller et al. (2011) studied children's daily fruit and vegetable intake and associations with child weight status. Thirty-nine mothers of young children (age 5 to 6 years) completed a Diet History Questionnaire about their child's food intake; the child's height and weight were measured by a trained staff member. The results showed that children who were overweight and obese consumed less fruit and vegetables than children of normal weight. In another study, Moore et al. (2005) studied young children's intake of fruit, vegetables, and dairy products and subsequent changes in blood pressure. Ninety-five

children initially 3 to 6 years were followed for a period of eight years with yearly check-ups of blood pressure and diet. Children who consumed an average of 4 or more servings of fruit and vegetables a day or had increased dairy consumption showed smaller gains in yearly systolic blood pressure throughout childhood.

In addition to direct health benefits, greater fruit and vegetable consumption simultaneously decreases the consumption of foods with minimal nutritional value (Epstein et al., 2001). Research by Epstein et al. tested a parent-focused approach to modify eating behavior in at-risk children and their parents. Thirty families were divided into two groups; one focused on increasing fruit and vegetable consumption while the other group focused on decreasing high-fat/high-sugar food intake. Nutrition education, workbook modules about healthy eating and behavior changes, and program-related activities were provided during the six month treatment, and follow-up with parents and children occurred at twelve months. Those children in the group that focused on increasing fruit and vegetables also decreased high-fat/high sugar food items among children and adults; those children in the group that focused solely on decreasing high-fat/high sugar items only led to a decrease of those items. Decreasing consumption of foods with minimal nutritional value and increasing fruit and vegetable consumption might further increase health benefits, particularly with regards to children's weight maintenance.

Government Recommendations Emphasize Fruit and Vegetable Consumption

Global and national recommendations encourage people of all ages to consume an assortment of fruit and vegetables in order to minimize their risk for chronic diseases and nutrient deficiencies, and optimize their health (USDA, 2012a; WHO & FAO, 2005). The World Health Organization recommends that individuals consume 400 grams of fruit and

vegetables per day, excluding potatoes and other starchy tubers (WHO & FAO, 2005). Worldwide recommendations for children's fruit and vegetable consumption have not been distinguished from adult serving recommendations. However, the United States Department of Agriculture has developed national recommendations for children's fruit and vegetable consumption that vary by age, gender, and activity level (USDA, 2012b). Recommendations for moderately active children ages two to five years are included in Appendix A. Children's daily recommended servings of vegetables always meet or exceed the recommended servings of fruit.

Children's Current Fruit and Vegetable Consumption

Despite the recommendations, children are not consuming the suggested amounts of fruit and vegetables (Fox et al., 2010; Lorson et al., 2009; Matheson et al., 2002). The National Health and Nutrition Examination Survey (1999-2002) showed that 50.2% of children age 2-5 were not meeting the recommendations for fruit intake and 78.3% of children were meeting the recommendations for vegetable intake (Lorson et al., 2009). These results came from one 24 hour recall of 1,202 children and were compared to the MyPyramid recommendations for young children. Another study based on an earlier NHANES (1999-2000) data from one 24 hour recall provided similar results: about one-half of children age 2-3 were consuming the recommended fruit and vegetables combined per day (Guenther, Dodd, Reedy, & Krebs-Smith, 2006). This was higher than the rest of the population in that dataset, in which about 40% were meeting recommendations. The authors suggested several reasons: young children have lower recommendations and they consume a higher amount of fruit juice.

Children consume more fruit than vegetables and have preferences for certain types of fruit and vegetables such as juice and french fries (Carruth, 2004; Fox et al., 2010; Lorson et al., 2009; Skinner et al., 1999). Recent data from the Feeding Infants and Toddlers Survey (FITS) indicated that fruit was favored over vegetables for children in all age groups (6-24 months) and that 16-32% of the children did not eat any vegetables on the sampled day (Carruth, 2004). This study also investigated the relationship between vegetable consumption and picky eating, pointing out that children who were perceived as "picky eaters" by the parent were more likely to eat french fries. Several other studies reported that the most commonly consumed vegetable was french fries and other fried potatoes (Fox et al., 2010; Lorson et al., 2009), and the most commonly consumed fruit was fresh fruit (Fox et al., 2010) or 100% fruit juice (Lorson et al., 2009).

Although recommendations propose equal or greater vegetable consumption than fruit consumption, fruit still exceeds vegetable consumption among the majority of young children (Fox et al., 2010). In addition, young children do not consume the recommended vegetable servings. If more vegetables than fruit are recommended for children but more fruit than vegetables are actually being consumed, it is informative to know the types and amounts of nutrients that children are obtaining from fruit and how they compare to vegetables.

Many Factors Influence Children's Fruit and Vegetable Consumption

Children's fruit and vegetable consumption is influenced by many factors: taste preference, food neophobia, exposure, parental modeling, availability, accessibility, and the child's physical, emotional, and social development. Since preferences for fruit and vegetables are established in childhood and persist into adulthood (Pearson et al., 2009), it is

necessary to investigate these young children's behaviors and preferences in an effort to promote the development of healthy food habits.

Taste preference influences children's fruit and vegetable consumption. Taste preference is the most influential factor in a preschooler's food intake at a meal or snack (Bear et al., 2007; Birch, 1999; Cooke, 2007; Segovia, Hutchinson, Laing, & Jinks, 2002). Children are born with an innate predisposition for sweet and salty food over that which is sour or bitter (Birch, 1999). This taste preference may be due to greater taste sensitivity at a young age (Bear et al., 2007; Segovia et al., 2002). Children have a greater number of fungiform papillae and a higher taste bud density on their tongues than adults, which makes them more sensitive to a lower threshold of a particular taste (Segovia et al., 2002). Bitter substances, such as those found in some vegetables, can be detected by 30 different types of receptors on the human tongue (Bear et al., 2007). This sensitivity to bitter substances is theorized to have been necessary for early survival since many bitter substances found in nature are poisonous (Cooke, 2007). The physiological structure of the tongue and the negative response to a bitter taste does not support consumption of some vegetables (Bear et al., 2007).

An early study by Birch (1979) documented the impact of taste preference among young children. In her investigation of the dimensions of children's food preferences, Birch asked thirty-seven preschool children to rank their liking of fruit items in order from least to greatest. The results showed that familiarity and level of sweetness accounted for the greatest variance of fruit preference among preschool children. Current literature supports this finding; children have a clear preference for items which are sweet, such as fruit, over

those which are bitter or sour, such as some vegetables (Dennison, Rockwell, & Baker, 1997).

Food neophobia influences children's fruit and vegetable consumption. Taste preferences may contribute to food neophobia, or an unwillingness to try new foods (Wardle et al., 2005). Just as humans are predisposed to favor items that are sweet instead of bitter, they are more likely to consume food that is familiar rather than novel (Cooke, 2007). A positive experience with food that is not followed by gastrointestinal problems may be one reason for preference of familiar, tested food items (Birch et al., 1987). There is a perceived 'safety' in consuming familiar food (Bear et al., 2007).

A child's level of food neophobia affects their food consumption, particularly fruit and vegetables (Cooke, 2007; Cooke et al., 2003; Dovey et al., 2008). Food neophobia reaches a peak between the ages of two and six and typically declines thereafter (Dovey et al., 2008). As children grow older and begin to learn which foods are safe to eat, they express less food neophobia (Cooke, 2007; Dovey et al., 2008), have a greater enjoyment of food, and have a higher consumption of both fruit and vegetables (Cooke et al., 2003).

Cooke et al. (2003) also reported that intake of fruit and vegetables can be predicted by food neophobia. In their study, parents and principle caregivers of 564 children ages two to six years completed a food frequency questionnaire and an adapted questionnaire from the Child Food Neophobia Scale designed to assess the extent to which children reject unfamiliar foods. Children who had less food neophobia had a greater intake of fruit and vegetables. At the same time, older children (who also tended to have less food neophobia) showed greater acceptance of vegetables than their younger peers, but the same acceptance for fruit.

Exploring ways to decrease food neophobia may lead to greater acceptance of novel foods, including fruit and vegetables (Dovey et al., 2008; Osborne & Forestell, 2012).

Early exposure influences children's fruit and vegetable consumption.

Decreasing food neophobia and increasing a child's preference for a particular food may be accomplished with repeated exposure to novel food items (Birch et al., 1987; Osborne, & Forestell, 2012; Sullivan & Birch, 1990; Wardle, Cooke, & Gibson, 2003; Wardle et al., 2005). Multiple exposures to a food, such as a fruit or vegetable, are generally required to alter preferences for that food item (Sullivan & Birch, 1990); this is known as exposure-based modification of behavior (Wardle et al., 2005).

Research by Wardle et al. (2003) demonstrates the effectiveness of increasing preference for fruit and vegetables through repeated exposure. Each child (n=72) in this study was assigned to a reward group, exposure group, or control group and tested over a period of eight days. In the exposure group, children were offered a taste of fresh, sweet red pepper and told they could eat as much as they wanted; children in the reward group were offered a sheet of cartoon stickers if they tried a taste of the red pepper; and children in the control group received no intervention. Results indicated that children in the exposure group showed a significant increase in their liking and consumption of red pepper after the intervention, while children in the reward group showed a level of liking intermediate to the control and exposure groups. Exposure alone had the greatest effect on consumption.

Exposure to fruit and vegetables can come in a variety of different ways, including visual exposure and taste exposure (Birch et al., 1987; Osborne & Forestell, 2012). Osborne & Forestell (2012) showed that both visual and taste exposure can effectively increase fruit consumption but not vegetable consumption. In their study, parents were given two books,

one about healthy eating (*Eat Healthy, Feel Great*) and one about fruit and vegetables (*Eating the Alphabet*), to read to their children (ages 4-8 years) over an eight day period. Some of these parents were also given fruit and vegetables to offer to their children throughout the trial period, with and without the books. At the end of the trial, children who were offered the food and/or read to during the trial period were much more likely to eat fruit, but notably, not vegetables at the end of the trial period.

Another study suggested that in order for a child to enjoy the consumption of a particular food, they must have an experience tasting that food (Birch et al., 1987). The researchers exposed children (n=51, ages 2-5 years) to seven novel fruit by allowing them to either "look" or "taste" a small sample of fruit 5, 10, or 15 times. While visual exposure to the fruit increased visual appeal later in the study, it did not increase taste preference. The researchers suggest that in order for a child to have an increased taste preference for fruit, he or she must actually have an experience with the food that is relevant for later judgments; in other words, to increase taste preference for fruit, a child must actually taste it.

Parental modeling influences children's fruit and vegetable consumption. Positive parental modeling has been shown to increase a child's fruit and vegetable consumption (Cooke, 2007; Cooke et al., 2003; Miller et al., 2011; Pearson et al., 2009; Wardle et al., 2005; Vereecken, Rovner, & Maes, 2010). When parents consume a particular fruit or vegetable, they help decrease their child's food neophobia by demonstrating the safety of eating that particular food (Cooke, 2007; Pearson et al., 2009), which in turn improves a child's preference for a variety of foods (Miller et al., 2011).

A child's fruit and vegetable consumption is particularly associated with a mother's fruit and vegetable consumption (Miller et al., 2011). Mothers (n=39) from a variety of

different backgrounds (race, marital status, income, weight) were given a subsection of the Diet History Questionnaire to assess their fruit and vegetable consumption and another questionnaire to estimate fruit and vegetable consumption among their children, 5 to 6 years of age. Higher fruit and vegetable consumption by the mother was significantly associated with higher fruit and vegetable consumption by the child. The authors suggested the primary reason for this association was positive role modeling of fruit and vegetable consumption provided by the mothers. In addition, mothers are typically the caregiver in charge of food preparation and the gatekeeper over the food that is available and accessible in the home.

Since dietary habits develop within the context of the family, parental modeling of fruit and vegetable consumption is an important predictor of their child's fruit and vegetable consumption (Vereecken et al., 2010). Parents, particularly mothers, have a major role in helping their children meet fruit and vegetable recommendations.

Availability and accessibility influences children's fruit and vegetable consumption. Throughout early childhood, parents and caregivers determine the type of food available in the home and the foods accessible at meal and snack times (Wardle et al., 2005). Availability is the term used to describe when a food is on hand in the immediate food environment (Timperio et al., 2008). A food item must first be available at home or preschool in order to make it accessible to a child. Accessibility is a condition in which food is within a person's reach and ready to be consumed (Bere & Klepp, 2005). In application, availability is identified whether the adult has purchased the food and it is present in the home whereas accessibility means that food, such as fruit and/or vegetables, have been prepared (i.e. washed, sliced, and peeled) for consumption and have been placed in an area where a child can easily pick it up and eat it (Goldman et al., 2012). Research shows that

both availability and accessibility are two of the best predictors of children's fruit and vegetable consumption.

There are several factors that affect fruit and vegetable availability and accessibility in the home including the cost of fruit and vegetables and children's asking skills (Blanchette & Brug, 2005; Cassaday, Jetter, & Culp, 2007; Drewnowski & N. Darmon, 2005). One of the main barriers to availability of fruit and vegetables is the cost, particularly among low income families (Cassaday et al, 2007). Research shows that low-income families would need to devote 43% to 70% of their food budget to fruit and vegetables in order to purchase the amount recommended by the 2005 Dietary Guidelines. Since there is an inverse relationship between energy density and price, it is easier for families to lower their food consumption costs by choosing foods that are more energy dense; yet, these items are often less nutrient dense and may exclude items such as fruit and vegetables (Drewnowski & N. Darmon, 2005). Asking skills, on the other hand, can be one way to increase both availability and accessibility of fruit and vegetables (Blanchette & Brug, 2005). When children have the ability to ask their parent or caregiver to buy or prepare fruit and/or vegetable(s), that item is more likely to be purchased and later offered to the child.

Once food items are available at preschool or home, they must be accessible to the child at meal or snack times in portions that are safe and suitable (Goldman et al., 2012). Specifications for mealtime food accessibility at the preschool level are nationally regulated (USDA, Food and Nutrition Services 2013). Within the Child and Adult Care Food Program, under the direction of the Food and Nutrition Services, all meals in child care settings must offer (or make accessible) one-fourth cup of fruit or vegetables at every meal for children ages one or two years, and one-half cup of fruit or vegetables for children ages

three to five years. Regardless of portion size, fruit and vegetables should be prepared by an adult, since some items can be a choking hazard for young children (Branen & Fletcher, 2012; Dietz & Stern, 1999). Parents and caregivers in the home can increase accessibility of fruit and vegetables by washing, peeling, slicing, and offering them at mealtimes (Goldman et al., 2012). Burchett (2003) encourages parents to use preparation methods that maximize preferred sensory qualities (juiciness, color, bite-sized portions, accompanied by a dip or sauce) and to pair fruit and vegetables with preferred tastes and flavors.

Making fruit and vegetables available and accessible increases consumption through higher exposure to fruit and vegetables, greater parental modeling of fruit and vegetable consumption, and reinforcement of taste preference development (Blanchette & Brug, 2005). In order to have a positive experience with a fruit or vegetable, it must be in the immediate food environment and prepared in a way that is safe and suitable for consumption.

Physical development influences children's fruit and vegetable consumption. A child's physical development determines what types and forms of fruit and vegetables can be offered. While an infant's feeding is mainly a reflexive activity under the brainstem's control, a toddler's food consumption is controlled by both the brainstem and cerebral cortex (Stevenson & Allaire, 1991). Mature chewing and swallowing consists of voluntary and involuntary components, requiring attention and skill from the novice child. Oral motor control development during feeding continues throughout childhood and is typically developed and refined by early adolescence (Morris & Klein, 2000). Since some vegetables and fruit (such as apples with peels, baby carrots, cherry tomatoes, and whole grapes) are a choking hazard for young children, these food items should be avoided unless cooked and/or served properly (Branen & Fletcher, 2012; Dietz & Stern, 1999).

As a child's mouth and motor skills develop, he or she also experiences a range of oral and sensory events with the introduction of novel food items (Stevenson & Allaire, 1991). Textures, mouth feel, temperatures, and other physical features of food are discovered by the tongue and mouth during this time. Young children's fruit and vegetable consumption is affected by their preferences for certain physical characteristics (Fox, Reidy, Novak, Ziegler, 2006; Lorson et al., 2009). This can play an important role in fruit and vegetable preference, considering the wide variation of physical features among fruit and vegetables (Poelman & Delahunty, 2011; Skinner et al., 1999).

Cognitive and emotional development influences children's fruit and vegetable consumption. In addition to physical development, a child's cognitive and emotional development must be considered during meal and snack times (Morris & Klein, 2000). A child's ability to recognize and ask for fruit and vegetables depends on their developmental age (Resnicow et al., 1997). Children may have difficulty asking for fruit and vegetables using traditional classifications because these food classification groups are abstract to the child (Matheson et al., 2002). Preschool children rely on concrete characteristics such as colors, shapes, and textures to classify food. Therefore, food groups ("fruit" and "vegetable") should not be a central theme at meal and snack times; rather, parents and caregivers must focus on concepts and features that are understandable to the child.

A child's emotional development impacts their interactions with caregivers at meal and snack times. Children are in a period of independence and separation from parents (Morris & Klein, 2000). Feeding is a realm in which children struggle between dependence, or being fed, and independence, or feeding themselves (Fletcher et al., 1997). From an emotional developmental perspective, a child's assertion of independence may negatively

influence fruit and vegetable consumption and willingness to try new food items (Morris & Klein, 2000). Parents and caregivers must remember the child's emotional and cognitive development while fostering healthy long term patterns in their child's food intake by offering food to their child and allowing him or her to choose if and how much to eat.

Parenting Styles

Parenting styles, such as authoritative, authoritarian, or permissive, impact a child's consumption of fruit and vegetables during meal and snack times (O'Conner et al., 2010; Vereecken, Rovner, & Maes, 2010; Wardle et al., 2005; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002). Authoritarian parenting is a style in which the adult shapes, controls, and evaluates a child's behaviors and attitudes based on a set of standards (Baumrind, 1971). In feeding, the parent controls all aspects of the food environment including what, when, and how much their child will consume (Fletcher et al., 1997). Authoritative parenting is a cooperative parenting style in which the adult is responsive to the child's needs and individuality while setting firm boundaries (Baumrind, 1971). At meal and snack times, there is a shared responsibility where the adult chooses what food and when it will be presented and the child chooses how much and whether to eat (Fletcher et al., 1997). Permissive parenting is a style characterized by an adult who uses little punishment, does not clearly define rules, and avoids asserting his or her authority (Baumrind, 1971). In feeding, the child controls the eating environment including what, when, and how much he/she will consume (Fletcher et al., 1997). While authoritarian parenting techniques tend to decrease a child's consumption of fruit and vegetables, parents who are authoritative generally have children with higher fruit and vegetable consumption (Vereecken et al., 2010).

Authoritarian parenting: Decreased fruit and vegetable consumption.

Authoritarian parents might practice control or employ contingencies in order to increase their child's consumption of a food item, such as fruit or vegetables (Birch et al., 1984). This can lead to instrumental eating, in which consumption of a particular food item (i.e. vegetables) is a 'means' to an 'end' reward: praise, dessert, or a special privilege. Employing contingencies at meal and snack times can negatively impact a preschool child's preference for a particular food, because it encourages an action, food intake, without a specific behavior change.

In order to test the effects of contingencies on food preferences, Birch et al. (1984) performed a study in which forty-five preschool children were placed in either an "instrumental" group or a "control" group and tested. During a series of special snack times, children in the instrumental group were provided a certain milk-based drink and given either verbal praise or a tangible reward (movie ticket) after drinking the beverage. At the end of the experimental phase, all the children that participated in the group with verbal or tangible rewards had a significantly ($p < 0.001$) decreased preference for the beverage they were presented with; whereas, the children in the control group showed a slight but non-significant increase in preference. These findings may apply to fruit and vegetable consumption, in which an explicit or implicit reward is applied to modulate a child's consumption.

Research demonstrates that forcing or coercing a child to consume food is counterproductive and may lead to less intake of that food long term (Fisher et al., 2002; Branen & Fletcher, 1999). When a child is not eating sufficient amounts or expresses food neophobia, some parents may pressure their child to eat and inadvertently cause him or her to further refuse food (Haycraft & Blissett, 2010; Vereecken et al., 2010). This inverse

relationship between parental control and children's fruit and vegetable consumption has been reported in previous literature (Wardle et al., 2005). When external control on food intake is employed during early childhood, it can also cause a decrease in later self control related to eating (Branen & Fletcher, 1999).

Authoritative parenting: Increased fruit and vegetable consumption. A more positive approach to feeding children can be seen from authoritative feeding styles (Fletcher et al., 1997; O'Conner et al., 2010). Authoritative feeding practices tend to promote fruit and vegetable consumption among children by providing a nurturing, proactive structure to meal and snack times (O'Conner et al., 2010). A component of authoritative or cooperative feeding is the adult's responsibility to help children recognize internal cues (Ramsay et al., 2010), which may be beneficial for lifelong health.

O'Conner et al. (2010) suggests that children of authoritative parents have a higher consumption of fruit and vegetables. Parents of Head Start Children (n=755) were given several questionnaires: the Caregiver's Feeding Styles Questionnaire, Children's Behavior Questionnaire, and a home fruit and vegetable availability questionnaire. A three day dietary recall was conducted for both the child and parent to measure fruit and vegetable consumption. Authoritative parents were more likely to use practices that enhanced availability and accessibility of fruit and vegetables, reported greater frequency of using teachable moments, and tended to apply less firm discipline. Overall, this study and others suggest that the constellation of authoritative parenting behaviors promote fruit and vegetable consumption in young children.

Considerations for feeding young children: the division of responsibility. Ellyn Satter and subsequent authors suggest a division of responsibility in feeding young children

(Fletcher & Branen, 1999; Satter, 2005). Parents are responsible for what and when food is offered and children are in charge of choosing how much and whether they eat those foods; this concept applies to fruit and vegetables. An appropriate feeding relationship between the caregiver and the child assists with proper growth and development of the child (Ramsay et al., 2010; Satter, 2005). Children are naturally interested in eating for survival, so parents simply need to support these natural inclinations and offer foods that are nutrient-dense (Scheidlin, 2005). Child appropriate serving sizes of nutrient dense foods, such as fruit and vegetables, are intended to help a child meet his or her nutrient needs (Ramsay, Branen, & Johnson, 2012). The key is to offer nutritious choices at the child's meals and snacks, and allow him or her to choose how much and whether to eat those items.

Summary

Chronic diseases such as obesity, diabetes, cardiovascular disease, hypertension, and cancer have become a global burden, claiming millions of lives and costing billions of dollars in healthcare (Druss et al., 2001; Hayat, Howlader, Reichman, & Edwards, 2006; Kearney et al., 2005; WHO, 2013). Many chronic disease states can be alleviated or reversed with increased fruit and vegetable consumption (Bazzano et al., 2002). Although most of the research in chronic diseases has focused on adults, children also experience several health benefits from greater fruit and vegetable consumption including maintenance of a healthy body weight (Miller et al., 2011) and lower gains in yearly systolic blood pressure throughout childhood and early adolescence (Moore et al., 2005). Fruit and vegetables are rich sources of many nutrients, including vitamins, minerals, fiber, and other biologically active compounds which contribute to these health benefits (Lampe, 1999).

Global and national recommendations correctly emphasize fruit and vegetable consumption (USDA, 2012a). As a result, parents might feel a particular obligation to increase their child's intake of fruit and vegetables (Haycraft & Blissett, 2010). However, research shows that forcing or coercing a child to consume fruit and vegetables is counterproductive (Branen & Fletcher, 1999). Parents need more information and reassurance about fruit and vegetable consumption among children and nutrient intake in order to foster a healthy feeding relationship.

The majority of previous research has investigated fruit and vegetable consumption combined (Guenther et al., 2006; Vereeken, 2010; Wardle et al., 2005); yet, few studies have described young children's fruit consumption and vegetable consumption separately. Rather, "fruit and vegetables" have been considered a single unit in most of the literature. Since preferences for fruit and vegetables by young children varies by taste and other factors, the consumption and nutrient intake from fruit and vegetables should be treated as unique and different categories.

The purpose of this study was to determine the amount of fruit and vegetables consumed by children ages two to five years, the nutrient content from the fruit and vegetables consumed, and the types of fruit and vegetables consumed most frequently and in the highest amount. Results from this study will allow professionals and dietitians to identify current patterns in young children's fruit consumption and vegetable consumption and inform parents and caregivers on amounts of key nutrients contained in frequently consumed fruit and vegetables.

Chapter Three

Promoting the Positive: Children's Nutrient Intake from Fruit is Similar to their Intake from Vegetables

Abstract

Preferences for fruit and vegetables are established in childhood and persist into adulthood, demonstrating a need for further investigation of young children's fruit and vegetable consumption. The objectives of this study were to 1) describe the amount, frequency, and average nutrient intake from young children's fruit consumption and vegetable consumption; and 2) determine whether there are significant differences in children's fruit consumption and vegetable consumption by age, gender, body-mass index (BMI), ethnicity, and socioeconomic status (SES). Fruit consumption and vegetable consumption of young children, two to five years of age (n=821), was identified using the 2009-2010 National Health and Nutrition Examination Survey dietary data from a 24 hour recall. Mean, standard error, and multiple comparisons using p-values from a Tukey's HSD post-hoc test were completed using "R" software. Children consumed approximately three times as many fruit servings as vegetable servings regardless of age, gender, BMI, ethnicity, and SES. Potato products and fruit juice were consumed most frequently and in the greatest amounts. Children obtained more fiber, vitamin C, folate, magnesium, and potassium from fruit than from vegetables; and more vitamin A and E from vegetables than from fruit. Children's nutrient intake from fruit indicates that while caregivers should continue to offer and encourage vegetables, they can be informed that children's fruit consumption may provide similar nutrients as vegetables to meet the recommended dietary allowance.

Introduction

Fruit and vegetable consumption yields many health benefits: increased immune function and decreased risk of cardiovascular disease, hypertension, obesity, and some forms of cancer (Ford & Mokdad, 2001; Lampe, 1999; Miller et al., 2011; Moore et al., 2005; World Cancer Research Fund, 1997; WHO, 2002). Six of the nine major risk factors for developing atherosclerotic heart disease, the leading cause of death in the Western nations, may be reduced by eating a healthy diet including fiber from fresh produce (Anderson, 2003). An estimated 2.7 million lives could be saved each year if fruit and vegetable consumption was sufficiently increased (WHO, 2002). Global and national recommendations encourage the consumption of both fruit and vegetables as part of a healthy diet (USDA, 2012a; WHO and Food and Agriculture Organization, 2005).

Although fruits and vegetables provide health benefits, few adults or children consume the recommended amount of fruit and vegetables combined (Fox, Condon, Briefel, Reidy, & Deming, 2010; Lorson, Melgar-Quinones, & Taylor, 2009; Matheson, Spranger, & Saxe, 2002). Adults' low fruit and vegetable consumption may be a result of their low fruit and vegetable consumption in childhood, since many habits of food intake are developed in early childhood and persist into adulthood (Pearson, Timperio, Salmon, Crawford, & Biddle, 2009). One of the most formative times for the development of fruit and vegetable preference is during early childhood (Fox et al., 2010).

Many factors influence a child's consumption of fruit and vegetables including taste preference, food neophobia, previous exposure to fruit and vegetables, and parenting techniques (Birch, 1999; Branen & Fletcher, 1999; Dovey, Staples, Gibson, & Halford, 2008; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Sullivan & Birch, 1990). Children have

an innate preference for sweet or salty foods over bitter and sour foods (Birch, 1999), and they experience the greatest food neophobia, or unwillingness to try new foods, during the ages of two to six years (Dovey et al., 2008). One way to increase preference is by giving children multiple exposures to particular food items including fruit and vegetables (Sullivan & Birch, 1990). However, forcing or coercing a child to consume food, such as fruit and vegetables, is counterproductive and may lead to less intake of that food long term (Branen & Fletcher, 1999; Fisher et al., 2002).

Since preferences for fruit and vegetables are established in childhood and persist into adulthood, there is a need for further investigation of young children's fruit and vegetable consumption. Currently, children's daily vegetable serving recommendations always meet or exceed fruit serving recommendations; however, children continue to consume more fruit than vegetables. While the majority of research has focused on both fruit and vegetable consumption, few studies have investigated young children's fruit consumption and vegetable consumption, separately, as well as their nutrient intake from fruit and vegetables. The purpose of this study was to describe the amount, frequency, and average nutrient intake from young children's fruit consumption and vegetable consumption and determine whether there are significant differences in children's fruit consumption and vegetable consumption by age, gender, BMI, ethnicity, and SES.

Methods

Children's intake data from NHANES. Fruit consumption and vegetable consumption of young children, two to five years of age (n=866), was identified using the 2009-2010 National Health and Nutrition Examination Survey (NHANES). The NHANES data was obtained through a complex, multistage probability sampling method and is

considered nationally representative (Centers for Disease Control and Prevention [CDC], 2011a). In-person proxy interviews with the caregiver who purchases food for the household were conducted to gather children's (ages one to eleven years) food intake over a 24-hour period (CDC, 2009). Signed parental consent was acquired prior to gathering a child's food intake. Protocols for the NHANES 2009-2010 were approved by the National Center for Health Statistics research ethics review board (CDC, 2011b) and details about these protocols can be found online (CDC, 2009; United States Department of Health and Human Services, 2011). Permission to use this dataset was obtained via email from the Centers for Disease Control (personal communication, 2012).

Data organization. Children's fruit consumption, vegetable consumption, and nutrient intake were analyzed using the primary NHANES 24-hour food recall (CDC, National Center for Health Statistics, 2012). Data were organized by child demographics including age (two, three, four, or five years), gender, body-mass index (separated into normal, at risk for overweight, and overweight categories based on CDC growth chart percentiles), ethnicity, and socioeconomic status [determined by the poverty index ratio (PIR) level]. All food items were categorized into USDA specified food groups and subgroups using a seven digit sequence number, which corresponded to a food name (Ahuja et al., 2012). The "fruit" and "vegetable" food groups, as defined by the USDA's Food Surveys Research Group (FSRG), were used for this study. Recorded nutrients for each food item included kilocalories, carbohydrates, protein, fat, fiber, vitamin A, vitamin C, vitamin E, folate, magnesium, and potassium (MyPlate, 2013). Nutrient composition of food items, per amount, was previously determined by the USDA using the Food and Nutrient Database for Dietary Studies 5.0 (Ahuja et al., 2012).

Fruit and vegetables consumed by children ages two to five years, along with corresponding nutrients for these food items, were isolated from the original dataset. Fruit and vegetables were analyzed as separate categories including the following data: 1- total fruit (F); 2- fruit juice (FJ); 3- total fruit excluding fruit juice (F-FJ); 4- total vegetables (V); 5- potato products and Puerto Rican starchy vegetables (PP); and 6- total vegetables excluding potato products and Puerto Rican starchy vegetables (V-PP). Previous research has reported that fruit juice and potato products are among the most frequently consumed fruit and vegetables, respectively (Lorson et al., 2009); thus, the servings and nutrient content with and without these items was investigated.

Average consumption of fruit and vegetables, including their corresponding nutrients, was compared to reference values after separating the data based on each child's demographic variables. USDA fruit and vegetable serving recommendations for a child of moderate physical activity were compared to children's fruit and vegetable consumption (USDA, 2012b). The average nutrient content from consumed fruit and vegetables were compared to the dietary reference intake (DRI) values for children ages two to five years (Institute of Medicine [IOM], 2011a; IOM 2011b). The Estimated Average Requirement (EAR) was used except when an EAR had not been established, in which the Adequate Intake (AI) was used as a reference value (IOM, 2000).

MyPyramid equivalent conversion. Using the MyPyramid Equivalents Database (MPED 2.0), fruit and vegetable consumption (reported in grams) was converted to servings as cup-equivalents (Bowman, Friday, & Moshfegh, 2008). The majority of the MPED food codes corresponded to food codes for the NHANES 2009-2010 dataset. In cases where food codes did not match, a similar food item was used to calculate serving sizes following

protocols from previous literature (Welsh et al., 2010). For example, "fruit juice blend, 100% juice, with added vitamin C" from MPED was used to calculate servings of "fruit juice blend, incl. citrus, 100% juice" from the NHANES dataset. Nutrients for the original food were contained in the NHANES dataset; therefore, the MPED substitutions (16 items) were used only for the conversion of the gram amount to a serving amount.

Data analysis. Fruit and vegetable consumption by servings was analyzed for statistical significance ($p < 0.05$) using 'R' software. Mean, standard error, and multiple comparisons using p-values from a Tukey's HSD post-hoc test were completed. Gender was treated as a two-level class factor; age a four-level class factor, ethnicity a five-level class factor; body mass index (BMI) a three-level class factor; and socioeconomic status a four-level class factor. A comparison between variable classes was repeated for all fruit and vegetable data.

Results

Demographics. A total of 866 children ages 2-5 years were included in the 2009-2010 NHANES dataset, of which 821 children (94.8%) consumed fruit, vegetable(s), or both as part of their food intake on the recorded day (Table 1). Children two years of age comprised the greatest portion of the sample (34.1%; n=280) and children five years of age comprised the least (20.2%; n=166). Males and females equally represented about one-half of the sample. Non-Hispanic White children comprised the greatest percentage of the sample (35.0%; n=287), followed by Mexican American children (27.9%; n=229), Non-Hispanic Black children (17.2%; n=141), other Hispanic children (11.0%; n=91), and other race - including multiracial children (8.9%; n=83). Nearly three-fourths of the children (n=605) were in the normal weight category (under the 85th percentile for age), while 11.8% (n=97) of

the children were at risk for overweight (85^{th}-95^{th} percentile for age), and 12.4% (n=102) of the children were overweight (above the 95^{th} percentile for age). Almost one-half (49.3%; n=405) of the children were from a low income household; only 13.2% (n=108) of the children came from high income households.

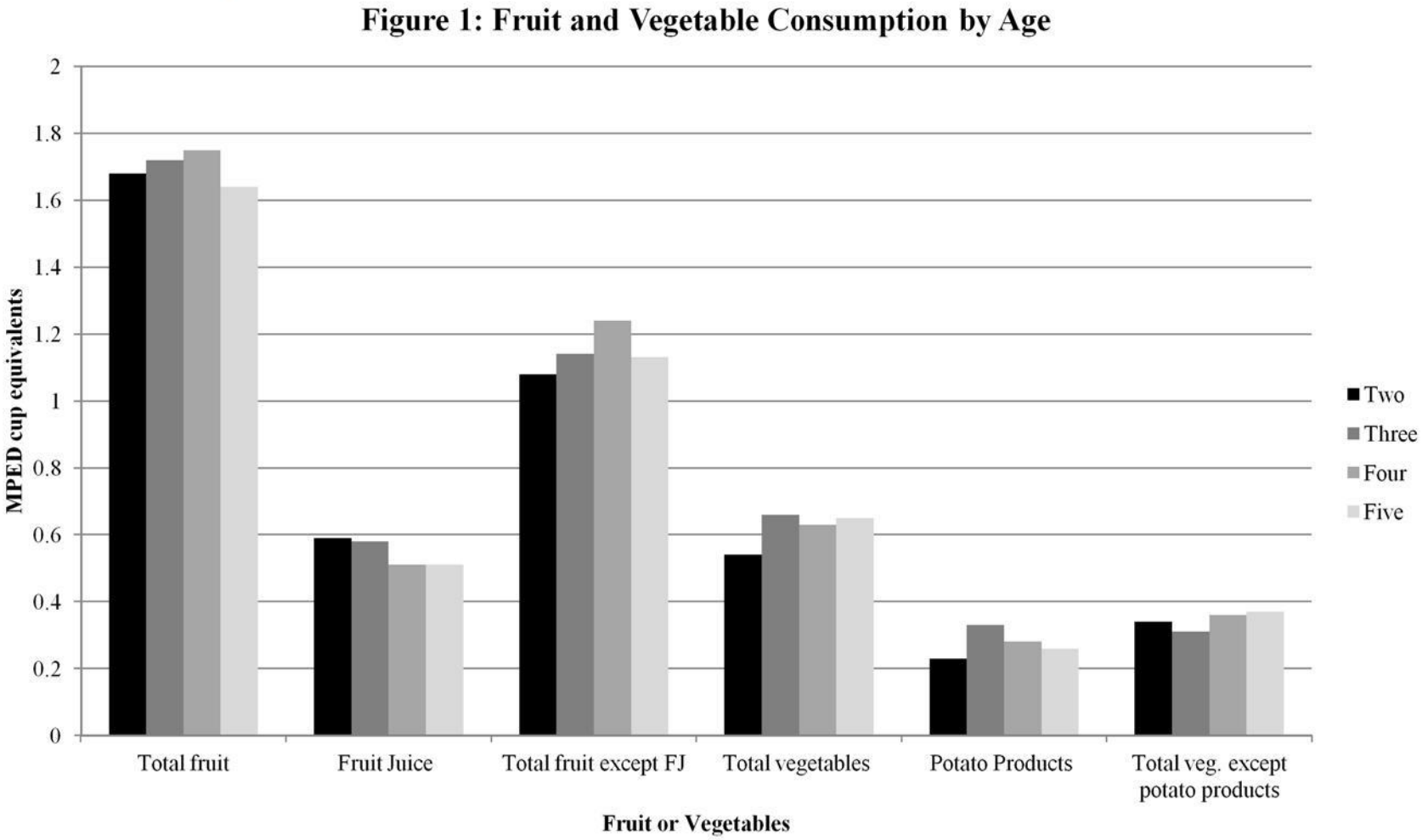
Total fruit consumption and vegetable consumption. Children's total amount of fruit consumed (1.69 ± 0.05 servings) was approximately three times the total amount of vegetables consumed (0.61 ± 0.02 servings) for all demographic variables (Table 1). There were no significant difference in fruit consumption for age, gender, and BMI. However, Mexican American and Other Hispanic children's total fruit consumption was significantly higher ($p < 0.05$) than Non-Hispanic Black children. In addition, children from middle income households had significantly higher total fruit consumption than children from low income households ($p < 0.05$). Children's total vegetable consumption did not vary significantly among any demographic variables.

Table 1: Average consumption of fruit and vegetables by age, gender, race, body mass index (BMI), and household income (2009-2010). Mean servings are reported as MyPyramid cup-equivalents

Demographic Characteristic	Sample n	Sample %	% fruit rec.[a]	Total Fruit[b]	Fruit Juice (FJ)	Total Fruit minus FJ	% veg. rec.[a]	Total Vegetables	Potato Products (PP)	Total Vegetables minus PP
				← Mean servings ± standard error →						
Total Sample	821	94.8%	129.5%	1.69 ± 0.05	0.553 ± 0.03	1.14 ± 0.04	44.4%	0.61 ± 0.02	0.27 ± 0.01	0.34± 0.02
Age Category (years)										
Two	280	34.1%	128.0%	1.68 ± 0.11	0.59 ± 0.04	1.08 ± 0.07	39.3%	0.54 ± 0.04	0.23 ± 0.02^{x}	0.34 ± 0.02
Three	175	21.3%	131.0%	1.72 ± 0.14	0.58 ± 0.05	1.14 ± 0.09	48.0%	0.66 ± 0.06	0.33 ± 0.03^{y}	0.31 ± 0.03
Four	200	24.4%	133.3%	1.75 ± 0.13	0.51 ± 0.04	1.24 ± 0.10	45.8%	0.63 ± 0.05	0.28 ± 0.02^{x,y}	0.36 ± 0.03
Five	166	20.2%	125.0%	1.64 ± 0.15	0.51 ± 0.05	1.13 ± 0.10	47.3%	0.65 ± 0.06	0.26 ± 0.02^{x,y}	0.37 ± 0.03
Gender										
Male	432	52.6%	127.2%	1.67 ± 0.09	0.55 ± 0.03	1.13 ± 0.06	44.4%	0.61 ± 0.03	0.27 ± 0.02	0.33 ± 0.02
Female	389	47.4%	131.0%	1.72 ± 0.10	0.56 ± 0.03	1.17 ± 0.06	45.1%	0.62 ± 0.04	0.27 ± 0.02	0.36 ± 0.02
Race/Ethnicity										
Mexican American	229	27.9%	137.1%	1.8 ± 0.13^{x}	0.56 ± 0.04	1.24 ± 0.09^{x}	45.8%	0.63 ± 0.05	0.23 ± 0.02	0.33 ± 0.03
Other Hispanic	91	11.1%	141.7%	1.86 ± 0.21^{x}	0.69 ± 0.08	1.17 ± 0.13^{x,y}	50.9%	0.7 ± 0.09	0.26 ± 0.03	0.45 ± 0.06
Non-Hispanic White	287	35.0%	128.8%	1.69 ± 0.11^{x,y}	0.51 ± 0.03	1.18 ± 0.08^{x}	44.4%	0.61 ± 0.04	0.28 ± 0.02	0.36 ± 0.02
Non-Hispanic Black	141	17.2%	106.7%	1.4 ± 0.13^{y}	0.53 ± 0.05	0.86 ± 0.08^{y}	42.9%	0.59 ± 0.06	0.33 ± 0.03	0.29 ± 0.03
Other Race & Multiracial	73	8.9%	134.1%	1.76 ± 0.23^{x,y}	0.55 ± 0.07	1.21 ± 0.16^{x,y}	39.3%	0.54 ± 0.07	0.25 ± 0.03	0.31 ± 0.04
BMI category										
Normal weight	605	73.7%	135.6%	1.67 ± 0.07	0.54 ± 0.02	1.14 ± 0.05	42.9%	0.63 ± 0.03	0.28 ± 0.01	0.34 ± 0.02
At risk for overweight	97	11.8%	127.2%	1.79 ± 0.19	0.63 ± 0.07	1.15 ± 0.13	45.8%	0.59 ± 0.07	0.23 ± 0.03	0.37 ± 0.04
Overweight	102	12.4%	128.0%	1.68 ± 0.19	0.57 ± 0.06	1.11 ± 0.12	41.5%	0.57 ± 0.06	0.3 ± 0.03	0.33 ± 0.04
Household income										
Low income	405	49.3%	123.4%	1.62 ± 0.09^{x}	0.54 ± 0.03	1.07 ± 0.06	45.1%	0.62 ± 0.04	0.3 ± 0.02	0.31 ± 0.02^{x}
Low middle income	90	11.0%	127.2%	1.67 ± 0.19^{x,y}	0.5 ± 0.06	1.17 ± 0.14	36.4%	0.5 ± 0.06	0.25 ± 0.03	0.28 ± 0.03^{x,y}
Middle income	149	18.1%	152.4%	2 ± 0.18^{y}	0.69 ± 0.06	1.31 ± 0.11	48.0%	0.66 ± 0.06	0.26 ± 0.03	0.42 ± 0.04^{x,y}
High income	108	13.2%	128.8%	1.69 ± 0.17^{x,y}	0.5 ± 0.05	1.19 ± 0.12	46.5%	0.64 ± 0.07	0.21 ± 0.02	0.41 ± 0.04^{y}

[a] Fruit and vegetable recommendations (rec.) are taken from an average of My Plate recommendations for children ages 2-5 of moderate physical activity for age, gender, race, BMI, and income categories.
[a] Fruit juice is included in total fruit; potato products are included in total vegetables.
^{xyz} Means with different superscripts (x,y,z) indicate significant differences (P<0.05).

Figure 1: Average servings consumed among children ages two to five years of total fruit, fruit juice, fruit excluding fruit juice, total vegetables, potato products, and total vegetables excluding potato products.



Consumption of potato products and fruit juice. Average consumption of fruit juice was 0.55 ± 0.03 servings, and average consumption of potato products was 0.27 ± 0.014 servings. There was no significant difference in fruit juice intake by age, gender, ethnicity, BMI, and SES. Children age 3 years ate significantly more ($p < 0.05$) potato products than children age 2 years. Consumption of potato products based on gender, ethnicity, BMI, or SES was not significantly different.

Total fruit and vegetable consumption excluding fruit juice and potato products. Children's average consumption of fruit excluding fruit juice (F-FJ) and vegetables excluding potato products (V-PP) was 1.14 ± 0.041 servings and 0.34 ± 0.02 servings, respectively. Consumption of whole fruit and 100% fruit juice accounted for 67.5% of children's fruit intake, while consumption of vegetables excluding potato products made up 55.7% of children's intake of vegetables. Regarding F-FJ, Mexican American and Non-Hispanic White children ate significantly more than Non-Hispanic Black children ($p < 0.05$). No significant difference in F-FJ consumption was identified for age, gender, BMI, and SES. Children from high income families ate significantly more V-PP ($p < 0.05$) than children in low income families. The amount of consumed servings of V-PP was not significantly different among age, gender, ethnicity, and BMI groups.

Nutrient intake from fruit and vegetables. Children's average calorie intake from fruit during the 24-hour recall was 176.68 kcal, and their average intake from vegetables was 121.01 kcal (Table 2). When FJ and PP were excluded from these totals, calories from fruit were 110.27 kcal (66.41 kcal less) and calories from vegetables were 30.16 kcal (90.85 kcal less). Carbohydrate intake from total fruit was an average of 2.6 times greater than carbohydrate intake from total vegetables; fat intake from total vegetables was 3.7 times

greater than fat intake from total fruit. Neither fruit nor vegetables contributed a nutritionally significant amount of protein. Fiber from consumed fruit was 3.18 grams compared to fiber from consumed vegetables, 2.01 grams. Vitamin C, folate, magnesium, and potassium intakes were higher from consumed fruit than vegetables (Table 3); whereas, Vitamin A and Vitamin E intakes were higher from consumed vegetables. Among all ages, children greatly exceeded the Vitamin C recommendation with the consumption of fruit alone. Nutrient intake from combined fruit and vegetable consumption contributed between 20-60% of a child's DRI for a given nutrient. Fruit contributed more of the investigated micronutrients than vegetables based on the amount consumed by young children.

Fruit and vegetables consumed most frequently and in the highest amount. Apple juice and french fries were consumed in the greatest amount. The fruit items consumed most frequently and in the highest amount were identical, with minor variation in order. Vegetables consumed by children in the highest amount included french fries, potato chips, raw tomatoes, cucumbers, and lettuce; fruit consumed by children in the highest amount included apple juice, apples, bananas, fruit juice blend, and orange juice.

Table 2: Mean macronutrient intake from total fruit and vegetables (FV) and total FV minus fruit juice (FJ) and potato products (PP), by age and gender

		Calories (kcal)		**Carbs (gm)**		**Fat (gm)**		**Protein (gm)**		**Fiber (gm)**	
	DRIs (ages 2-5)	Varies[a,b]		100 g/d[c]		Varies[a]		Varies[a]		(Age + 5) g/d[d]	
Age Two		**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**
MALE	**Total FV**	**174.26**	**97.43**	**43.12**	**13.57**	**1.43**	**4.41**	**0.73**	**2.07**	**3.07**	**1.66**
	Minus FJ/PP	108.28	25.22	27.06	4.37	0.56	0.61	1.00	1.03	2.77	0.85
FEMALE		**186.55**	**121.59**	**46.43**	**17.12**	**1.38**	**5.01**	**0.67**	**2.25**	**3.12**	**2.06**
		109.38	35.36	27.61	6.44	0.47	0.90	0.94	1.20	2.76	1.24
Age Three											
MALE	**Total FV**	**191.73**	**164.58**	**48.19**	**21.31**	**1.53**	**7.08**	**0.58**	**2.61**	**3.32**	**2.25**
	Minus FJ/PP	122.97	33.55	31.44	5.98	0.40	0.90	1.11	1.17	3.00	1.05
FEMALE		**172.80**	**127.03**	**43.26**	**17.57**	**1.29**	**6.22**	**0.51**	**2.28**	**2.82**	**2.01**
		104.03	27.97	26.52	5.37	0.33	0.57	0.88	0.89	2.49	0.85
Age Four											
MALE	**Total FV**	**159.95**	**108.39**	**39.56**	**15.73**	**1.44**	**5.27**	**0.70**	**2.36**	**2.98**	**2.12**
	Minus FJ/PP	100.33	31.36	25.14	6.02	0.53	0.63	1.00	1.10	2.68	1.23
FEMALE		**191.32**	**98.66**	**48.04**	**14.81**	**1.56**	**4.81**	**0.67**	**2.14**	**3.86**	**1.77**
		128.49	26.19	32.71	5.17	0.51	0.50	1.15	0.83	3.56	1.01
Age Five											
MALE	**Total FV**	**183.46**	**127.62**	**45.93**	**18.06**	**1.40**	**4.98**	**0.60**	**2.11**	**3.41**	**2.08**
	Minus FJ/PP	116.61	29.82	29.63	6.10	0.42	0.51	1.05	0.87	3.08	0.79
FEMALE		**153.42**	**122.79**	**38.49**	**17.95**	**1.37**	**4.88**	**0.46**	**2.39**	**2.9**	**2.1**
		98.27	33.24	25.14	6.87	0.32	0.58	0.88	1.15	2.61	1.09
Average	**Total FV**	**176.68**	**121.01**	**44.13**	**17.02**	**1.43**	**5.33**	**0.62**	**2.28**	**3.18**	**2.01**
	Minus FJ/PP	110.27	30.16	27.91	5.72	0.43	0.65	0.99	1.04	2.83	1.02

[a] Calorie, fat, and protein needs vary by age and activity level.
[b] United States Department of Agriculture. (2012). *Supertracker*. Retrieved from http://www.choosemyplate.gov/supertrackertools/supertracker.html
[c] Institute of Medicine. (2011). *Dietary reference intakes (dris): Estimated average requirements*. Retrieved from http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity Files/Nutrition/DRIs/1_ EARs.pdf
[d] Williams, C. L., Bollella, M., & Wynder, E. L. (1995). A new recommendation for dietary fiber in childhood. *Pediatrics*, *96*(5), 985 -988.

Table 3: Mean micronutrients intake from total fruit and vegetables, by age and gender

DRIs	Vitamin A (mcg) [a]	Vitamin C (mg) [a]	Vitamin E (mg) [a]	Folate (mcg) [a]	Magnesium (mg) [a]	Potassium (mg) [b]
Ages 2 - 3	210 mcg/d	13 mg/d	5 mg/d	120 mcg/d	65 mg/d	3000 mg/d
Ages 4 - 5	275 mcg/d	22 mg/d	6 mg/d	160 mcg/d	110 mg/d	3800 mg/day

Age Two	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**
MALE	14.32	49.37	59.51	7.33	0.4	0.64	25.88	21.28	30.12	16.86	469.03	255.24
% DRI	**7%**	**24%**	**458%**	**56%**	**8%**	**13%**	**22%**	**18%**	**46%**	**26%**	**16%**	**9%**
FEMALE	12.14	58.58	65.08	10.91	0.39	0.84	23.82	26.86	30.33	19.99	490.29	303.5
% DRI	**6%**	**28%**	**501%**	**84%**	**8%**	**17%**	**20%**	**22%**	**47%**	**31%**	**16%**	**10%**
Age Three												
MALE	20.73	79.83	60.72	8.01	0.44	1.25	23.82	26.57	32.33	25.25	498.55	398.37
% DRI	**10%**	**38%**	**467%**	**62%**	**9%**	**25%**	**20%**	**22%**	**50%**	**39%**	**17%**	**13%**
FEMALE	22.73	76.37	60.06	12.43	0.4	1.03	21.39	24.06	27.71	20.63	445.72	329.72
% DRI	**11%**	**36%**	**462%**	**96%**	**8%**	**21%**	**18%**	**20%**	**43%**	**32%**	**15%**	**11%**
Age Four												
MALE	20.96	102.91	57.6	12.48	0.46	0.89	29.63	27.56	28.29	20.72	444.88	322.23
% DRI	**8%**	**37%**	**262%**	**57%**	**8%**	**15%**	**19%**	**17%**	**26%**	**19%**	**12%**	**8%**
FEMALE	30.91	133.9	66.28	10.63	0.46	0.81	26.95	20.04	31.01	17.46	495.78	282.73
% DRI	**11%**	**49%**	**301%**	**48%**	**8%**	**14%**	**17%**	**13%**	**28%**	**16%**	**13%**	**7%**
Age Five												
MALE	16.95	79.51	64	11.8	0.4	0.91	25	24.05	29.07	22.09	483.84	346.69
% DRI	**6%**	**29%**	**291%**	**54%**	**7%**	**15%**	**16%**	**15%**	**26%**	**20%**	**13%**	**9%**
FEMALE	33.09	65.75	62.57	8.77	0.43	0.75	28.34	23.63	27.42	21.01	428.94	334.89
% DRI	**12%**	**24%**	**284%**	**40%**	**7%**	**13%**	**18%**	**15%**	**25%**	**19%**	**11%**	**9%**
Average	**21.48**	**80.78**	**61.98**	**10.3**	**0.42**	**0.89**	**25.6**	**24.25**	**29.53**	**20.5**	**469.63**	**321.67**

[a] Institute of Medicine. (2011). *Dietary reference intakes (dris): Estimated average requirements*. Retrieved from http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity Files/Nutrition/DRIs/1_ EARs.pdf

[b] Institute of Medicine. (2011). *Dietary reference intakes (dris): Recommended dietary allowances and adequate intakes, elements*. Retrieved from http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity Files/Nutrition/DRIs/New Material/2_ RDA and AI Values_Vitamin and Elements.pdf

[p] Percent of Dietary Reference Intake for a given nutrient provided by fruit or vegetable consumption

Table 4. Commonly consumed fruit, fruit excluding fruit juice, vegetables, and vegetables excluding potato products, by amount and frequency (NHANES 2009-2010)

	Highest Amount Consumed	Most Frequently Consumed
Fruit		
	APPLE JUICE	APPLE JUICE
	APPLE, RAW	BANANA, RAW
	BANANA, RAW	APPLE, RAW
	FRUIT JUICE BLEND, 100% JUICE	FRUIT JUICE BLEND, 100% JUICE
	ORANGE JUICE, W/ CALCIUM, CAN/BOTTLED/CARTON	GRAPES, RAW, NS AS TO TYPE
Fruit (excluding fruit juice)		
	APPLE, RAW	BANANA, RAW
	BANANA, RAW	APPLE, RAW
	FRUIT JUICE BLEND, 100% JUICE	FRUIT JUICE BLEND, 100% JUICE
	GRAPES, RAW, NS AS TO TYPE	GRAPES, RAW, NS AS TO TYPE
	ORANGE, RAW	ORANGE, RAW
Vegetables		
	WHITE POTATO, FRENCH FRIES, FROM FROZEN, DEEP-FRIED	TOMATO CATSUP
	WHITE POTATO CHIPS, REGULAR CUT	WHITE POTATO, FRENCH FRIES, FROM FROZEN, DEEP-FRIED
	TOMATOES, RAW	WHITE POTATO CHIPS, REGULAR CUT
	CUCUMBER, RAW (INCLUDE CUCUMBER, NFS)	LETTUCE, RAW
	LETTUCE, RAW	TOMATOES, RAW
Vegetables (excluding potato products)		
	TOMATOES, RAW	TOMATO CATSUP
	CUCUMBER, RAW (INCLUDE CUCUMBER, NFS)	LETTUCE, RAW
	LETTUCE, RAW	TOMATOES, RAW
	TOMATO CATSUP	CARROTS, RAW
	CARROTS, RAW	MUSTARD (INCL HORSERADISH MUSTARD, CHINESE MUSTARD)

Discussion

In this study, regardless of age, gender, ethnicity, BMI, and household income, children ages two to five years exceeded national fruit recommendations and consumed less than one-half the vegetable recommendations. Children have an innate predisposition for food items which are sweet and salty, such as fruit, over those which are bitter or sour, such as some vegetables (Sullivan & Birch, 1990). Children also have greater taste sensitivity to certain food items (Bell & Tepper, 2006) and a higher food neophobia during the early years of childhood (Dovey et al., 2008), which may explain the higher fruit consumption and lower vegetable consumption identified in this study.

Children's higher fruit consumption resulted in a greater intake of fiber, Vitamin C, folate, magnesium, and potassium than vegetables; whereas, vegetable consumption contributed greater amounts of Vitamins A and E than fruit. Two nutrients that have been historically low in young children's diets are Vitamin C and fiber (Butte et al., 2010; Gidding et al., 2006). Previous research by Hansen et al. showed that the only foods offering substantial amounts of Vitamin C were fruit and vegetables (Hansen et al., 1979). Our results showed that fruit consumption alone met over 100% of the Vitamin C recommendation for young children, regardless of age or gender. Furthermore, over one-half (61%) of the fiber requirements for young children were met by combined fruit (37%) and vegetable (24%) consumption.

Between 20-60% of a child's nutrient needs for any given nutrient investigated in this study were met by fruit and vegetables combined. While fruit and vegetables are good sources of these particulate nutrients, our results suggest that children rely on other nutrient-dense food sources in addition to fruit and vegetables to meet their recommended daily

allowance for some nutrients (N. Darmon, et al., 2005). Appropriate servings from all nutrient rich food sources including colorful fruit and vegetables, whole grains, lean meats, seafood, eggs, beans and nuts, and low-fat and nonfat dairy products will help ensure that nutrient needs are met (Drewnowski, 2005; Ramsay, Branen, & Johnson, 2012).

Although some research indicates that weight is negatively correlated to fruit and vegetable consumption (Miller et al., 2011) and positively correlated to fruit juice consumption (Dennison, Rockwell, & Baker, 1997), in this study we found that children who were "overweight" did not eat significantly more or less fruit, fruit juice, vegetables, or potato products than children of normal weight. Similarly, recent research demonstrated that consumption of 100% fruit juice was associated with better diet quality and caused no increased risk for children being overweight (O'Neil, Nicklas, Rampersaud, & Fulgoni, 2011). The effects of potato product consumption during childhood have not been thoroughly investigated by the literature. Longitudinal studies conducted with adults demonstrated that potato chips and potato consumption was correlated to weight gain (Mozaffarian, Hao, Rimm, Willett, & Hu, 2011). More research regarding the long-term effects of potato product consumption among young children is needed.

In the present study, only fruit consumption varied by ethnicity. Mexican American and Other Hispanic children's total fruit consumption was significantly higher than Non-Hispanic Black children's total fruit consumption. Fruit intake excluding fruit juice consumption was significantly higher among Mexican American and Non-Hispanic White children than by Non-Hispanic Black children. Variation in fruit and vegetable consumption among children and adolescents might be due to cultural preferences for certain fruit and vegetables (Reynolds et al., 1999) and familial traits (Cooke et al., 2003). Parents and

caregivers have a significant influence on availability and accessibility of fruit and vegetables in the home (Goldman, Radnitz, & MicGrath, 2012). Further research investigating ethnicities with higher fruit consumption, specifically Mexican American children, could be useful in understanding ways to promote fruit and vegetable consumption among all ethnicities.

Household income also had a significant effect on children's fruit and vegetable consumption. Children from low income families, which included over one-half of the sample, ate significantly less total fruit and vegetables excluding potato products than children from middle and high income families; nonetheless, fruit consumption by low income children still exceeded recommendations. In addition, potato products were consumed in the highest amount by children from low income families. This might be due to the difference in cost, convenience, palatability, and subsequent satiety from potato product consumption (Drewnowski & N. Darmon, 2005). Vegetables are not typically energy-dense; although fried potato products contain more fat and more energy per serving, making them a less expensive option for meeting daily energy requirements. While an inverse relationship between energy density and cost exists for many food items (Drewnowski & N. Darmon, 2005), research demonstrates that most fruit and vegetables have a high nutrient-to-price score, meaning that an individual can obtain more nutrients from fruit and vegetables for a lower price (N. Darmon, M. Darmon, Maillot, & Drewnowski, 2005).

Future studies pertaining to children's fruit and vegetable consumption are needed. While this study focused on macronutrients (carbohydrates, protein, fat, and fiber) and specific micronutrients (vitamin A, C, E, folate, magnesium, and potassium) there is an array of other nutrients offered by fruit and vegetables that are worthy of research. Studies related

to specific health benefits of fruit and vegetable consumption during early childhood are warranted. In addition, a longitudinal study focusing on fruit consumption and vegetable consumption, separately, during early childhood and subsequent intake during adulthood would further substantiate fruit and vegetable recommendations for young children.

A few limitations have been recognized in this study. Food intake of young children varies from day to day (Birch, Johnson, Andersen, Peters, & Schulte, 1991). A greater number of recorded days may provide a more accurate representation of children's average food or nutrient intake. However, a large sample size accounts for some of this variation by taking into consideration the individual differences across the population (Rockett & Colditz, 1997). The child's food intake in NHANES was reported by the primary caregiver rather than the child; as a result, some reporting bias may have occurred (CDC, 2009). Measures were taken by NHANES interviewers to ensure quality data collection, including in-person interviews for the first day of the food recall, and provision of portion size references for the parent. Moreover, fruit and vegetable definitions from the FSRG were used and therefore excluded fruit and vegetables in mixed dishes that were primarily meat or grain (Ahuja et al., 2012). Fruit and vegetable content from these mixed dishes were marginal and likely had no significant impact on nutrient intake. In addition, 45 children out of the 866 children in the sample did not consume a fruit or vegetable on the given day and were excluded from this study.

Implications for Healthcare Providers, Dietitians, and Parents

Childhood is a pivotal time period for the development of food habits (Fox et al., 2010). Children have a preference for fruit (Lorson et al., 2009), yet they can develop an eventual liking of vegetables with increased exposure (Sullivan, & Birch, 1990). Fruit and

vegetables supply an adequate amount of Vitamin C based on children's current consumption. For certain micronutrients, such as vitamins A, E, folate, magnesium, and potassium, dietary sources in addition to fruit and vegetables can help children meet their needs. While it is important to continue encouraging vegetable consumption, parents and caregivers can be informed that children's fruit consumption provide similar nutrients as vegetable consumption to meet recommended dietary allowances.

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Appendix A: MyPlate Fruit and Vegetables Recommendations

Table 5: MyPlate recommendations for children who are moderately active*

			Servings (MyPyramid cup-equivalents)	
Age	**Gender**	**Calories**	**Fruit**	**Vegetables**
2	**male**	**1000**	**1**	**1**
	female	**1000**	**1**	**1**
3	**male**	**1400**	**1.5**	**1.5**
	female	**1200**	**1**	**1.5**
4	**male**	**1400**	**1.5**	**1.5**
	female	**1400**	**1.5**	**1.5**
5	**male**	**1400**	**1.5**	**1.5**
	female	**1400**	**1.5**	**1.5**

* moderately active is defined as 30-60 minutes of moderate activity

(USDA, 2012b)

Table 6: Mean micronutrients intake from fruit and vegetables (FV) minus fruit juice and potato products, by age and gender

DRIs	Vitamin A (mcg) [a]		Vitamin C (mg) [a]		Vitamin E (mg) [a]		Folate (mcg) [a]		Magnesium (mg) [a]		Potassium (mg) [b]	
Ages 2-3	210 mcg/d		13 mg/d		5 mg/day		120 mcg/d		65 mg/d		3000 mg/d	
Ages 4-5	275 mcg/d		22 mg/d		6 mg/d		160 mcg/d		110 mg/d		3800 mg/day	
Age Two	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**	**Fruit**	**Veg**
MALE	12.43	58.96	32.25	5.24	0.29	0.30	17.05	12.85	19.87	7.89	298.62	99.99
(% of DRI)	**5.92%**	**28.07%**	**248.05%**	**40.33%**	**5.88%**	**5.93%**	**14.20%**	**10.71%**	**30.57%**	**12.13%**	**9.95%**	**3.33%**
FEMALE	11.25	69.45	36.72	8.69	0.30	0.44	15.38	19.09	19.13	10.03	295.81	128.16
	5.36%	**33.07%**	**282.48%**	**66.86%**	**6.00%**	**8.82%**	**12.82%**	**15.91%**	**29.44%**	**15.43%**	**9.86%**	**4.27%**
Age Three												
MALE	19.97	56.38	34.22	7.96	0.36	0.41	16.28	14.78	22.00	9.23	323.46	127.72
(% of DRI)	**9.51%**	**26.85%**	**263.25%**	**61.24%**	**7.13%**	**8.29%**	**13.57%**	**12.32%**	**33.85%**	**14.20%**	**10.78%**	**4.26%**
FEMALE	21.89	38.06	33.90	7.34	0.31	0.30	13.25	12.25	17.44	7.86	266.11	98.20
	10.42%	**18.12%**	**260.75%**	**56.44%**	**6.18%**	**5.94%**	**11.04%**	**10.21%**	**26.84%**	**12.09%**	**8.87%**	**3.27%**
Age Four												
MALE	19.63	123.74	31.45	9.60	0.33	0.39	18.49	17.50	18.18	9.31	276.44	137.29
(% of DRI)	**7.14%**	**45.00%**	**142.97%**	**43.65%**	**5.42%**	**6.54%**	**11.56%**	**10.94%**	**16.53%**	**8.46%**	**7.27%**	**3.61%**
FEMALE	26.68	116.01	40.64	4.89	0.36	0.38	18.66	14.12	21.48	9.49	340.14	124.96
	9.70%	**42.19%**	**184.72%**	**22.23%**	**6.04%**	**6.35%**	**11.66%**	**8.82%**	**19.53%**	**8.63%**	**8.95%**	**3.29%**
Age Five												
MALE	16.28	66.78	41.11	7.76	0.32	0.42	18.18	11.82	19.82	9.55	311.93	128.92
(% of DRI)	**5.92%**	**24.29%**	**186.88%**	**35.27%**	**5.34%**	**7.08%**	**11.36%**	**7.38%**	**18.02%**	**8.69%**	**8.21%**	**3.39%**
FEMALE	31.10	54.90	33.27	7.21	0.31	0.33	15.91	17.63	17.31	9.64	270.67	125.97
	11%	**20%**	**151%**	**33%**	**5%**	**6%**	**10%**	**11%**	**16%**	**9%**	**7%**	**3%**
Average	18.89	73.38	34.48	7.31	0.32	0.37	16.3	15.11	19.32	9.07	295.61	120.47

[a] Institute of Medicine. (2011). *Dietary reference intakes (dris): Estimated average requirements*. Retrieved from http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity Files/Nutrition/DRIs/1_ EARs.pdf

[b] Institute of Medicine. (2011). *Dietary reference intakes (dris): Recommended dietary allowances and adequate intakes, elements*. Retrieved from http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity Files/Nutrition/DRIs/New Material/2_ RDA and AI Values_Vitamin and Elements.pdf

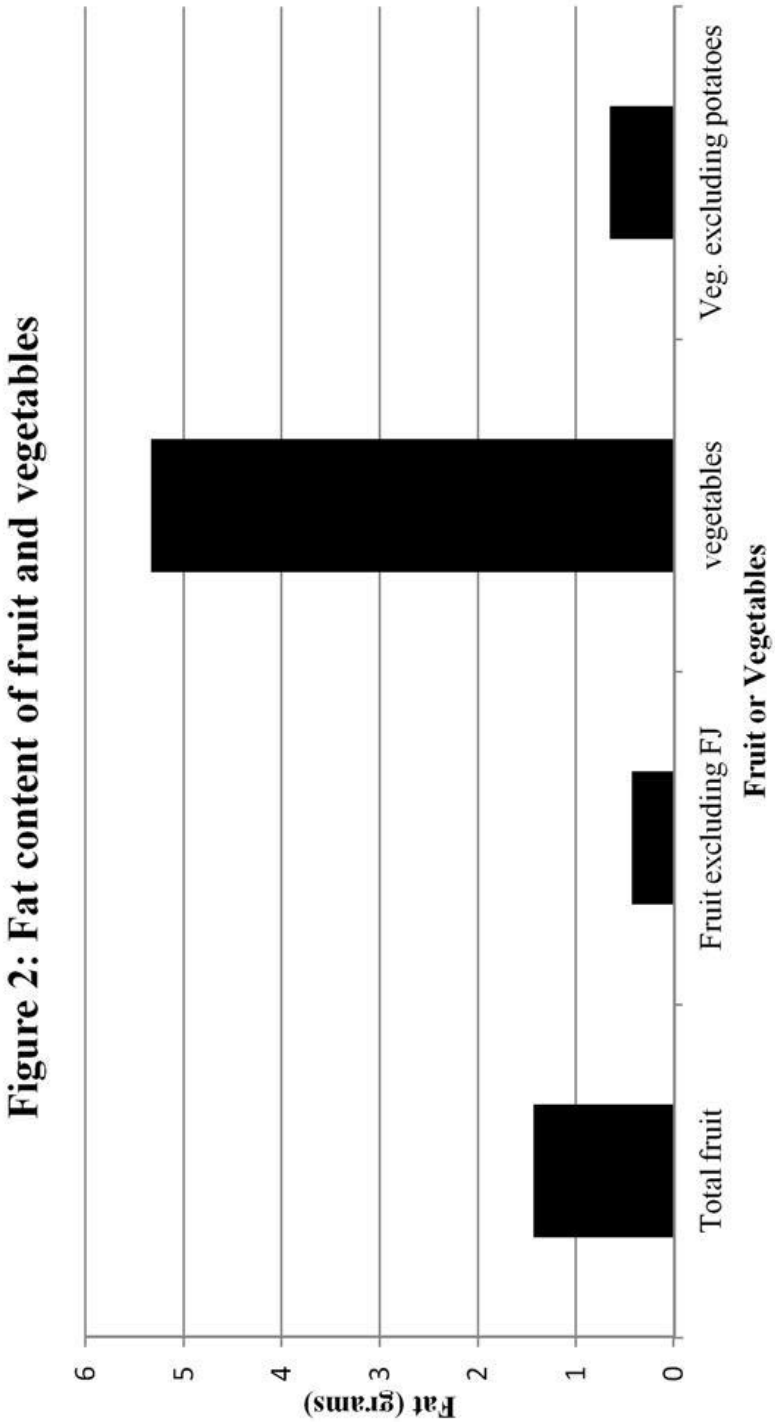


Figure 2: Fat content of fruit and vegetables
Fat (grams)
0
1
2
3
4
5
6
Total fruit
Fruit excluding FJ
vegetables
Veg. excluding potatoes
Fruit or Vegetables

Figure 3: Percentage of micronutrient recommendation from total FVC

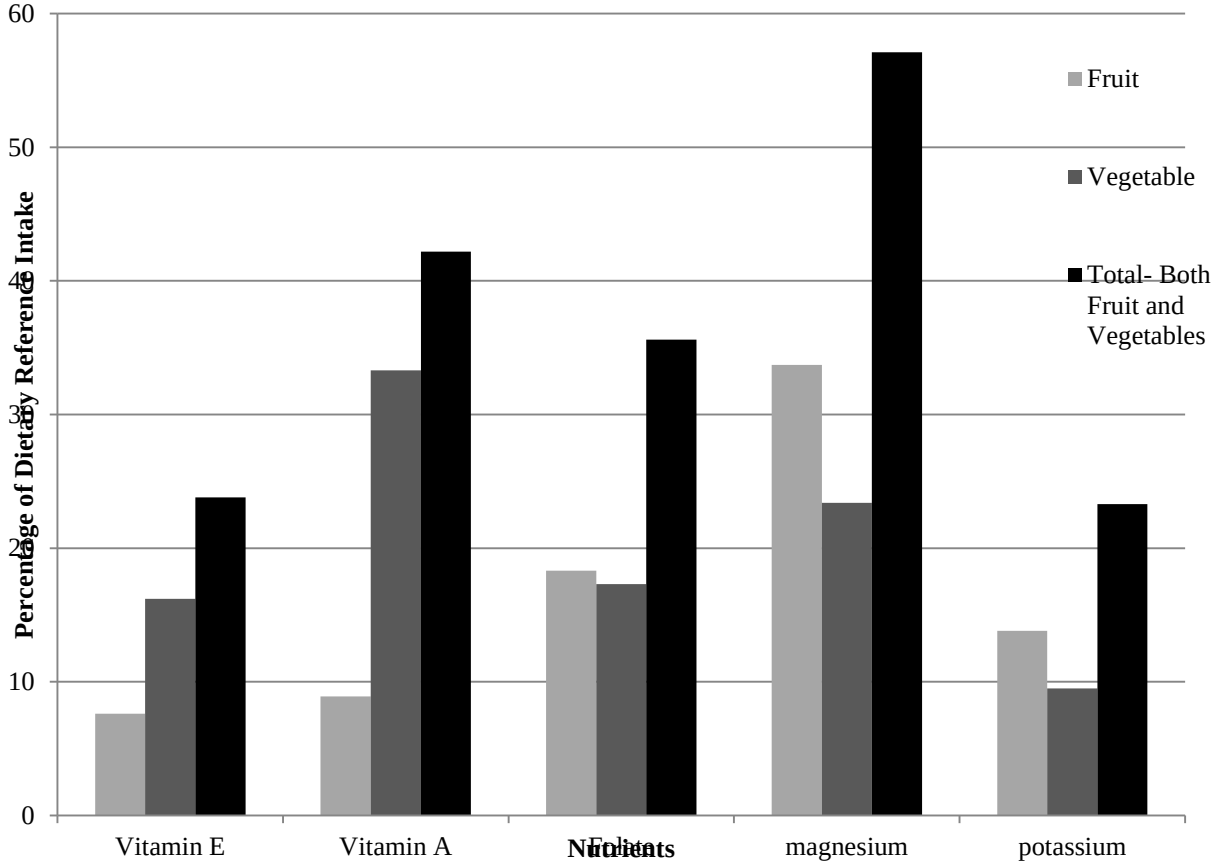


Figure 4: Ages of children

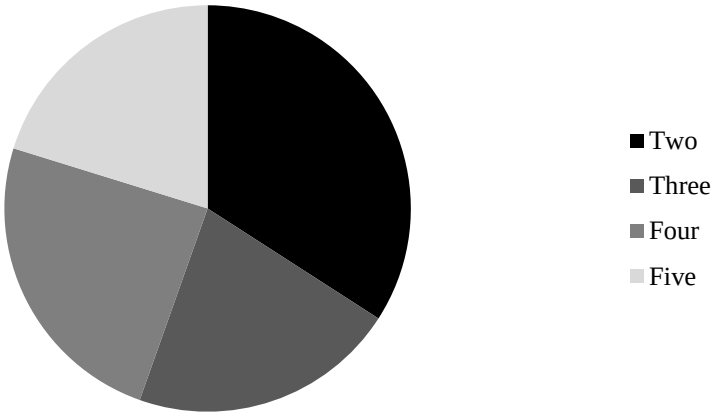


Figure 5: Gender of children

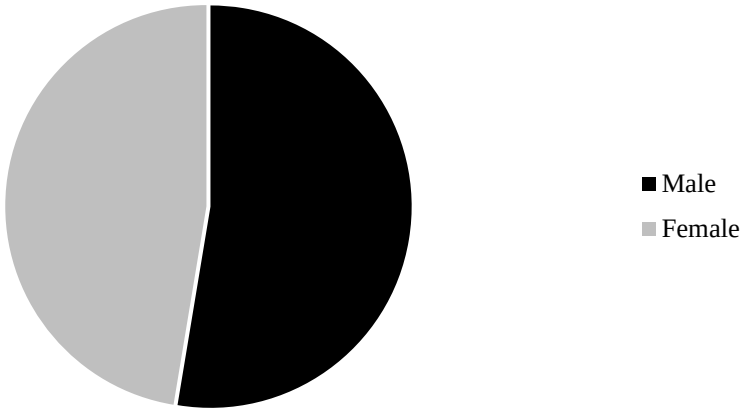


Figure 6: Ethnicity of children

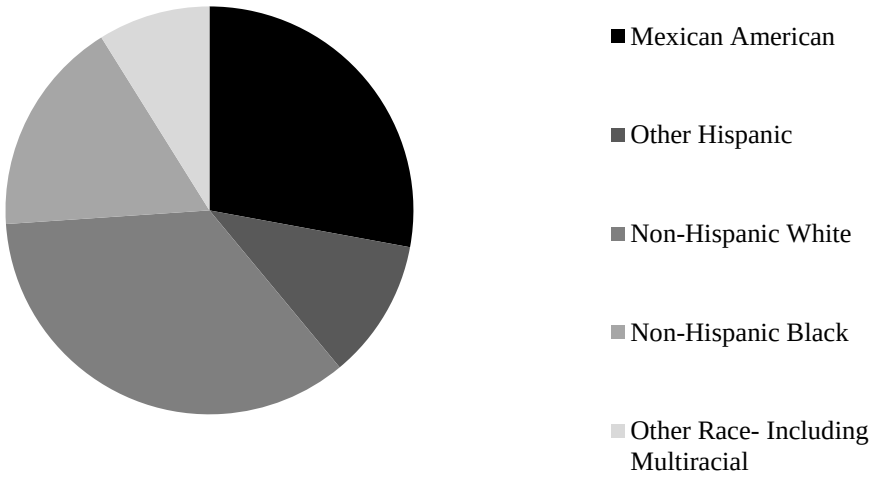


Figure 7: Body-mass-index of children

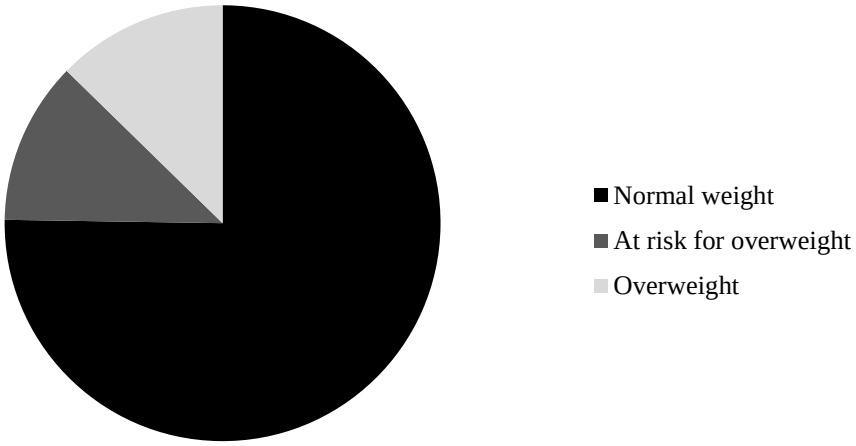


Figure 8: Household income of family

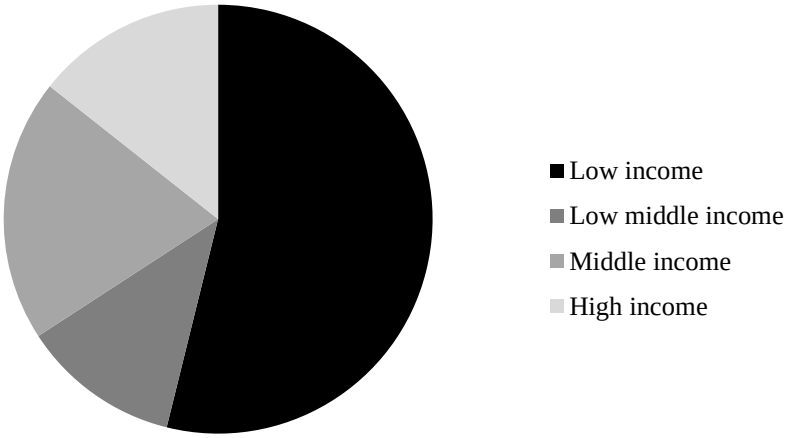


Figure 9: Percentage of micronutrient recommendation met by one serving of consumed fruit or vegetables (NHANES 2009-2010)

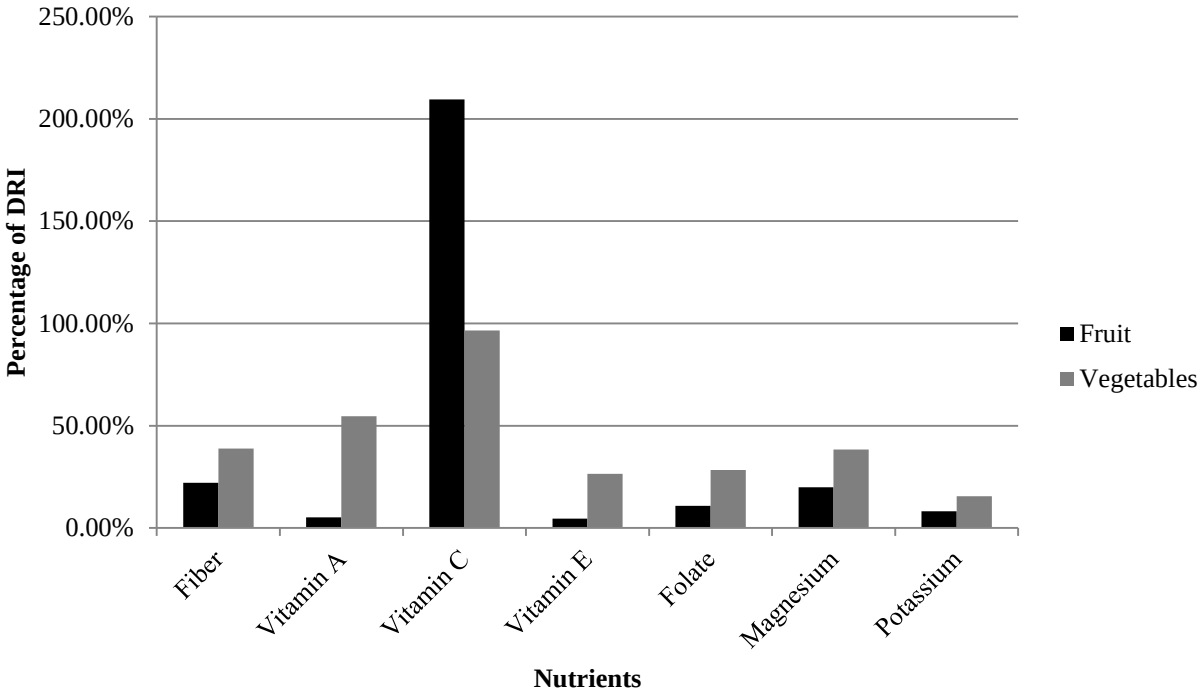
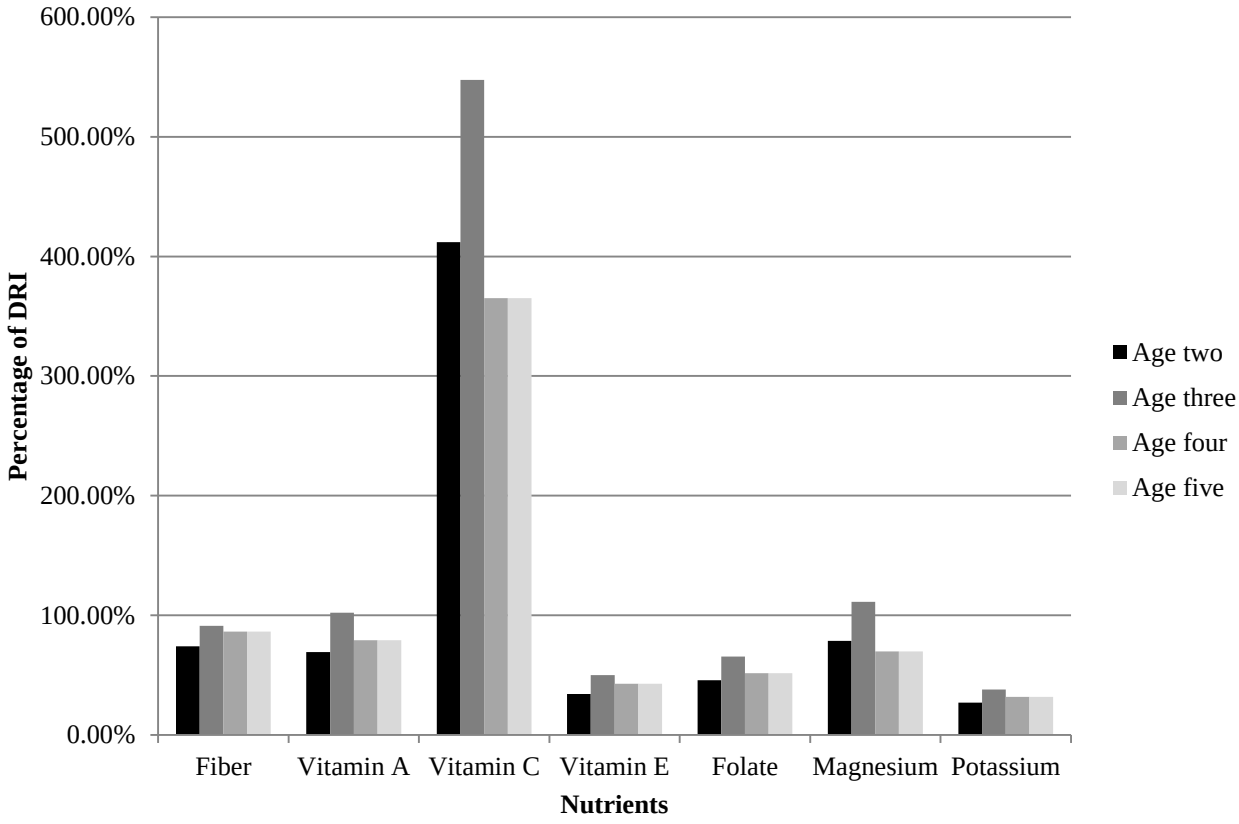


Figure 10: Children's nutrient intake, hypothetically meeting MyPlate fruit and vegetable recommendations



Appendix C: Letter of Permission to Use NHANES dataset

Document 1. Personal Correspondence with the Centers for Disease Control, granting permission to use the NHANES dataset.

From: CDC-INFO [CDCINFO@cdc.gov]
Sent: Monday, January 23, 2012 12:04 PM
To: wall5164@vandals.uidaho.edu
Subject: RE: NHANES data

Thank you for your inquiry to CDC-INFO. In response to your request for information on permission to use NHANES data and when the 2009 to 2010 dietary data will be available, we are pleased to provide you with the following information.

As other data 2009 to 2010 NHANES data is processed and ready for public release it will be released on the NHANES website. To view this text, please visit the following: http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/faqs09_10.htm#2

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[THREAD ID:1-27FDWI] [SR No.:1-133418129]