FRUIT AND VEGETABLE CONSUMPTION IN PRESCHOOL-AGED, LOW-INCOME MEXICAN-AMERICAN CHILDREN: A COMPARATIVE ANALYSIS

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ABSTRACT OF THE THESIS

Fruit and vegetable consumption in preschool-aged,

low-income Mexican-American children:

a comparative analysis.

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Childhood obesity is an emerging epidemic. According to data found in the Pediatric Nutrition Surveillance System, over 12.5 million children are overweight or obese in the United States. The prevalence of obesity is higher in Mexican-American children than other ethnic groups in the US. Current research has found that higher intakes of fruits and vegetables have been shown to help prevent and reduce chronic diseases like obesity. Low fruit and vegetable consumption may also be a contributing factor to unhealthy weight gain in children. Moreover, low consumption of fruits and vegetables may reinforce the preference for other unhealthful foods like sugar-sweetened beverages and refined carbohydrates.

The objective of this study was to look at fruit and vegetable consumption in Mexican-American children at ages 2 and 4, and to examine its association with their weight status. At both time points, fruits and vegetables were estimated in cups and the nutrient intake was analyzed. It was found that fruit intake met the 2010 USDA food guidelines set for these ages, but significantly lower consumption of vegetables was observed at both ages. Micronutrients found in fruits and vegetables showed that vitamin

A, C, and folate met the Dietary Reference Intakes (DRI) set for 2- and 4- year old children. However, significantly low intakes in vitamin E and potassium were observed. Furthermore, dietary fiber was significantly below the DRI at both time points. A significant 12% increase in the BMI-for-age percentile from children at 2 years of age to 4 years of age was found. However, no relationship was found between fruit and vegetable consumption with BMI-for-age percentile. Nevertheless, fruit and vegetable consumption remains important because of the vital role it plays in preventing and reducing chronic diseases in the Mexican-American population.

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I. INTRODUCTION

Childhood obesity is an emerging epidemic, which has reached about 12.5 million children and adolescents in the United States (Ogden, Carroll, Kit, & Flegal, 2012). To define overweight or obesity in children, a measurement called Body Mass Index (BMI) for Age Percentile is utilized. Children categorized as overweight are at or above the 85th percentile and those who are obese are at or above the 95th percentile. In the United States, 31.6% of children (10- to 17-years old) are overweight and 16.4% are obese (Singh, Kogan, & van Dyck, 2010). The prevalence of obesity among 2- to 5-year-olds is 12.1% in the U.S. (Ogden et al., 2012). In New Jersey, 31% of children ages 10 through 17 years are overweight/obese and of these children, 34.4% are Hispanic (National Survey of Children's Health, 2007). According to the Pediatric Nutrition Surveillance System 2009 Report, children <5 years have a 14.7% prevalence for obesity. The state with the highest prevalence for obesity in children this young is New Jersey at 18.4% (Polhamus, Dalenius, Mackintosh, Smith & Grummer-Strawn, 2011).

Mexican-American children have a higher obesity rate when compared to children in the general US population (Alexander, Sherman, & Clark, 1991; Hernandez-Valero et al., 2007; Ogden, Flegal, Carroll, & Johnson, 2002). Furthermore, Mexican-American children (ages 5 through 19 years) who have immigrated to the US have an increased risk of overweight and obesity (Hernandez-Valero et al., 2012). The concern is that children who are obese may become or remain obese into adulthood, which may increase the risk of associated comorbidities (Biro & Wien, 2010; Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). The Hispanic population has an increase risk of developing

Type 2 diabetes mellitus, which may lead to cardiovascular diseases (Zhang, Wang, & Huang, 2009). In fact, dyslipidemia, a precursor to Type 2 diabetes mellitus, was identified in Hispanic children as young as ages 2 and 3 years (Shea et al., 2003). Diet, specifically fruits and vegetables, has been shown to help prevent and reduce chronic diseases (Damasceno, de Araujo, de Freitas, de Almeida, & Zanetti, 2011; De Natale et al., 2009; Nikolic, Nikic, & Petrovic, 2008). However, 82.9% of Mexican-American children are not consuming the recommended amounts of fruits and vegetables (Lorson, Melgar-Quinonez, & Taylor, 2009).

Fruit and vegetable consumption can be influenced by several factors such as genetics, socio-economic status, food insecurity, food accessibility in the neighborhood and at home, parent modeling, and diet (Alaimo, Olson, Frongillo, & Briefel, 2001; Bell & Tepper, 2006; Dave, Evans, Pfeiffer, Watkins, & Saunders, 2010; Martin, Lee, Couch, Morrison, & Woo, 2011; Nord, Andrews, & Carlson, 2005; Singh, Siahpush, Hiatt, & Timsina, 2011; Swinburn, Egger, & Raza, 1999; Turnbull & Matisoo-Smith, 2002; Wang & Zhang, 2006; Worobey, Ostapkovich, Yudin, & Worobey, 2010). Children learn dietary habits and food preferences as early as preschool (Birch & Fisher, 1998). Children are only eating 2.1 servings per day of fruits and vegetables combined, which is below United States Agricultural Association Dietary Guidelines (Cullen et al., 2001, United States Department of Agriculture, 2011). Reinforcing fruit and vegetable consumption in preschoolers may lead to consuming fruits and vegetables as they age. Research shows a decrease in fruit and vegetable consumption as age increases (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). So if children are only eating 2.1 servings per day of fruits and vegetables combined, then this number may dwindle further as they become older (Cullen et al., 2001). This is a major problem because if children are not consuming the adequate amount of fruits and vegetables, they may not obtain beneficial nutrients for physical development and prevention of diseases.

Although much research exploring the influences on weight gain and dietary habits has been conducted, research on dietary habits of Mexican-American children is limited. This is unfortunate, since Mexican-American children are a high-risk population for weight gain and have higher prevalence for certain diseases. Therefore, this thesis will focus on the issue of fruit and vegetable consumption and weight gain in low-income Mexican-American preschool-aged children.

II. REVIEW OF THE LITERATURE

In recent years, media advertisements have been promoting initiatives like "Campaign to End Obesity," and "Strong4Life." First Lady Michelle Obama began the "Let's Move!" campaign in 2010 to encourage children to live healthier lifestyles and combat the childhood obesity epidemic within a generation (*Let's move! America's move to raise a healthier generation for kids,* 2012). These campaigns and several others aim to eradicate the childhood obesity crisis, since the prevalence of childhood obesity has increased over the past 30 years. Childhood overweight and obesity is defined by the Centers for Disease Control and Prevention (CDC) using the Body Mass Index (BMI) based on height, weight, age and sex of the child (CDC, 2012). Overweight children are those who have a BMI-for-age percentile at or above the 85^{th} and below the 95^{th} percentile. Obese children are those who have a BMI-for-age percentile at or above the 95^{th} percentile.

According to the CDC, about 12.5 million children and adolescents between the ages of 2 to 19 have been diagnosed as obese and overweight (Ogden, Carroll, Kit, & Flegal, 2012). In the United States, 31.6% of children (10- to 17-years old) are overweight and 16.4% are obese (Singh, Kogan, & van Dyck, 2010). Prevalence of obesity has been found to differ amongst ethnicities. Mexican-American children (2- to 19- year-olds) have a higher prevalence for severe obesity (above 97^{th} percentile) when compared to whites (Wang & Zhang, 2006). Much like the nation, 31% percent of New Jersey children ages 10 through 17 years were overweight or obese, however, in looking only in the Hispanic children population, 34.4% were reported overweight or obese, using BMI for age and sex at or above the 85^{th} percentile (National Survey of Children's

Health, 2007). The US Hispanic population refers to participants from Central America, South America, the Caribbean (Puerto Rico, Cuba, Dominican Republic), and Spain. Throughout this review, studies using Hispanic samples were used as reference because there is limited research on childhood obesity in Mexican-Americans. According to the US Census Bureau (2010), Mexican-Americans made up over half of the Hispanic population.

The prevalence of this disease can be observed in children as young as preschool age. In the Pediatric Nutrition Surveillance System 2009 report, New Jersey ranked with the highest prevalence for obesity in children <5 years at 18.4% when compared to the other states (Polhamus, Dalenius, Mackintosh, Smith & Grummer-Strawn, 2011). Preschool children who were identified as at or above the 85^{th} BMI percentile were likely to have a twofold risk for being overweight or obese by the age of 11 years (Shankaran et al., 2011). Results suggest that children with a high BMI at an early age would be at a higher risk of being overweight or obese as an adolescent. In support of this finding, the National Health and Nutrition Examination Survey III (NHANES III) examined Mexican-American children between the ages of 2 through 19 years. The study separated the ages into three groups: 2-5 years, 6-11 years, and 12-19 years. About 13.1% of children in the 2- to 5-year-old group were obese and 26.3% were overweight or at risk for overweight (Flegal, Ogden, & Carroll, 2004). The other two age groups showed even higher percentages for overweight or at risk for overweight and obesity status. This suggests that although the prevalence of obesity is lower at an early age in Mexican-American children, as they grow older, the risk of becoming overweight or obese may increase. This is a serious issue, as the prevalence of this disease coincides with comorbidities that may result from the increase in weight.

The prevalence in obesity and Type 2 diabetes mellitus (T2DM) is found in Mexican-American adults, which may lead to cardiovascular disease (Fryar, Wright, Eberhardt, & Dye, 2012). Children at an early age can exhibit symptoms of T2DM when overweight or obese. Dyslipidemia has been identified as a precursor to T2DM and cardiovascular disease (Bao, Srinivasan, Wattigney, Bao, & Berenson, 1996). Shea et al. (2003) studied obese and hyperinsulinemic Hispanic children at 2- to 3-year-olds and found that dyslipidemia was present in this group. A fasting insulin level positively correlated with triglyceride levels and was inversely correlated with HDL-cholesterol levels. Similar results were observed in Mexican-American children from 8- to 20-year-olds. The older the children were, the higher the potential the child had to have abnormal high-density lipoprotein (HDL), cholesterol, and triglycerides (Fortmeier-Saucier, Savrin, Heinzer, & Hudak, 2008). These findings suggest that parents and researchers should be concerned with children's health and diet at an early age to combat obesity and comorbidities.

Health consequences due to inadequate intake of fruits and vegetables

Diet has been linked with many diseases. School-aged children (9- to 13-year-olds) from low-income urban schools in Mexico have a significant intake of food containing high fat, high sugar, and refined carbohydrates. As a result, this unhealthful dietary lifestyle was positively associated with coronary vascular disease (CVD, Perichart-Perera et al., 2010). Fruit and vegetable consumption only contributed 3% and 4%, respectively, of their overall energy intake.

Fruit and vegetable consumption has been identified as a factor in preventing or improving some disease states. Fruits and vegetables are rich in nutrients and antioxidants and have been associated with the decrease in chronic diseases and inversely associated with development of coronary heart disease (CHD) (United States Department of Agriculture, 2010). Individuals who reported fruit consumption greater than 5 items per day and vegetable consumption greater than 3 items per day had 60% and 70% lower risks of developing heart disease, respectively, when compared to those who consumed <1 fruit or vegetable per day (Nikolic, Nikic, & Petrovic, 2008). Also, those with low amounts of vegetable intake displayed a 4.04 fold increase for CHD (Nikolic et al., 2008). Type 2 diabetic patients on a high carbohydrate and high fiber diet consisting of legumes, fruits, vegetables, and whole cereals have shown an improvement on blood plasma glucose, insulin responses, and triglyceride-rich lipoprotein levels (De Natale et al., 2009). Apart from T2DM, high blood pressure may lead to cardiovascular problems and dyslipidemia. Afflicted adolescents have shown a significant decrease in systolic and diastolic blood pressure when 2 or more fruits daily were consumed and a lowering of systolic blood pressure when vegetables were consumed daily (Damasceno, de Araujo, de Freitas, de Almeida, & Zanetti, 2011). These studies indicate that fruit and vegetable consumption plays a major role in preventing certain chronic disease states.

Although fruits and vegetables may help prevent chronic diseases, Mexican-American children are not consuming an adequate amount of fruits and vegetables per day. According to the 2010 United States Department of Agriculture (USDA) Dietary Guidelines, 4 to 5 servings for both fruits and vegetables are recommended per day (United States Department of Agriculture, 2011). However, Mexican-American children do not meet these recommendations. In a study by Lorson, Melgar-Quinonez, and Taylor, (2009), 88.8% of Mexican-American children (2- to 18-year-olds) met fruit recommendations and 57.7% met vegetable recommendations according to the MyPyramid guidelines. Mexican-American children are not consuming enough fruits and vegetables in order to attain the full benefits these foods provide in terms of preventing diseases like obesity, T2DM, and cardiovascular disease.

Factors influencing healthy eating

Fruit and vegetable consumption can be influenced by many factors such as genetic-based taste preferences, socio-economic status (SES), food insecurity, and food accessibility in the neighborhood and at home. Also, negative parent modeling and poor diet may impede a child's physical development and health (Alaimo, Olson, Frongillo, & Briefel, 2001; Bell & Tepper, 2006; Dave, Evans, Pfeiffer, Watkins, & Saunders, 2010; Martin, Lee, Couch, Morrison, & Woo, 2011; Nord, Andrews, & Carlson, 2005; Singh, Siahpush, Hiatt, & Timsina, 2011; Swinburn, Egger, & Raza, 1999; Turnbull & Matisoo-Smith, 2002; Wang & Zhang, 2006; Worobey, Ostapkovich, Yudin, & Worobey, 2010).

Genetic Food Preferences

A positive relationship between obesity and genetic markers has been identified through previous research. However, other genetic markers for taste have been found to be associated with fruit and vegetable intake, which may be another factor affecting obesity. Researchers investigated a possible overlap between genetics of obesity and diet, which included the analysis of fruit and vegetable consumption, macronutrients, energy, and BMI of parents and their adult children. A negative correlation was found between BMI and fruit and vegetable intake (Martin, Lee, Couch, Morrison, & Woo, 2011).

Vegetable and fruit consumption was classified as heritable based on the results of the study, which may be explained by taste preferences. A compound known as PROP (6-n-propylthiouracil) has a bitter and sometimes sweet taste, which has been used in various studies to determine if people have different sensitivity when tasting this compound (Drewnowski, Henderson, & Shore, 1997). Research has found that subjects are more likely to dislike the bitter PROP solution if they are more sensitive to bitterness. This suggests that those who are more sensitive to bitter tasting foods like certain vegetables (e.g. cruciferous), would most likely not consume these products. In terms of sensitivity to the bitter taste of PROP, studies categorize subjects into three groups: non-tasters, medium tasters, and supertasters. Young children were more likely to consume bitter tasting vegetables if they were nontasters rather than tasters of PROP. For example, preschool aged children who were nontasters have been observed to accept spinach and cruciferous vegetables like broccoli (Bell & Tepper, 2006; Turnbull & Matisoo-Smith, 2002). In the Bell and Tepper (2006) study, children who were nontasters were more likely to consume 0.5 cups per day more of vegetables than tasters. Keller and Tepper (2004) showed that girls who were PROP tasters had a higher BMI when compared to nontasters indicating that these participants were less likely to have consumed bitter-tasting vegetables, which may result in low overall vegetable consumption. These studies were mainly composed of Caucasian, middle-to-high SES preschoolers.

Lumeng, Cardinal, Sitto, and Kannan (2008) examined low SES families with preschoolers in a Head Start program; about 53% of the subjects were nonwhite. Children who had a higher BMI z-score displayed greater sensitivity to the taste of PROP. However, race and gender were not associated with PROP. This could have been due to the small sample size. Furthermore, parents whose children who have been identified as PROP tasters may have a difficult time in feeding their child healthy foods and may resort to giving foods that children may accept. Higher sugar intakes may be a result of this and therefore contribute to the child being overweight (Keller & Tepper, 2004).

As hinted above, there may be an underlying effect of vegetable and fruit preference on BMI status. At a minimum, however, these studies suggest that genetic factors like tasting preferences play a significant role in determining the preference of fruit and vegetable intake. Genetic factors aside, other factors like socio-economic status may also play a role in influencing fruit and vegetable consumption

Socio-Economic Status

There have been studies in regards to the relationship of socio-economic status (SES) with overweight and obesity. Populations in poverty have been shown to have the highest rates of obesity (Drewnowski & Specter, 2004). Using data from National Health Interview Surveys (NHIS) from 1992-2008, participants with <$10,000 in family income had the highest prevalence for obesity in comparison to higher family income. From 1992-2008, there was a 42.3% and 19.2 % significant increase in prevalence of obesity and overweight, respectively, in families with incomes of <$10,000 per year, respectively (Singh, Siahpush, Hiatt, & Timsina, 2011). However, this study did not segregate family incomes by ethnic groups. Although research suggests poverty and obesity are related, a paradox was observed in the Mexican-American population. Alaimo, Olson, Frongillo, and Briefel (2001) analyzed Non-Hispanic white and black and Mexican-American children (2- to 16-year-olds) using data from NHANES III survey from 1988 to 1994. There was no statistical significance association for 2- to 7-year-old children being overweight and living in a low-income family. However, 8- to 16-year-old Non-Hispanic white children of low-income families had a significant prevalence of overweight; this was not seen in Non-Hispanic black children or in Mexican-American children of that age range which was consistent with a later study using NHANES III and NHANES 1999-2002 data (Wang & Zhang, 2006). In the Drewnowski and Specter (2004) study, energy costs (US dollars/Megajoule) was identified as having an inverse relationship with energy density (MJ/kg). Low energy-dense foods like refined grains, fats, or added sugars were considered the low-cost option. Poverty level may not be an independent factor for the prevalence of overweight in Mexican-American children but SES status along with food insecurity may be a contributing factor.

Food Insecurity

Defined by the1996 World Food Summit, food security is “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life” (Food and Agriculture Organization Corporate Document Repository, 1998). As of 2004, 43.9% of low-income households below the 130% poverty level with children had food insecurity (Nord, Andrews, & Carlson, 2005). Low-income, food insecure preschool Mexican-American children have been found to have a higher prevalence of poor health when compared to Non-Hispanic-White preschool children (Alaimo et al., 2001). Analyzing the NHANES 1999-2002 data, Casey et al. (2006) reported 42.4% of food insecure Mexican-American children were at risk of becoming overweight or obese. However, no association between Mexican-American children’s overweight status and child food-security status was found. Another study shows that Mexican-American children living with very low food security have been found to consume higher total energy intakes, percentage of calories from fat, calcium, and added sugar (Sharkey, Nalty, Johnson, & Dean, 2012). These children were observed to be low in dietary fiber and vitamin D intake. A food insecure household with children may have poor health due to the family low-income and as a result may lead to childhood obesity.

Home Environment

The economic environments in terms of income and costs of foods, and the physical environment, referring to the proximity of food outlets in the neighborhood, have been suggested as mediating factors in obesity and diet quality (Swinburn, Egger, & Raza, 1999; Wang, Kim, Gonzalez, MacLeod, & Winkleby, 2007). Also, the children's access to fruits and vegetables in the home contributes significantly to the overall consumption of these foods (Dave, Evans, Pfeiffer, Watkins, & Saunders, 2009). Hispanic parents who promoted fruit and vegetable consumption were considered positive role models. As a result, more fruits and vegetables were made available in the household for their children. However, those who were unemployed and believed in the benefits of fast food consumption had lower amounts of fruit and vegetable accessible in the home (Dave et al., 2009).

Parental Control and Modeling

As mentioned above, parent modeling may be a factor in a child's preference for fruit and vegetable consumption. Johnson and Birch (1994) found a significant association between maternal feeding control and 2- to 4-year-olds girls' caloric compensation. A positive relationship between parental restriction of highly palatable foods in daughters and eating in the absence of hunger was identified (Fisher, Birch, Smiciklas-Wright, & Picciano, 2000; Fisher & Birch, 2002). The daughters who ate in the absence of hunger were five times more likely to be overweight. A study by Costanzo and Woody (1985) had also found a significant association between restraint of daughter's food intake and an increase in daughter's percentage overweight. Birch and Fisher (2000) identified a bidirectional model where the mother-daughter dyads showed an association in poorer short-term eating regulation in daughters with maternal feeding restrictions. As a result, the daughter's increase in weight-for-height was promoted by an increase in energy intake.

This mother-child dyad was also observed in the consumption of fruits and vegetables. Fisher, Mitchell, Smiciklas-Wright, and Birch (2002) found that 5-year-old daughters' consumption of fruits and vegetables was positively correlated to mother's consumption of fruits and vegetables. In recent findings, Worobey, Ostapkovich, Yudin, and Worobey (2010) reported that the more mothers tried and liked vegetables and fruits the more that their preschool-aged daughters tried and liked these foods as well. Although this study did not find a strong correlation between mother-with-son in trying and liking fruits and vegetables, a strong correlation indicated that the more fruits and vegetables the sons tried, the more liking of fruits and vegetables occurred. Mothers or primary caregivers may play a critical role in consumption and acceptance of fruits and vegetables by preschoolers. However, these studies have mostly examined this relationship in mothers and children who are Caucasian. Mexican-American mother-child interactions may vary from these patterns due to their culture, socioeconomic status, and access to vegetables and fruits.

Concerns of inadequate fruit and vegetable consumption

According to the USDA, children at age 2 should consume 1 cup of fruit and 1 cup of vegetables daily (United States Department of Agriculture, 2010). Children 4-years-old should consume 1.5 cups of fruit and 1 to 1.5 cups of vegetables daily (United States Department of Agriculture, 2010). Fruit and vegetable consumption has become a major concern in the United States because if children are not consuming the adequate amount of fruits and vegetables, these children may not be obtaining beneficial nutrients for physical development and prevention of diseases. If children are not eating fruits and vegetable then what are they eating? In a recent study, 2- to 3-year-old children were reported to exceed the maximum discretionary energy allowances set by federal recommendations for both solid fats and added sugars by over 98% (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). The researchers also found that the consumption of fruit and vegetable decreased as age increased.

Basch, Zybert, and Shea (1994) performed a 3-year longitudinal study on New York City healthy Latino mothers and their preschool-aged children of low socioeconomic status. The majority of the mothers were born in the Dominican Republic, while their children were born in the United States. Results indicated that only 6.8% of children consumed the daily recommendation of fruits and vegetables as set by the Public Health Service at that time (*Healthy People 2000: National health promotion and disease prevention objectives,* 1990). Fruit was consumed more frequently than vegetables. However, 36% of the total fruit and vegetable intake was solely accounted for by 100% fruit juice intake. Deep yellow and dark green vegetables were consumed less frequently. A number of micronutrients (vitamins A and C, iron, potassium), macronutrients, and fiber showed a significant increasing trend from the lowest quintile to the highest in fruit and vegetable intake. Also, children who consumed more fruits and vegetables were less likely to drink sugar-sweetened beverages and ate less fried food. However, the mean intake of vegetable was only 1.0 serving per day, which did not meet the recommended number of servings.

In another study, researchers examined fruit and vegetable intake according to "5-A-DAY" guidelines in healthy white children at age 2 and 5 years of age (Dennison, Rockwell, & Baker, 1998). Results showed children's intake of vegetables was 0.5 servings per day. Children who consumed more than 0.5 servings per day were found to eat vegetables more frequently throughout the day, while the other children only ate on one occasion. Fruit juice contributed 54% of fruit servings per day. Vegetable and fruit nutrients were analyzed. There was a positive correlation between vegetable consumption with both vitamin A and beta-carotene. Fruit and vegetable consumption positively correlated with fiber, potassium, and total energy intake. An inverse relationship of fruit and vegetable intake was found with saturated fat and total fat. Legumes had a positive relationship with vitamin A. Potatoes had a positive correlation with cholesterol and total fat. Vitamin C intake was found in both citrus fruits and non-citrus fruit juices due to fortification and natural vitamin C. Children were found to not meet RDA when they did not consume two servings per day of fruits and vegetables. This suggests that children may be consuming too much fat and not receiving enough fiber and other nutrients that come from fruits and vegetables.

More recent findings on fruit, vegetable, macronutrient, and micronutrient intake can be found in the 2008 Feeding Infant and Toddlers Study (FITS), a cross-sectional, descriptive, national survey that evaluates dietary patterns in infants, toddlers, and preschoolers within the United States. When analyzing the fruit and vegetable consumption of 2- and 3-year-old children, 69.7% consumed at least 1 vegetable and 86.5% consumed at least 1 fruit (Fox, Condon, Briefel, Reidy, & Deming, 2010). Looking at the overall dietary intake of macronutrients, percentage of energy from carbohydrate, protein, and fat were within the Estimated Average Requirement (EAR) (Butte et al., 2010). Percentage of energy from saturated fat was 12%, which is above the EAR of <10%. Dietary fiber did not meet the EAR of 19 grams per day. The FITS study preschoolers only consumed 10 grams per day. In terms of micronutrients, a deficiency in vitamin E and potassium was observed, while folate, vitamin K, vitamin A, and vitamin C met the EAR. These findings were not separated by race or ethnicity but were treated as a whole for the sample. Differences in fruit, vegetable, and nutrient intake may vary among these groups.

For example, the concern for fruit and vegetable consumption has also been researched in Mexican children. Specifically Perez-Lizaur, Kaufer-Horwitz, and Plazas (2008) studied economically deprived, primary school-aged children (7- to 10-year-olds) from Mexico City. Personal and environmental correlates of fruit and vegetable consumption were analyzed. On average, children consumed fruits and vegetables once per day. Also, girls were likely to eat more fruits than boys. The low fruit and vegetable consumption is below the United States average of 2.1 servings per day (Cullen et al., 2001). However, the Cullen et al. (2001) study did not take into account their low-socioeconomic status, which may have resulted in a lower fruit and vegetable consumption. If Mexican children were having problems in consuming an adequate amount of fruits and vegetables, it would be reasonable to ask if this pattern is similar in Mexican-American children.

Overall, these studies indicate that children, as young as preschool-age in the United States are not consuming the recommended amount of fruits and vegetables per day.

Micronutrient deficiencies may reduce health benefits

As described above, low fruit and vegetable consumption may contribute to nutrient deficiencies in the diet, which may reduce health benefits related to these nutrients. Common nutrients found in either fruits, vegetables or both are potassium, dietary fiber, vitamin C, vitamin E, vitamin K and folic acid. According to the FITS study, potassium, fiber and vitamin E were inadequate in preschool-aged children according to dietary recommendations (Butte et al., 2010). Positive relationships between fruits and vegetable intake with vitamin C, potassium, and fiber were also observed (Dennison, Rockwell, & Baker, 1998; Basch, Zybert, & Shea, 1994).

Many health benefits from nutrient intake are found in fruit and vegetable consumption (Van Duyn & Pivonka, 2000). Adequate amounts of potassium may reduce the risk of hypertension, stroke, and heart disease. Vitamin E helps protect the polyunsaturated fatty acids in the cell membrane from oxidation. Dietary fiber reduces high serum cholesterol levels, moves carcinogens rapidly through the digestive tract, and may help control diabetes. Also, a common occurrence found with low fiber intake in children is constipation. The risks for constipation decrease as fiber intake of vegetables increase (Maffei & Vicentini, 2011; Comas Vives, Polanco Allue, & Grupo de Trabajo Espanol para el Estudio del Estrenimiento en la Poblacion Infantil, 2005). In the FITS study, preschool-aged children's dietary intake showed that vitamin C, vitamin K, and folic acid met dietary recommendations (Butte et al., 2010). Food products other than fruits and vegetables may contain fortification of these nutrients. Nevertheless, preschoolers who consume below the recommended amount of fruits and vegetables may reduce their protective benefits found in these foods. This nutrient analysis has been shown in mostly Caucasian populations while Mexican-American preschoolers have not been examined.

Research into Mexican-American preschool-aged children in fruit and vegetable consumption has been limited. As previously mentioned, the 2008 FITS study contains the most recent data with a large sample on dietary intakes and energy consumption in preschoolers. Even though FITS targeted a national representative sample containing 21.3% Hispanics, they were not separated from other ethnic groups during analysis and the majority of the families were of middle-socioeconomic status (Briefel et al., 2010).

Summary and Hypotheses

Childhood obesity is increasing at an exponential rate in the United States. In the Mexican-American population obesity and comorbidities like CHD and T2DM are prevalent. Prevention and improvement of certain disease states have been shown with a higher consumption of fruits and vegetables. Adults and children in the United States are not consuming enough of these foods. Some contributing factors may be genetic food preferences, parent modeling, environmental, economic status, and dietary intake. Some research has found Hispanic and Mexican children to be consuming inadequate amounts of fruits and vegetables. However, little to no research has been conducted with Mexican-American preschoolers in terms of fruit and vegetable consumption. For this reason, a comparative study regarding dietary intake related to fruit and vegetable consumption by children at 2- and 4-year-olds will be conducted as this thesis project.

Given the inadequate consumption of fruits and vegetables shown by preschool children in previous studies, the aim of this study was to explore nutrient intake in the overall diet, actual fruit and vegetable consumption, and its association with weight status.

It was hypothesized that in Mexican-American preschoolers' overall diet analyses:

- An increase in percent carbohydrate intake as the children age from 2 to 4 years, which will decrease percent protein and percent fat intake (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010).
- Micronutrient intake, specifically vitamin A, vitamin C, vitamin K, and folate, will meet the set DRI values at both time points (Dennison, Rockwell, & Baker, 1998; Basch, Zybert, & Shea, 1994; Butte et al., 2010).
- Micronutrient intakes, specifically vitamin E, potassium, and fiber, will not meet the set by DRI values at both time points (Butte et al., 2010, Dennison, Rockwell, & Baker, 1998; Basch, Zybert, & Shea, 1994, Sharkey, Nalty, Johnson, & Dean, 2012).

In separating fruit and vegetable intake from the 48-hour diet recalls:

- Participants will not meet fruit and vegetable recommendations set by the 2010 USDA dietary guidelines at age 2 or at age 4 years (Dennison, Rockwell, & Baker, 1998; Perez-Lizaur, Kaufer-Horwitz, & Plazas, 2008; Lorson, Melgar-Quinonez, & Taylor, 2009; Cullen et al., 2001; Basch, Zybert, & Shea, 1994).

- Participants will increase in weight status as they age, due to low fruit and vegetable consumption (Perichart-Perera et al., 2010; Casey et al., 2006; Martin, Lee, Couch, Morrison, & Woo, 2011).

In contrast to the FITS study, low-income Mexican-American children will solely be targeted in this thesis. The literature on dietary intake in Mexican-American preschoolers is limited and therefore the results from this project will provide additional knowledge on the relationship between fruit and vegetable intake and obesity risk factors to aid in the prevention of future health risks in this ethnic age group.

III. METHODS

Subjects

All subject data were drawn from the Rutgers Infant Nutrition and Growth (RING) Project, funded by the National Institute of Child Health and Human Development (grants HD 39697 and HD 47338) and approved by the Institutional Review Board of Rutgers University. The project had a longitudinal design where the children's data was collected from birth until 5 years of age. Mothers and their infants were recruited from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Program in New Brunswick, NJ. WIC guidelines for eligibility stipulate a gross family income of 185% or below the poverty line (New Jersey Department of Health and Senior Services, 2012; United States Department of Health & Human Services, 2012). Due to these criteria, all subjects in the RING Project were from low-income households, with enrollment restricted to black and Hispanic mothers who chose to formula-feed their infants. During the recruitment process, an English or Spanish written informed consent, depending on mother's primary language, was given to the mother to enroll herself and her child (Appendix A). Mothers were notified that with their continued consent, home visits would occur at 3-, 6-, 12- months and then only once a year approximately at the child's birthday until the age of 5 years. For the present study, only mothers of Mexican origin and their children were included (N = 37). Data used was confined to information obtained at the time of enrollment, at the 2-year home visit, and at the 4-year home visit.

Maternal and child demographics and anthropometric measurements

Mothers enrolling their infant and themselves in the RING Project were asked with the aid of a bilingual research assistant to fill out a demographic form indicating their ethnicity, years in school, years living in the United States, home address, and contact information (Appendix B). Prepregnancy measurements of maternal height and weight and birth information were obtained through the WIC client database where participants were registered (Appendix C). During recruitment, mothers were reminded that they would be notified a month before each home visit and that they would be compensated for their participation.

Data collection and home visit procedures

The month prior to the child's birthday, mothers were sent postcards reminding them of their child's participation in the RING project. Two weeks later, the project coordinator called the mother to schedule the home visit and was asked to verbally confirm her and her child's participation in this project. The home address was confirmed during this phone call. Also, mothers were reminded that the data collection would take place on two consecutive days. Two Human Subject certified research assistants were then scheduled to visit the mother and child. For home visits with Spanish speaking mothers, a bilingual research assistant was scheduled to gather data. Specific data collected from subjects were the child's age, anthropometric measurements, and 48-hour diet recalls.

Day 1

On Day 1 of the home visit, the research assistants measured the child's weight, height, and arm circumference. These measurements were recorded on the child's home visit form (Appendix D). Using the dietary recall form found in Appendix E, the research assistant questioned the mothers on their child's eating behavior and whether it was typical or atypical for the previous day (e.g. Child was sick and did not eat much would be considered atypical.). The mother was then asked to recall what the child ate and drank from 24-hours before the home visit until the time of the visit. Employment of food models aided mothers in reporting the amount of food and drink the child consumed (Appendix F). A research assistant then verbally confirmed the home visit for the next day and left the participant's home.

Day 2

The same research assistants visited mother and child the following day. The mother was again asked if the child's eating behavior was normal or abnormal for the previous day. The mother was then asked to report the child's food and drink intake from the day before until the time of the Day 2 visit. After all information was gathered, $30 compensation was given and the mother signed a receipt confirming payment (Appendix G).

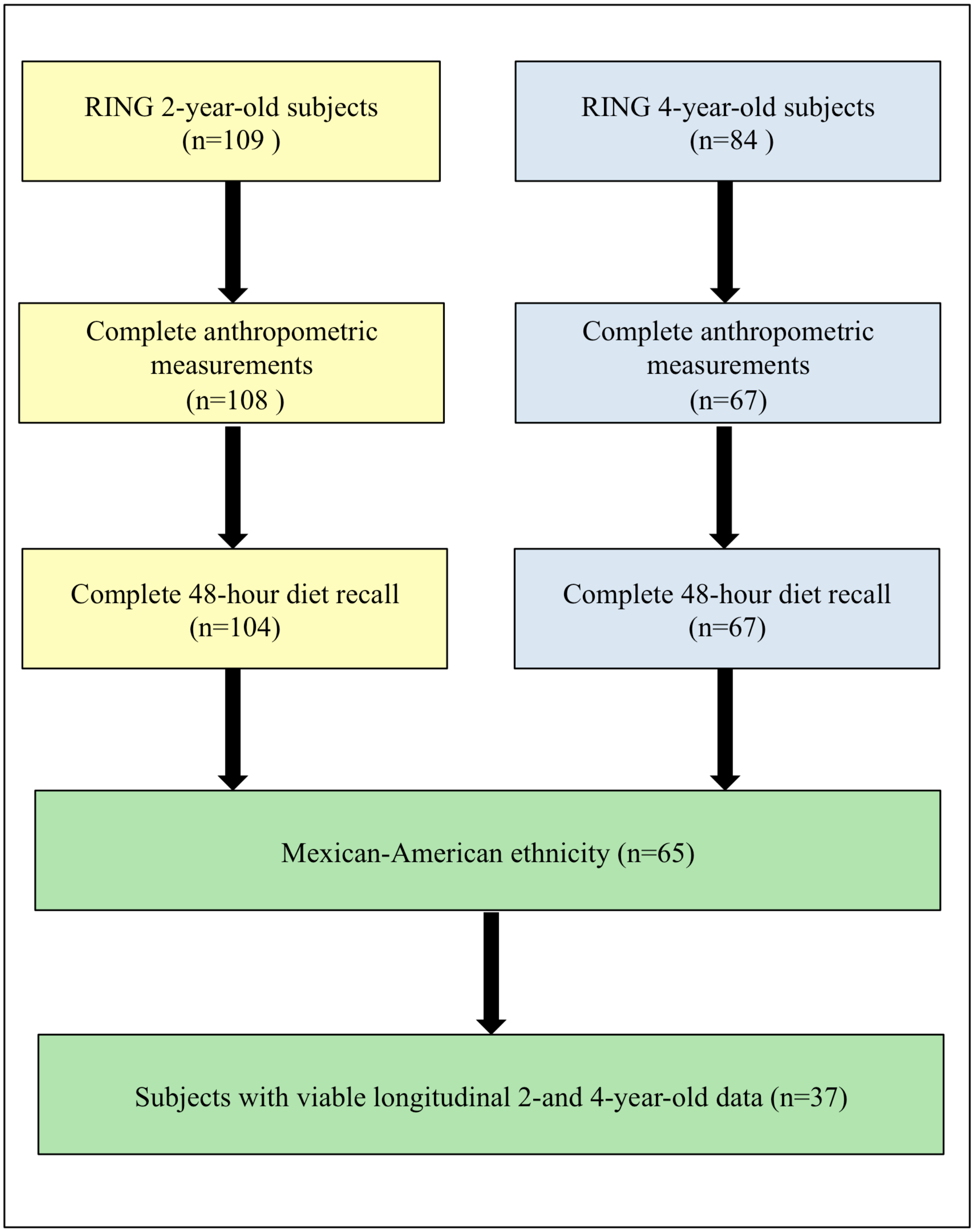
Data Preparation

Preceding data analysis, dietary recalls collected during home visits by research assistants were inputted into Nutritionist Pro™ and later reviewed by the research Project Coordinator for accuracy. The Nutritionist Pro ™ Diet Analysis 2010 was used to evaluate total nutrient intakes from food and beverages the child consumed (Axxya Systems, Stafford, TX). Nutritionist Pro™ Diet Analysis contains an extensive database with over 51,000 brand-name foods, ethnic foods, fast foods, ingredients and recipes. The software allows for unlimited, additional nutrient input on novel foods and recipes. When a food item in a dietary recall was not quantified accurately, available literature was used to help assign the correct measurements to be inputted into Nutritionist Pro™.

The RING data was comprised of 109 subjects at 2 years and 84 subjects at 4 years. However, only 37 subjects comprised this study this study based on complete anthropometric measures available at both 2 and 4 years, at least a 24-hour diet recall, and having a Mexican-American ethnicity. As shown in Figure 1, subjects excluded were those who had incomplete anthropometric measures or incomplete diet recalls (e.g. categorized as having an atypical diet). In this thesis, 48-hour diet recalls were collected, but at times only a 24-hour diet recall was considered usable because mothers did not provide enough information for a second day, the child became sick, or child had an atypical diet.

Using average height and healthy weight as reference, the Estimated Energy Requirements (EER) equation was formed for each age group and gender (National Research Council, 2006). Children from age 2 to 3 require 1,000 to 1,400 kilocalories, with no gender differences in their requirement. However, gender differences in EER are considered for children between the ages of 4 and 8; girls are recommended to consume 1,200 to 1,800 kilocalories and boys 1,200 to 2,000 kilocalories. The kilocalorie range is given because children have varied activity levels and accommodate needs at different ages. Anthropometric measurements were also calculated using WHO Anthro Software (version 3.2.2), provided by the World Health Organization (WHO) to accurately report child’s percent BMI-for-age. All data for this study were entered into the IBM Statistical Package for the Social Sciences Software (IBM SPSS version 19.0, Armonk, NY).

Figure 1: Exclusion criteria for RING participants.



IV. RESULTS

Statistical Analyses

Descriptive demographics and anthropometric measurements are shown below as means and standard deviations. Mean Dietary Reference Intakes (DRIs) are compared to subjects' actual nutrient intakes at both time points using single sample t-tests (National Research Council, 2006). Differences between the children at age 2 and 4 in anthropometric measures, energy intake, macronutrients, micronutrients, and fruit and vegetable consumption are identified using independent sample t-test, paired sample t-test, or Spearman correlation coefficients. Statistical significance was set at $p < 0.05$ for all analyses.

Demographic and anthropometric characteristics of participants

The maternal and children demographic characteristics and anthropometric measurements are presented in Table 1. Mother's mean years of school indicated that the majority of the mothers did not complete elementary education. Maternal Body Mass Index (BMI, kilograms per meter squared) was calculated using the weights and heights obtained from WIC. Mothers were shown to have a prepregnancy BMI of 26.9 kg/m^2, implying that many mothers were overweight. Children included in this study were close to the target ages of 2 and 4 years at both time points. Between groups analysis was utilized to compare children's anthropometric measures for weight, height, percent BMI-for-age and sex. As subjects grew older, a significant increase in weight and height was observed ($p<0.0001$). The means for BMI-for-age percentile were 63.6 ± 29.7 and 75.5 ± 23.9 for 2- and 4-year-olds, respectively. In a paired sample t-test comparing BMI-for-age percentile between 2- and 4-year-olds, an increased significant difference was identified (p = 0.036). No relationships were found between mothers' BMI and children's percent-BMI-for-age at either age.

Table 1. Characteristics of mothers at time of recruitment and children (n=37).

	Mother			Child (2 yrs)		Child (4 yrs)		
				17 female, 20 male				
Measurements	Mean	SD†		Mean	SD†	Mean	SD†	p-value
Age (years)	27.2[a]	5.1	Age (years)	2.02	0.06	3.99	0.01	N/A
Years of education	7.3[a]	2.9	Weight (g)	12.9	2.1	17.0	2.0	0.0001
Years in U.S.	7.5[b]	2.8	Height	86.4	4.5	101.7	3.3	0.0001
Prepregnancy BMI	26.9[c]	5.4	% BMI-for-age	63.6	29.7	75.5	23.9	0.036

a Missing data at time of recruitment, n=35.

b Missing data at time of recruitment, n=34.

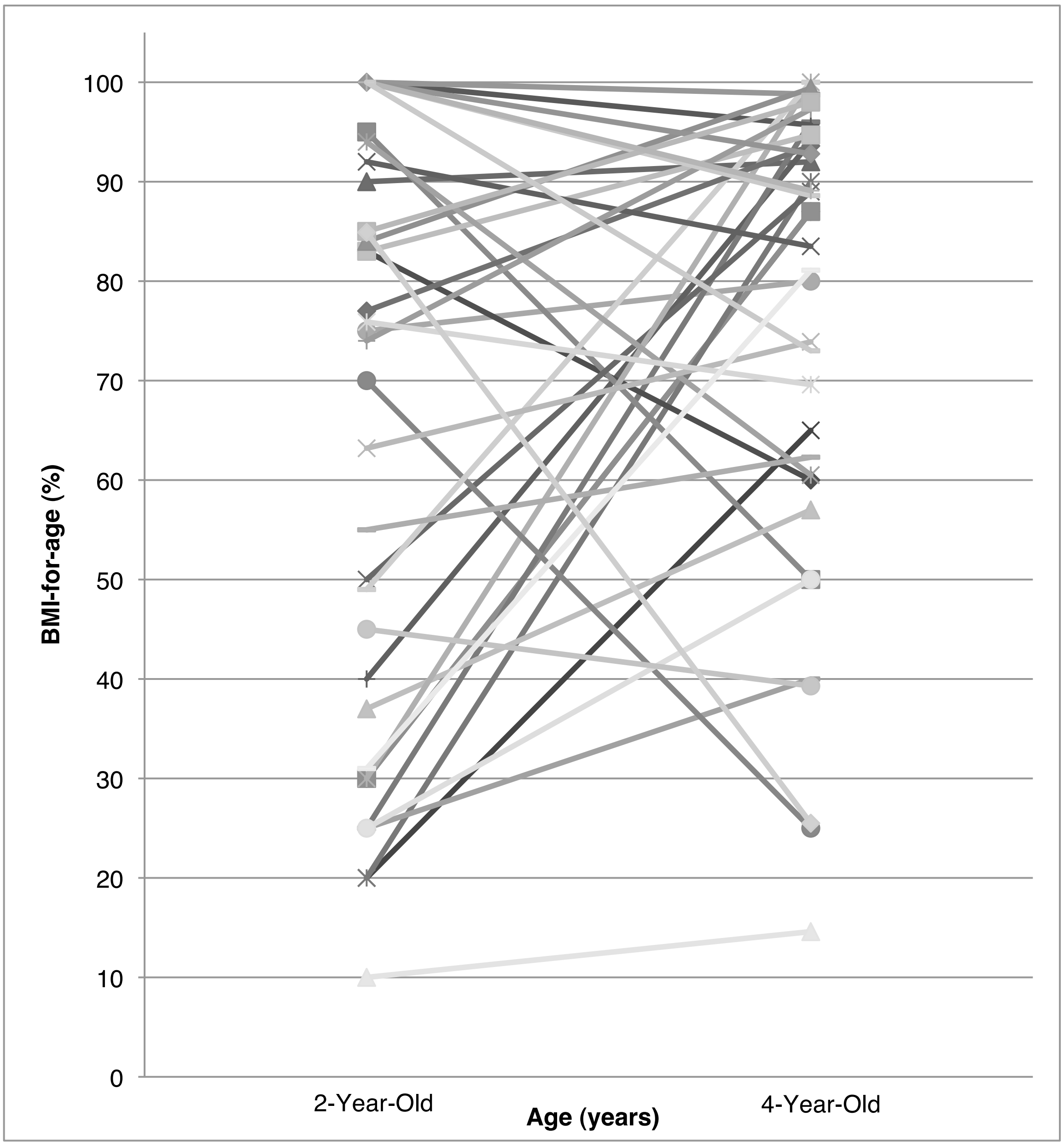
c Missing data at time of recruitment, n=28.

†SD = Standard Deviation

N/A = Not applicable for analysis.

To visually illustrate the pattern of this change in children's BMI, Figure 2 shows each participant's BMI-for-age percentile tracked at both time points. The lines illustrate which participants increased or decreased their BMI-for-age percentile as the children aged. As shown, some participants remained below the 85^{th} percentile (n=14). Four children were above the 85^{th} percentile at age 2 but then dropped below the $<85^{th}$ percentile by 4 years of age. In contrast, 12 participants who were categorized with $<85^{th}$ percentile at age 2 were found to have increased to above the 85^{th} percentile by the time they were 4-year-olds. Most alarming were the children who maintained a BMI-for-age percentile above the 85th percentile (n=7). About 30% (n=11) of the participants at age 2 were above the 85th percentile, but by the age of 4 about 51% (n=19) of them were above the 85th percentile.

Figure 2. Comparing percent BMI-for-age at age 2 and 4 years.



Nutrient analysis of the overall diet in 2- and 4-year-olds

Children at age 2 have different DRIs than when they are 4-year-olds. In analyzing the overall diet of the participants, t-tests were used to compare the children's overall macronutrients to the appropriate DRI values (Table 2). Percent carbohydrate, protein, and fat were not significantly different from the percent DRI at either age. In contrast, fat percentage significantly decreased as the children aged ($p<0.01$). However in a paired sample t-test between groups, a significant increase in the percent carbohydrate from age 2 to 4 was observed ($p<0.01$).

Table 2. Paired sample t-test comparing macronutrient means between 2 and 4 year olds.

	2-Year-Old			4-Year-Old			
Measures	DRI[a]	Mean	SD[†]	DRI[a]	Mean	SD[†]	*p*-value
Carbohydrate (%)	45-65	39.1	18.4	45-65	53.1	8.1	0.01
Protein (%)	5-20	14.2	8.8	10-30	15.9	4.1	0.33
Fat (%)	30-40	38.5	12.4	25-35	31	6.4	0.01
Fiber (g)	19	9.6*	6.4	25	9.4*	4.4	0.87

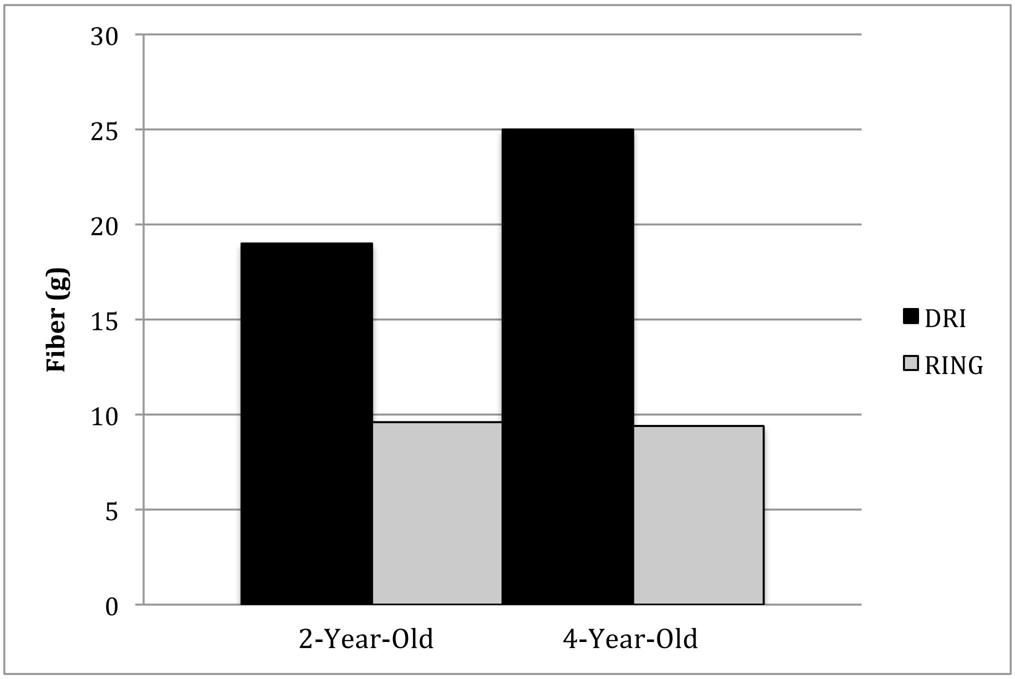
* Mean is significantly different from the DRI (p<0.001) using one-sample t-test (2-tailed).

a Dietary Reference Intake

†SD = Standard Deviation

Fiber intake was significantly below the DRI at both ages ($p<0.001$). Figure 3 further illustrates the disparity between the DRI and the children's intake at both ages. The DRI for fiber intake increases as the child ages; in contrast, the subjects' fiber consumption remains relatively the same at both time points and significantly below the recommended intake.

Figure 3. Fiber intake compared to DRI at 2 and 4 years.



Micronutrients typically found in fruit and vegetables were analyzed, namely, vitamins A, C, E, and K, along with folate and potassium (Table 3). Again, t-tests were used to compare the children's overall micronutrients to the appropriate DRI values. Relative to the DRI, children at age 2 and 4 had significantly higher intakes of vitamin A, vitamin C, and folate ($p < 0.001$). Although these values were well above the DRI, these micronutrients did not exceed the recommended upper limits. Dissimilarly, potassium and vitamin E were below the DRI ($p < 0.001$) at both time points.

Table 3. Paired sample t-test comparing micronutrient means between 2- and 4-year-olds.

	2-Year-Old			4-Year-Old			
Measure	DRI[a]	Mean	SD[†]	DRI[a]	Mean	SD[†]	*p*-value
Vitamin A (ug)	300	488.7*	290.7	400	538.7*	262.3	0.39
Vitamin C (mg)	15	83.6*	68.1	25	98.8*	79.3	0.32
Vitamin E (mg)	6	1.3*	1.1	7	2.3*	2.8	0.04
Vitamin K (ug)	30	40	81.7	55	15.3*	9.1	0.08
Folate (ug)	150	217.9*	116	200	273.1*	109.7	0.04
Potassium (mg)	3000	1799.2*	814.7	3800	1686.4*	577.3	0.45

* Mean is significantly different from the DRI ($p<0.001$) using one-sample t-test (2-tailed).

a Dietary Reference Intake

†SD = Standard Deviation

Figure 4 shows the potassium intake for both age groups in comparison to the DRI values. The potassium DRI value increased as the children aged, however the subjects' intake in potassium did not increase to meet the recommended intake as they aged. In Figure 5, the between age groups analysis for vitamin E intake is illustrated. The figure shows that vitamin E DRI value increases as a child ages. Although a significant increase in vitamin E intake ($p = 0.04$) from age 2 to 4 was observed, vitamin E intake remained significantly below the DRI value at both time points.

Figure 4. Potassium intake compared to DRI at 2 and 4 years.

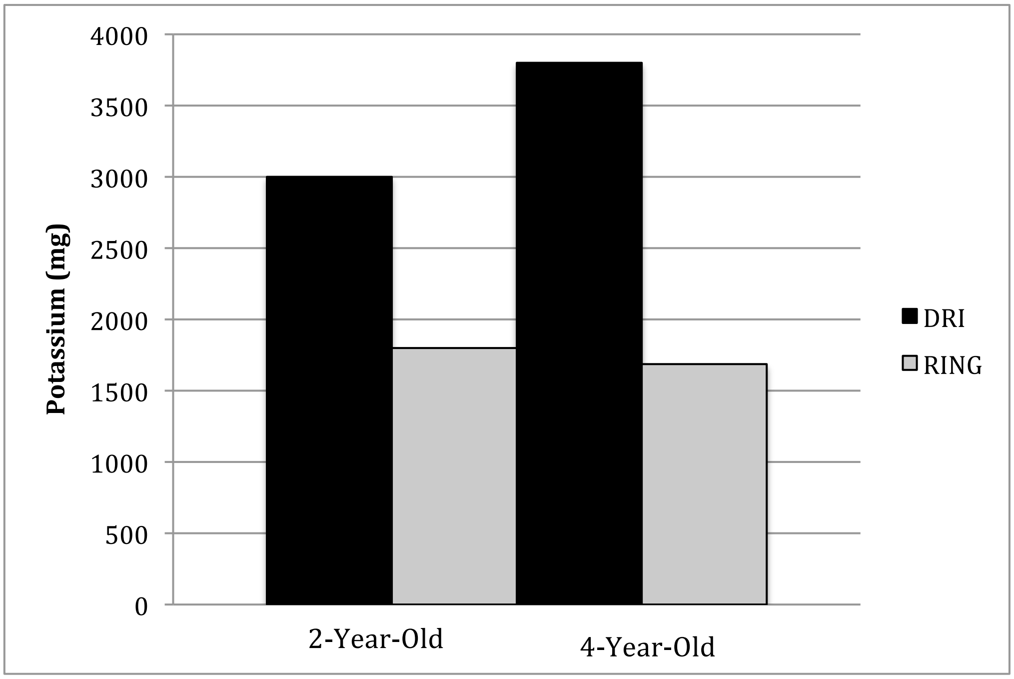
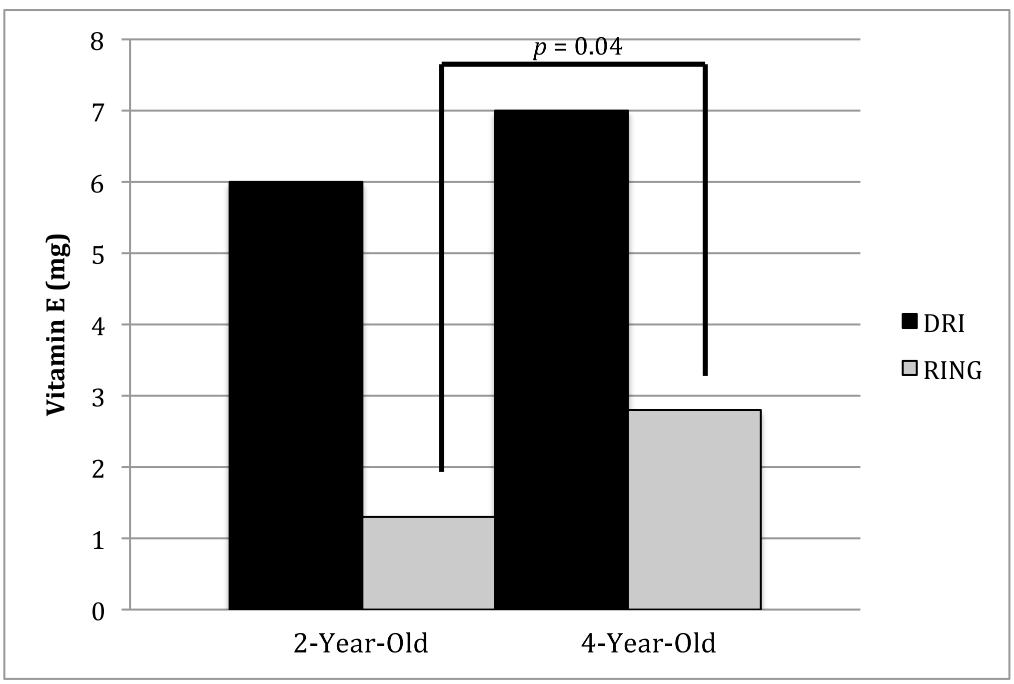
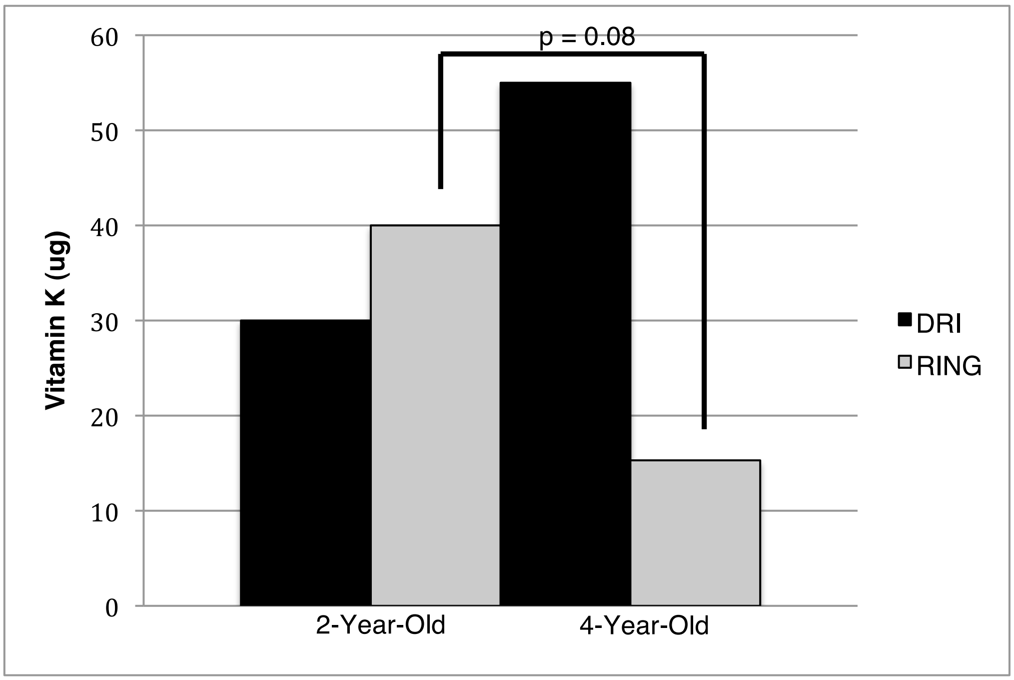


Figure 5. Vitamin E intake compared to DRI at 2 and 4 years.



Presented in Figure 6, vitamin K intake was adequate at age 2 when compared to the DRI value of 30ug, but when the subjects reached age 4, vitamin K intake did not meet the DRI value of 55ug. Also, a drop in Vitamin K intake from 2-year-old to 4-year-old subjects was observed.

Figure 6. Vitamin K intake compared to DRI at 2 and 4 years.



Analysis of fruit and vegetable consumption between 2- and 4-year-olds

The percentage of children who consumed a specific whole fruit and 100% fruit juice at least once in a day is listed in Table 4. Consumption of whole fruit and 100% fruit juice are described for both age groups. The highest percentage of children consuming specific fruits at age 2 and 4 were for apples, bananas, and oranges. Among the 37 participants, 12 different fruits were consumed at both time points. The 100% fruit juice was consistent between age groups. Ranked highest to lowest, children drank orange juice, apple juice, mixed juice, and grape juice.

Table 4. Percentage of children consuming select fruits at least once in a day (n=37).

2-Year-Old			4-Year-Old		
Whole Fruit	**%**	**n**	**Whole Fruit**	**%**	**n**
Apple	40.5	15	Banana	32.4	12
Banana	18.9	7	Orange	16.2	6
Orange	13.5	5	Apple	13.5	5
Grapes	13.5	5	Fruit Salad	5.4	2
Pear	10.8	4	Grapes	5.4	2
Watermelon	10.8	4	Pear	2.7	1
Fruit Salad	5.4	2	Prune	2.7	1
Strawberries	5.4	2	Peach	2.7	1
Pineapple	2.7	1	Strawberries	2.7	1
Plum	2.7	1	Mango	2.7	1
Cantaloupe	2.7	1	Watermelon	2.7	1
Honey Dew Melon	2.7	1	Pineapple	2.7	1
100% Juice	%	n	100% Juice	%	n
Orange Juice	35.1	13	Orange Juice	32.4	12
Apple Juice	21.6	8	Apple Juice	24.3	9
Mixed Juice[a]	16.2	6	Mixed Juice[a]	16.2	6
Grape Juice	8.1	3	Grape Juice	5.4	2
			Mango Juice	2.7	1

a Mixed juice was classified as two or more 100% juice combined together to form a new type of juice (e.g. Apple Grape juice).

In Table 5, vegetables consumed by children at age 2 and 4 are listed. The percentage of children consuming vegetables at each age group showed carrots and beans were among the highest consumed vegetable at 2 years and remained so at 4 years. As the children aged, the percent of children eating French fries increased from 5.4% to 21.6%. In contrast, the consumers of potatoes that were not fried decreased from 21.6% to 5.4%.

Table 5. Percentage of children consuming select vegetables at least once in a day (n=37).

2-Year-Old			4-Year-Old		
Vegetable Item	%	n	Vegetable Item	%	n
Bean	37.8	14	Tomato Sauce	29.7	11
Potato	21.6	8	French Fries	21.6	8
Carrot	10.8	4	Bean	18.9	7
Vegetable Soup	10.8	4	Carrot	13.5	5
Potato Chip	10.8	4	Corn	13.5	5
Lettuce	10.8	4	Ketchup	13.5	5
Tomato Sauce	5.4	2	Potato Chip	10.8	4
Ketchup	5.4	2	Broccoli	8.1	3
French Fries	5.4	2	Vegetable Soup	5.4	2
Tomato	5.4	2	Pea	5.4	2
Mixed Vegetables[a]	5.4	2	Lettuce	5.4	2
Corn	2.7	1	Potato	5.4	2
Broccoli	2.7	1	Pepper	2.7	1
Spinach	2.7	1	Hash Brown	2.7	1
Peanut Butter	2.7	1	Tomato	2.7	1
Green Bean	2.7	1	Vegetable Dish	2.7	1
Squash	2.7	1	Onion	2.7	1

a Mixture of vegetables with unknown individual amounts (e.g. A combination of peas, corn, and carrots.).

Although most children at both time points consumed fruits and vegetables at least once per day, the quantity of each fruit and vegetable item was undefined. In order to verify if children were reaching the daily recommendations for fruits and vegetables, the means of daily intake were calculated and are reported in Table 6. According to the USDA, children at age 2 should consume 1 cup of fruit and 1 cup of vegetables daily. Children 4-years-old should consume 1.5 cups of fruit and 1 to 1.5 cups of vegetables daily. A between group analysis comparing fruit consumption and vegetable consumption showed no significant difference with age. As shown in Table 6, the children consumed 1.4 cups of fruit at both time points, not significantly different from the recommended value. However, children only consumed 0.3 cups of vegetables at age 2 and age 4, which was significantly lower than the recommended value at both ages (p<0.001).

Table 6. Paired sample t-test comparing daily fruit and vegetable consumption means between 2- and 4-year-olds – mean (standard deviation, SD).

	2-Year-Old			4-Year-Old			
Measure	USDA[a]	Mean	SD	USDA[a]	Mean	SD	p-value
Fruit (cups)	1	1.4	1.3	1.5	1.4	1.2	0.984
Vegetable (cups)	1	0.3*	0.5	1 - 1.5	0.3*	0.3	0.983

* Mean is significantly different from the DRI (p<0.001) using one-sample t-test (2-tailed).

a United States Department of Agriculture: MyPlate

Fruit and vegetable consumption was next split into quartiles. As shown in Table 7, children were assigned a number dependent on the quantity of fruit or vegetable consumed according to the dietary recommendations. Those participants with a score of 4 were considered to be high consumers while those who scored a 1 were considered to be very low consumers of either fruits or vegetables. The majority of children at age 2 (62.2%) were ranked at the 4th quartile for quantity of fruit consumed, indicating these children were meeting or close to meeting the dietary recommendation of 1 cup. By age 4, close to half of the children were still consuming the recommended fruit intake

(45.9%). In contrast, vegetable quartiles showed children at age 2 and 4 with low consumption of vegetables. At age 2, 70.3% of children consumed little to no vegetables and by age 4, 48.9% of children continued to be at the 1st quartile.

Table 7. Children's fruit and vegetable consumption categorized into fruit and vegetable scores (n=37).

	2-Year-Old			4-Year-Old		
	Quartile	Percent	n	Quartile	Percent	n
	1	27.0	10	1	10.8	4
Fruit	2	5.4	2	2	27.0	10
	3	5.4	2	3	16.2	6
	4	62.2	23	4	45.9	17
	Quartile	Percent	n	Quartile	Percent	n
	1	70.3	26	1	48.9	18
Vegetable	2	10.8	4	2	24.3	9
	3	2.7	1	3	24.3	9
	4	16.2	6	4	2.7	1

No significant relationship between fruit and vegetable quartiles was found for the 2-year-olds. However, a strong, positive correlation between fruit and vegetable consumption was found in the 4-year-old group ($r = 0.507$, $p = 0.001$). Another significantly positive relationship was shown for participants who had a high fruit quartile at age 2 having a high fruit score at 4 years of age ($r = 0.474$, $p = 0.003$). No correlation was found for vegetable intake between 2- and 4-year-olds ($r= 0.073$, $p= 0.670$).

The fruit and vegetable quartile scores were next summed for each age group. In comparing the sum of fruit and vegetable consumption between age 2 and 4, a near significant, positive relationship ($r = 0.315$, $p = 0.058$) was observed. When splitting by gender, boys who were found to have a higher quartile score at age 2 were also higher at age 4 ($r = 0.488$, $p = 0.029$). In addition, percent BMI-for-age was correlated with fruit and vegetable consumption quartiles. A negative relationship was found at age 4 between vegetable quartile scores and percent BMI-for-age ($r = -0.353$, $p = 0.032$).

V. DISCUSSION

Developing good eating habits including higher fruit and vegetable consumption is important for long-term health and physical growth starting as early as the preschool years. Pursuant to expected development, the children's weight and height increased as they aged. The data for this thesis showed the mean Mexican-American mothers' prepregnancy BMI as overweight and the Mexican-American children showed a mean increase in BMI-for-age from about the 64th to the 76th percentile as they aged. Although maternal BMI and child BMI-for-age did not correlate, about 30% of 2-year-old children were above the 85th percentile. Still worse, over half of the participants were above the 85th percentile by the time the subjects were 4-years-old. The results suggest that these children may become or remain overweight in the upcoming years if this trend persists. In support of this finding, Whitaker (2004) conducted a study containing low-income preschool-aged children and their mothers. Maternal BMI, in the first trimester of pregnancy, was categorized as obese or nonobese and compared to their child's BMI at 2, 3, and 4 years of age. Having a mother identified as obese more than doubled the risk of obesity in children at 2 to 4 years of age. In an early study, a three-generation familial trend of obesity was identified for grandparents, parents, and the parents' school-aged children. Positive correlations were found between grandparents' BMI and parents' BMI as well as between maternal BMI and their children's BMI (Guillaume, Lapidus, Beckers, Lambert, & Bjorntorp, 1995). In a recent study, parental-offspring associations were shown between mothers' BMI and children's BMI as early as 3 years of age (Fleten et al., 2012).

Since fruits and vegetables have been identified as influencing factors in obesity and disease states, nutrients found in these foods were examined in the present study. As predicted, carbohydrate intake significantly increased from 2 to 4 years of age. At the same time, a decrease in fat consumption was observed. This could be due to higher consumptions of sugar and refined carbohydrates (Perichart-Perera et al., 2010; Drewnowski & Specter, 2004). Also, children may have fat and sweet taste preferences that have been shown to contribute to weight status. In a recent study, 6-to 9-years old girls that preferred fats and sweets had a high probability of being overweight or obese (Lanfer et al., 2012). If more sugar-sweetened beverages and refined carbohydrates are consumed, then perhaps fruits and vegetables are being substituted for these unhealthy food choices (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). An increase in carbohydrates has been associated with the rise in sugar-sweetened beverage intake, which has been positively associated with obesity and increased risk of certain disease states (e.g., diabetes) (Vartanian, Schwartz, & Brownell, 2007).

The RING participants' fiber intake did not significantly change as they aged. In fact, the children's fiber intake was on par with preschool-aged children in FITS at about 10 grams per day (Butte et al., 2010). However, these were significantly low intakes of fiber when compared to the DRI values at both time points. In another study on low-income, Mexican-American, elementary school-aged children, the average of fiber intake was 11.6 grams per day, which is slightly higher than both the FITS and RING participants (Trevino et al., 1999). Although these Mexican-American children had higher fiber intake, they still did not meet the recommended dietary allowances for their age. Also, fruit and vegetable consumption was found to be only half of the USDA dietary guidelines for Americans of that time. Since children were not consuming an adequate amount of fruits and vegetables, low fiber intake may have been a result.

The common micronutrients in fruits and vegetables are vitamin A, C, E, K, potassium, and folate. As predicted, RING participants met the DRI values set for vitamin A, vitamin C, and folate at both time points. The FITS children had even higher amounts of vitamin A and folate than the RING participants both ages. This could be due to the foods, not including fruits and vegetables that the FITS participants were consuming. Many foods are now fortified or enriched with vitamin A (e.g. milk) and folate (e.g., bread, dry cereal). On the other hand, Vitamin C intake was similar in the RING and FITS preschool-aged children. The majority of the RING participants consumed 100% juice daily, so high vitamin C intake may be attributed to citrus and non-citrus fruit juices (e.g., orange juice, apple juice) that are fortified with this vitamin (Dennison, Rockwell, & Baker, 1998). An earlier study examining low- to middle-income Mexican-American preschool-aged children reported adequate intake of vitamin C when data was compared to the current DRI values used in this thesis (Zive et al., 1995).

Micronutrients that did not meet DRI values were vitamin E and potassium at both time points. Although vitamin E intake did increase from age 2 to 4, the increase did not meet an adequate intake set by the National Research Council (2006). In contrast, FITS participants mean vitamin E intake was near the DRI value (6 mg per day) (Butte et al., 2010). However, about 37% of the FITS children did not meet the vitamin E adequate intake level. Since the FITS study did not separate by ethnicity, one might speculate that of these 37% children not consuming an adequate amount of vitamin E, a large portion may be Mexican-American. Also, similar intakes in potassium were found between RING and FITS participants. In another study analyzing Mexican-American preschool children (3- to 5-years-old), potassium levels did not meet the Recommended Dietary Allowances (RDA) (Mier et al., 2007). Mexican-American children may not be consuming enough dark green- and orange-colored vegetables. As found in this thesis, only a small percentage of children consumed these the specified colored vegetables. Fruits like bananas, peaches, and prunes contain potassium. As reported in the results, only about one-third or less of the participants consumed these kind of fruits at either age group.

In FITS, vitamin K intake met the DRI value for preschool-aged children. The RING 2-year-old children also met the DRI value. The recommended value of 30 ug per day is for 2-to 3-year-olds, which both the FITS and RING 2-year-olds fall under. However, by the age of 4, vitamin K intake was well below the recommend value of 55 ug per day. In the present study, children did not consume many green, leafy vegetables (e.g. spinach), cruciferous vegetables (e.g., broccoli), or fruits (e.g., berries, avocado), which are good sources for vitamin K. The inadequate consumption of vitamin K, vitamin E, and potassium may increase the risk for heart disease later on in life (Duyn & Pivonka, 2000).

The nutrients mentioned above are found in fruits and vegetables. In order to understand why some nutrients met the DRI and others did not, the servings of fruits and vegetables were examined. At both time points, children consumed the recommended servings for fruit. A previous finding by Lorson, Melgar-Quinonez, and Taylor (2009) shows children consumed the recommended MyPyramid value of fruit consumption from

2 to 5 years. When Mexican-Americans were split from a larger sample size (2 to 18 years), these children and adolescents combined only consumed 1.16 cups, which was 12% below the recommended intake. Also these Mexican-American children had the highest consumption of fruit when compared to Non-Hispanic White and Non-Hispanic African-Americans, but were still below the recommended intake. Furthermore, Perez-Lizaur, Kaufer-Horwitz, & Plazas (2008) showed that Mexican children only consumed 1 serving of fruits and vegetables combined per day. This indicates that more studies need to be conducted in Mexican-American preschool-aged children to determine if fruit consumption is a greater problem at a younger age or if adolescents need to be targeted.

On the other hand, vegetable intake in this study when compared to other studies confirms that children are not consuming enough vegetables despite ethnic differences. Preschool-aged children have been shown to only consume 0.76 cups of vegetables (Lorson et al., 2009), which is more than double what the Mexican-American children in the RING project consumed at either age. FITS did not go into detail on the amount of vegetables consumed on average; however, researchers found that 70% of 2- to 3-year-olds children consumed at least one vegetable per day (Fox, Condon, Briefel, Reidy, & Deming, 2010). According to the USDA food guidelines, one vegetable per day most likely does not meet the daily requirement of a one-cup serving in this age group.

Apart from low vegetable consumption being a concern, some of the highest vegetables consumed were tomato sauce and ketchup. Although tomatoes contain nutrients such as vitamin A and lycopene, they have little to no dietary fiber while other vegetables like beans, carrots, and broccoli are significant sources of dietary fiber. Also, from age 2 to 4 years, 10.8% of the children consumed potato chips at each time. What may be more disturbing is the consumption of French fries having increased by 16.2% over the 2-year period. In contrast, children in the FITS study shows a decrease in French fries consumption by 2% from children at age 2 years to children at age 3 years (Fox, Condon, Briefel, Reidy, & Deming, 2010). However, these children were not separated by low-income status or by ethnicity, which may have shown a higher consumption of French fries and other fried potatoes. If the increasing trend of fried food consumption persists in low-income Mexican American preschoolers, not only may this be causation in low vegetable consumption but also may result in poor health later in life.

Strengths

There are few studies that focus on low-income Mexican-American samples in the United States. This is especially true for preschool-aged, low-income, Mexican-American children and their fruit and vegetable consumption. The data in this study contributes to the literature as it concerns this demographic population. In previous research, fruits and vegetable intake patterns in this population was relatively unknown and therefore specific recommendations for this ethnic group may have been limited. In future nutrition education, the findings for this homogenous cohort of subjects may help target fruit and vegetable consumption in Mexican-American children. Another strength of this study is the comparative data, which allowed analysis of a population over-time as opposed to only a snapshot of the population. The 48-hour dietary recalls at both time points, helped identify key factors that may affect fruit and vegetable consumption. While studies like FITS used validated methods such as telephone interviews, the home visits used here helped personalize the dietary records because words for foods can be different depending on the person's Spanish dialect. Home visits were conducted to collect both anthropometric measurements and 24-hour dietary recalls. The bilingual research assistant helped break down the language barrier when communicating face-to-face with mothers and their children.

Limitations

The sample size for this study is relatively small. However, longitudinal data collection is both time consuming and labor intensive. Maintaining contact with families that often moved, scheduling research assistants in pairs (where one must be bilingual) to attend home visits, and traveling to mothers' homes were all essential to the data collection process. Furthermore, from the time of recruitment to the time of the actual home visits at age 2 and 4 years, many participants were lost, resulting in a smaller cohort and limited data collection. Another limitation in this study was the unavailability of 48-hour recalls for all children. Due to the child being sick or incomplete diet records collected during the home visit, when necessary a 24-hour diet recall was deemed sufficient in this study. Accuracy in analyzing dietary recalls was limited to the information provided when the diet recalls were collected. Sometimes mothers did not accurately estimate foods, so a literature-based approximation of the food portion had to be given. Having only a 24-hour diet recall for some subjects may have reduced the variability in fruits and vegetables consumed. Also, this study solely focused on low-income Mexican-American children at age 2 and 4 years; therefore these findings can only be applied to this preschool-aged population.

Conclusion

Current research shows that adequate fruit and vegetable intake is a problem in preschool-aged children and in this study has validated such results. As seen in the FITS study, Lorson et al. (2009) and Perez-Lizaur et al. (2008) studies children at a young age are not consuming the adequate amount of fruit and vegetables as recommended by the most current 2010 USDA food guidelines. Due to the low intake of fruits and vegetables in children that age, key nutrients for physical development and health have been below the DRI recommendations. Although not within the scope of this thesis, could substitution of foods with higher sugar content and refined carbohydrates for fruits and vegetables have led to an unhealthy diet? This would include foods such as sugar-sweetened beverages (e.g., fruit drinks) and fried foods (e.g., French fries). This unhealthy substitution of food may lead to a higher BMI status and other health complications. Future studies should explore associations between fruit and vegetable consumption with unhealthy food consumption. However, other factors have been shown to influence fruit and vegetable consumption in preschool-aged children, including genetic taste preference, socio-economic status, food insecurity, food accessibility in the neighborhood and in the home, and parent modeling.

Future research should continue to examine relationships between these influencing factors and fruit and vegetable intake in the Mexican-American population. Efforts should be made to reduce the loss of participants. Also, forming a more thorough dietary recall protocol that extends to 72-hours or more to increase possible variability in fruit and vegetable intake would be recommended. Perhaps more food models could be used to help determine portion sizes in fruit and vegetable intake. Nevertheless, researchers should be cautioned that mothers might see these food models as the amount of food served to their child but not what the child actually consumed. Also, a larger sample size of multiple time points would help identify relationships between fruit and vegetable consumption, nutrient intake, and BMI-for-age percentiles. However, more dietary information is needed in young, low-income Mexican-American children because they are at a high risk for obesity and other comorbidity disease states (e.g., Type 2 diabetes mellitus, cardiovascular disease). Disease risk factors are increased when consumption of micronutrients found in fruits and vegetables is decreased. Overall, the results of this study have provided further understanding of fruit and vegetable intake in this specific population which may help future studies and help in developing future nutrition interventions for preschool-aged, low-income Mexican-American children.

VI. REFERENCES

Alaimo, K., Olson, C. M., Frongillo, E. A.,Jr, & Briefel, R. R. (2001). Food insufficiency, family income, and health in US preschool and school-aged children. *American Journal of Public Health, 91*(5), 781-786.

Alexander, M. A., Sherman, J. B., & Clark, L. (1991). Obesity in Mexican-American preschool children--a population group at risk. *Public Health Nursing (Boston, Mass.), 8*(1), 53-58.

Bao, W., Srinivasan, S. R., Wattigney, W. A., Bao, W., & Berenson, G. S. (1996). Usefulness of childhood low-density lipoprotein cholesterol level in predicting adult dyslipidemia and other cardiovascular risks. the Bogalusa heart study. *Archives of Internal Medicine, 156*(12), 1315-1320.

Basch, C. E., Zybert, P., & Shea, S. (1994). 5-A-DAY: Dietary behavior and the fruit and vegetable intake of Latino children. *American Journal of Public Health, 84*(5), 814-818.

Bell, K. I., & Tepper, B. J. (2006). Short-term vegetable intake by young children classified by 6-n-propylthoiuracil bitter-taste phenotype. *The American Journal of Clinical Nutrition, 84*(1), 245-251.

Birch, L. L., & Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics, 101*(3 Pt 2), 539-549.

Birch, L. L., & Fisher, J. O. (2000). Mothers' child-feeding practices influence daughters' eating and weight. *The American Journal of Clinical Nutrition, 71*(5), 1054-1061.

Biro, F. M., & Wien, M. (2010). Childhood obesity and adult morbidities. *The American Journal of Clinical Nutrition, 91*(5), 1499S-1505S.

Briefel, R. R., Kalb, L. M., Condon, E., Deming, D. M., Clusen, N. A., Fox, M. K., et al. (2010). The feeding infants and toddlers study 2008: Study design and methods. *Journal of the American Dietetic Association, 110*(12 Suppl), S16-26.

Butte, N. F., Fox, M. K., Briefel, R. R., Siega-Riz, A. M., Dwyer, J. T., Deming, D. M., et al. (2010). Nutrient intakes of US infants, toddlers, and preschoolers meet or exceed dietary reference intakes. *Journal of the American Dietetic Association, 110*(12 Suppl), S27-37.

Casey, P. H., Simpson, P. M., Gossett, J. M., Bogle, M. L., Champagne, C. M., Connell, C., et al. (2006). The association of child and household food insecurity with childhood overweight status. *Pediatrics, 118*(5), e1406-13.

Center for Disease Control and Prevention. (2012). *Basics about childhood obesity.* From http://www.cdc.gov/obesity/childhood/basics.html, Retrieved on 08/04/2012

Comas Vives, A., Polanco Allue, I., & Grupo de Trabajo Espanol para el Estudio del Estrenimiento en la Poblacion Infantil. (2005). Case-control study of risk factors associated with constipation. the FREI study. [Estudio caso-control de los factores de riesgo asociados al estrenimiento. Estudio FREI] *Anales De Pediatria (Barcelona, Spain : 2003), 62*(4), 340-345.

Costanzo, P. R., & Woody, E. Z. (1985). Domain-specific parenting styles and their impact on the child's development of particular deviance: The example of obesity proneness. *Journal of Social and Clinical Psychology, 3*, 425-445.

Cullen, K. W., Baranowski, T., Rittenberry, L., Cosart, C., Hebert, D., & de Moor, C. (2001). Child-reported family and peer influences on fruit, juice and vegetable consumption: Reliability and validity of measures. *Health Education Research, 16*(2), 187-200.

Damasceno, M. M., de Araujo, M. F., de Freitas, R. W., de Almeida, P. C., & Zanetti, M. L. (2011). The association between blood pressure in adolescents and the consumption of fruits, vegetables and fruit juice--an exploratory study. *Journal of Clinical Nursing, 20*(11-12), 1553-1560.

Dave, J. M., Evans, A. E., Pfeiffer, K. A., Watkins, K. W., & Saunders, R. P. (2010). Correlates of availability and accessibility of fruits and vegetables in homes of low-income Hispanic families. *Health Education Research, 25*(1), 97-108.

Dave, J. M., Evans, A. E., Saunders, R. P., Watkins, K. W., & Pfeiffer, K. A. (2009). Associations among food insecurity, acculturation, demographic factors, and fruit and vegetable intake at home in Hispanic children. *Journal of the American Dietetic Association, 109*(4), 697-701.

De Natale, C., Annuzzi, G., Bozzetto, L., Mazzarella, R., Costabile, G., Ciano, O., et al. (2009). Effects of a plant-based high-carbohydrate/high-fiber diet versus high-monounsaturated fat/low-carbohydrate diet on postprandial lipids in type 2 diabetic patients. *Diabetes Care, 32*(12), 2168-2173.

Dennison, B. A., Rockwell, H. L., & Baker, S. L. (1998). Fruit and vegetable intake in young children. *Journal of the American College of Nutrition, 17*(4), 371-378.

Drewnowski, A., Henderson, S. A., & Shore, A. B. (1997). Genetic sensitivity to 6-n-propylthiouracil (PROP) and hedonic responses to bitter and sweet tastes. *Chemical Senses, 22*(1), 27-37.

Drewnowski, A., & Specter, S. E. (2004). Poverty and obesity: The role of energy density and energy costs. *The American Journal of Clinical Nutrition, 79*(1), 6-16.

Fisher, J. O., & Birch, L. L. (2002). Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. *The American Journal of Clinical Nutrition, 76*(1), 226-231.

Fisher, J. O., Birch, L. L., Smiciklas-Wright, H., & Picciano, M. F. (2000). Breast-feeding through the first year predicts maternal control in feeding and subsequent toddler energy intakes. *Journal of the American Dietetic Association, 100*(6), 641-646.

Fisher, J. O., Mitchell, D. C., Smiciklas-Wright, H., & Birch, L. L. (2002). Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *Journal of the American Dietetic Association, 102*(1), 58-64.

Flegal, K. M., Ogden, C. L., & Carroll, M. D. (2004). Prevalence and trends in overweight in Mexican-American adults and children. *Nutrition Reviews, 62*(7 Pt 2), S144-8.

Fleten, C., Nystad, W., Stigum, H., Skjaerven, R., Lawlor, D. A., Davey Smith, G., et al. (2012). Parent-offspring body mass index associations in the Norwegian mother and child cohort study: A family-based approach to studying the role of the intrauterine environment in childhood adiposity. *American Journal of Epidemiology, 176*(2), 83-92.

Food and Agriculture Organization Corporate Document Repository. (1998). *Rome decaration on world food security and world food summit plan of action.* From http://www.fao.org/docrep/003/w3613e/w3613e00.htm, Retrieved on 08/04/2012.

Fortmeier-Saucier, L., Savrin, C., Heinzer, M., & Hudak, C. (2008). BMI and lipid levels in Mexican American children diagnosed with type 2 diabetes. *Worldviews on Evidence-Based Nursing / Sigma Theta Tau International, Honor Society of Nursing, 5*(3), 142-147.

Fox, M. K., Condon, E., Briefel, R. R., Reidy, K. C., & Deming, D. M. (2010). Food consumption patterns of young preschoolers: Are they starting off on the right path? *Journal of the American Dietetic Association, 110*(12 Suppl), S52-9.

Guillaume, M., Lapidus, L., Beckers, F., Lambert, A., & Bjorntorp, P. (1995). Familial trends of obesity through three generations: The Belgian-Luxembourg child study. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 19 Suppl 3*, S5-9.

Healthy people 2000: National health promotion and disease prevention objectives(1990). No. PHS-50212). Washington, DC: DHHS publication.

Hernandez-Valero, M. A., Bustamante-Montes, L. P., Hernandez, M., Halley-Castillo, E., Wilkinson, A. V., Bondy, M. L., et al. (2012). Higher risk for obesity among Mexican-American and Mexican immigrant children and adolescents than among peers in Mexico. *Journal of Immigrant and Minority Health / Center for Minority Public Health, 14*(4), 517-522.

Hernandez-Valero, M. A., Wilkinson, A. V., Forman, M. R., Etzel, C. J., Cao, Y., Barcenas, C. H., et al. (2007). Maternal BMI and country of birth as indicators of childhood obesity in children of Mexican origin. *Obesity (Silver Spring, Md.), 15*(10), 2512-2519.

Johnson, S. L., & Birch, L. L. (1994). Parents' and children's adiposity and eating style. *Pediatrics, 94*(5), 653-661.

Keller, K. L., & Tepper, B. J. (2004). Inherited taste sensitivity to 6-n-propylthiouracil in diet and body weight in children. *Obesity Research, 12*(6), 904-912.

Krebs-Smith, S. M., Guenther, P. M., Subar, A. F., Kirkpatrick, S. I., & Dodd, K. W. (2010). Americans do not meet federal dietary recommendations. *The Journal of Nutrition, 140*(10), 1832-1838.

Lanfer, A., Knof, K., Barba, G., Veidebaum, T., Papoutsou, S., de Henauw, S., et al. (2012). Taste preferences in association with dietary habits and weight status in european children: Results from the IDEFICS study. *International Journal of Obesity (2005), 36*(1), 27-34.

Let's move! America's move to raise a healthier generation for kids. From http://www.letsmove.gov/learn-facts/epidemic-childhood-obesity. Retrieved on 08/02/2012.

Lorson, B. A., Melgar-Quinonez, H. R., & Taylor, C. A. (2009). Correlates of fruit and vegetable intakes in US children. *Journal of the American Dietetic Association, 109*(3), 474-478.

Lumeng, J. C., Cardinal, T. M., Sitto, J. R., & Kannan, S. (2008). Ability to taste 6-n-propylthiouracil and BMI in low-income preschool-aged children. *Obesity (Silver Spring, Md.), 16*(7), 1522-1528.

Maffei, H. V., & Vicentini, A. P. (2011). Prospective evaluation of dietary treatment in childhood constipation: High dietary fiber and wheat bran intake are associated with constipation amelioration. *Journal of Pediatric Gastroenterology and Nutrition, 52*(1), 55-59.

Martin, L. J., Lee, S. Y., Couch, S. C., Morrison, J., & Woo, J. G. (2011). Shared genetic contributions of fruit and vegetable consumption with BMI in families 20 y after sharing a household. *The American Journal of Clinical Nutrition, 94*(4), 1138-1143.

Mier, N., Piziak, V., Kjar, D., Castillo-Ruiz, O., Velazquez, G., Alfaro, M. E., et al. (2007). Nutrition provided to Mexican-American preschool children on the Texas-Mexico border. *Journal of the American Dietetic Association, 107*(2), 311-315.

National Research Council. (2006). In Otten J., Pitzi Hellwig J. and Meyers L. (Eds.), *Dietary reference intakes: The essential guide to nutrient requirements* (http://www.state.nj.us/health/fhs/wic/proginfo.shtml#income ed.). Washington, D.C.: The National Academies Press.

National Survey of Children's Health. (2007). *Data query from the child and adolescent health measurement initiative, data resource center for child and adolescent health website.* From www.childhealthdata.org , Retrieved 08/04/2012.

New Jersey Department of Health and Senior Services. (2012). *Women, infants, and children (WIC) income eligibility guidelines.* From http://www.state.nj.us/health/fhs/wic/proginfo.shtml#income, Retrieved 06/23/2012.

Nikolic, M., Nikic, D., & Petrovic, B. (2008). Fruit and vegetable intake and the risk for developing coronary heart disease. *Central European Journal of Public Health, 16*(1), 17-20.

Nord, M., Andrews, M., & Carlson, S. (2005). *Household food security in the United States, 2004* (Economic Research No. 11)

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA : The Journal of the American Medical Association, 307*(5), 483-490.

Ogden, C. L., Flegal, K. M., Carroll, M. D., & Johnson, C. L. (2002). Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA : The Journal of the American Medical Association, 288*(14), 1728-1732.

Perez-Lizaur, A. B., Kaufer-Horwitz, M., & Plazas, M. (2008). Environmental and personal correlates of fruit and vegetable consumption in low income, urban Mexican children. *Journal of Human Nutrition and Dietetics : The Official Journal of the British Dietetic Association, 21*(1), 63-71.

Perichart-Perera, O., Balas-Nakash, M., Rodriguez-Cano, A., Munoz-Manrique, C., Monge-Urrea, A., & Vadillo-Ortega, F. (2010). Correlates of dietary energy sources with cardiovascular disease risk markers in Mexican school-age children. *Journal of the American Dietetic Association, 110*(2), 253-260.

Pieper, J. R., & Whaley, S. E. (2011). Healthy eating behaviors and the cognitive environment are positively associated in low-income households with young children. *Appetite, 57*(1), 59-64.

Polhamus, B., Dalenius, K., Mackintosh, H., Smith, B., & Grummer-Strawn, L. (2011). *Pediatric nutrition surveillance 2009 report* . Atlanta.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shankaran, S., Bann, C., Das, A., Lester, B., Bada, H., Bauer, C. R., et al. (2011). Risk for obesity in adolescence starts in early childhood. *Journal of Perinatology : Official Journal of the California Perinatal Association, 31*(11), 711-716.

Sharkey, J. R., Nalty, C., Johnson, C. M., & Dean, W. R. (2012). Children's very low food security is associated with increased dietary intakes in energy, fat, and added sugar among Mexican-origin children (6-11 y) in Texas border colonias. *BMC Pediatrics [Computer File], 12*, 16.

Shea, S., Aymong, E., Zybert, P., Shamoon, H., Tracy, R. P., Deckelbaum, R. J., et al. (2003). Obesity, fasting plasma insulin, and C-reactive protein levels in healthy children. *Obesity Research, 11*(1), 95-103.

Shriver, L. H., Hildebrand, D., & Austin, H. (2010). Determinants of fruit and vegetable availability in Hispanic head start families with preschool-aged children living in an urban Midwestern area. *Journal of Nutrition Education and Behavior, 42*(5), 299-306.

Si, D., Bailie, R., Wang, Z., & Weeramanthri, T. (2010). Comparison of diabetes management in five countries for general and indigenous populations: An internet-based review. *BMC Health Services Research [Computer File], 10*, 169.

Singh, G. K., Kogan, M. D., & van Dyck, P. C. (2010). Changes in state-specific childhood obesity and overweight prevalence in the United States from 2003 to 2007. *Archives of Pediatrics & Adolescent Medicine, 164*(7), 598-607.

Singh, G. K., Siahpush, M., Hiatt, R. A., & Timsina, L. R. (2011). Dramatic increases in obesity and overweight prevalence and body mass index among ethnic-immigrant and social class groups in the united states, 1976-2008. *Journal of Community Health, 36*(1), 94-110.

Skelton, J. A., Cook, S. R., Auinger, P., Klein, J. D., & Barlow, S. E. (2009). Prevalence and trends of severe obesity among US children and adolescents. *Academic Pediatrics, 9*(5), 322-329.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine, 29*(6 Pt 1), 563-570.

Trevino, R. P., Marshall, R. M.,Jr, Hale, D. E., Rodriguez, R., Baker, G., & Gomez, J. (1999). Diabetes risk factors in low-income Mexican-American children. *Diabetes Care, 22*(2), 202-207.

Turnbull, B., & Matisoo-Smith, E. (2002). Taste sensitivity to 6-n-propylthiouracil predicts acceptance of bitter-tasting spinach in 3-6-y-old children. *The American Journal of Clinical Nutrition, 76*(5), 1101-1105.

United States Department of Agriculture. (2011). *MyPlate food groups.* Retrieved on 08/04, 2012, from http://www.choosemyplate.gov/food-groups/

United States Department of Health & Human Services. (2012). *United states federal poverty guidelines.* From http://aspe.hhs.gov/poverty/12poverty.shtml. Retrieved on 06/23/2012.

U.S. Census Bureau. (2010). *The Hispanic population: 2010*. From www.census.gov/prod/cen2010/briefs/c2010br-04.pdf. Retrieved on 08/13/2012.

Van Duyn, M. A., & Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature. *Journal of the American Dietetic Association, 100*(12), 1511-1521.

Vartanian, L. R., Schwartz, M. B., & Brownell, K. D. (2007). Effects of soft drink consumption on nutrition and health: A systematic review and meta-analysis. *American Journal of Public Health, 97*(4), 667-675.

Wang, M. C., Kim, S., Gonzalez, A. A., MacLeod, K. E., & Winkleby, M. A. (2007). Socioeconomic and food-related physical characteristics of the neighbourhood environment are associated with body mass index. *Journal of Epidemiology and Community Health, 61*(6), 491-498.

Wang, Y., & Zhang, Q. (2006). Are American children and adolescents of low socioeconomic status at increased risk of obesity? changes in the association between overweight and family income between 1971 and 2002. *The American Journal of Clinical Nutrition, 84*(4), 707-716.

Whitaker, R. C. (2004). Predicting preschooler obesity at birth: The role of maternal obesity in early pregnancy. *Pediatrics, 114*(1), e29-36.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

Worobey, H., Ostapkovich, K., Yudin, K., & Worobey, J. (2010). Trying versus liking fruits and vegetables: Correspondence between mothers and preschoolers. *Ecology of Food and Nutrition, 49*(2), 87-97.

Zhang, Q., Wang, Y., & Huang, E. S. (2009). Changes in Racial/Ethnic disparities in the prevalence of type 2 diabetes by obesity level among U.S. adults. *Ethnicity & Health, 14*(5), 439-457.

VII. APPENDIX

Appendix A: *Informed Consent Form*

Forma de Consentimiento Informado

Nombre del Proyecto: Proyecto de Nutrición y Desarrollo Infantil – Rutgers University
Investigador: John Worobey, PhD.

Usted está siendo invitada a participar en una investigación, a cargo del Dr. John Worobey, un profesor en el Departamento de Ciencias de la Nutrición de la Universidad de Rutgers. El propósito de esta investigación es observar los patrones de crecimiento entre infantes y niños y ver como éstos se relacionan con niveles de actividad y el consumo de alimentos. La información recolectada en esta investigación nos ayudará a entender mejor el crecimiento y desarrollo de niños como el suyo. Esta carta contiene información sobre el estudio y sobre las condiciones de su participación. Si tiene preguntas en relación con esta investigación y su participación por favor pregunte en cualquier momento.

Su participación en esta investigación incluye lo siguiente:

1) Que nos permita visitrla en su casa por aproximadamente una hora tres veces durante el primer año de vida de su bebé (a los 3, 6 y 12 meses), y una vez cuando el/ella tenga 2, 3, 4 y 5 años de edad.
2) Permitir que su hijo(a) lleve en su pierna una pequeña computadora el dia de la visita y mantenerla ahí por 24 horas. Esta computadora mantiene un registro de los movimientos de la pierna de su hijo(a).
3) El dia de la visita contestar unas preguntas sobre la personalidad y el comportamiento de su hijo(a), y sus actitudes como mamá hacia la alimentación de su hijo(a); permitir que pesemos y midamos a su hijo(a), mantener un registro de cuando come su hijo(a), y dejarnos que veamos cuando le de comer a su hijo(a).

- Su participación es voluntaria (No tiene que participar en este estudio si no desea).
- Puede dejar de participar en el estudio o negarse a participar en cualquier procedimiento o a contestar cualquier pregunta en cualquier momento sin tener ninguna penalidad o repercusión para usted o su hijo(a).
- Su identidad y la de su hijo(a) se mantendrán confidenciales en cualquier reporte que resulte de esta investigación, excepto de ser requerido por la ley. El grupo de investigación y el Institutional Review Board of Rutgers University (El Comité Institucional de Revisión de Proyecto de Rutgers University) son los únicos partidos que tendrán acceso a la información. En caso de publicar un reporte de este estudio o de mostrar los resultados en una conferencia profesional, se utilizaran sólo los resultados del grupo entero. Toda la información del estudio se mantendrá archivada por cinco años.

No hay riesgos previsibles en la participación de este estudio. Se puede beneficiar teniendo la oportunidad de hacer preguntas sobre el desarrollo de su hijo(a) si toma parte en este estudio. Como beneficio principal recibirá $30 dólares en efectivo por cada visita de dos días por un total de $210 dólares si termina el estudio completo.

Por favor firme en las líneas si acepta participar en esta investigación. Se le dará una copia de esta carta para sus records. Si tiene más preguntas sobre su participación, contacte al Dr. John Worobey, Department of Nutrtional Sciences, 26 Nichol Ave., New Brunswick, NJ (worobey@rci.rutgers.edu) Tel: 732-932-6517 y se les podrán aclarar en cualquier momento. Si tiene alguna otra pregunta acerca de sus derechos como un participante en cualquier estudio investigativo puede contactar al Administrador de Programas Patrocinados en:

Rutgers University Institutional Review Board for the Protection of Human Subjects
Office of Research and Sponsored Programs
3 Rutgers Plaza. New Brunswick, NJ 08901-8559
Tel: 732-932-0150 ext. 2104 Email: humansubjects@orsp.rutgers.edu

"He leído y entendido la descripción de la investigación, he tenido la oportunidad de hacer preguntas sobre mi participación y la de mi hijo(a) y acepto participar en esta investigación":
Firmas:

____________________________ Participante

____________________________ Testigo (asistente del investigador)
Fecha: ____________________

Esta Forma de Consentimiento Informado fue aprobada por el "Rutgers Institutional Review Board for the Protection of Human Subjects" el dia 3 de Abril del 2009; el permiso expira el 2 de Abril del 2010.

Appendix B: *Recruiting information form*

RECRUITING INFORMATION FORM-RING PROJECT

Name of Recruiter:____________________ Recruiting date: ________________

BABY'S INFORMATION *(INFORMACION DEL BEBE)*

First Name: _________________________ Last Name: _______________________
(Nombre) *(Apellido)*
Date of Birth : Dia de Nacimiento:

MOTHER'S INFORMATION *(INFORMACION DE LA MAMA)*

First Name: _________________________ Last Name: _______________________
(Nombre) *(Apellido)*

Best time to contact:_____________________ Speaks English?: __________
(mejor hora para contactarla) *(Habla Ingles?)*

Address: _________________________
(Dirección)
____
____

Phone #: _________________________
(Teléfono)

ALTERNATE CONTACT INFORMATION
(Datos de la persona con quien se le puede localizar)

Name: _________________________
(Nombre)

Relationship to the baby's mother?:_______________
(Relación que tiene con la mamá del bebé?)

Phone #: _________________________
(Teléfono)

PARENTS' DEMOGRAPHICS
Mother's Place of Origin: _____________________ Father's Place of Origin: ______________

Mother's level of schooling:_______________ Father's level of schooling: ___________

Time living in the U.S.________________

Mother employed?:_______________ Father employed? _________________
_________________________ _________________________

Best time to contact: _________________________ 08/19/02

Appendix C: *General Information Form*

GENERAL INFORMATION FORM- RING

(Data obtained from WIC records)
Household WIC ID #: ____________________

INFANT'S INFORMATION
First Name: ________________________ Last Name: ______________________________

Female____ Male ____ Race/Ethnicity:___________________________

Date of Birth: _______________ Birth Weight: ________________ Birth Length: ______________

Gestation Weeks: _____________ Birth order:______

MEASUREMENT INFORMATION

Date	Age at Measurement	Weight	Length	BMI	Hemoglob.

MOTHER'S INFORMATION
First Name: __________________________ Last Name:___________________________

Date of Birth: ________________ Race/Ethnicity:____________________

PREGNANCY INFORMATION
Pre-Pregnancy Weight: ___________ Weight at delivery: _____________

Weight gained during pregnancy: ___________

Measurement DURING pregnancy

Date	Pregnancy week	Weight	Height	BMI	Hemoglob.

Measurement AFTER pregnancy

Date	Age at Measurement	Weight	Height	BMI	Hemoglob.

FEEDING INFORMATION
Formula provided :_____________________________________

Ever Breastfed? ________ End Date__________________

Reason for formula feeding? ____

Age Formula Introduced: ________________ # of Ounces a day _________

09/23/2002

Appendix D: *Home Visit Report*

Home-Visit Report-Ring Project

Subject #:_________________ Date: _____________

Home visitors: ____

Measurements:

Arm (cm):__________ Weight (kg):_________ Height (cm):__________

Before you leave the house ask:

1. Was the child's behavior in the past 24 hours typical? _____________ (yes/no)
a. If "No", why not? ____
____

b. What do you think might have contributed to such an atypical behavior? (e.g. baby just had shots, baby was sick, etc.)____

2. Will your telephone number and address be the same for the next three months?
____
a. If answer is "No", new address: ________________ new tel. #__________
____
____

3. Thank you very much for your help and remember that we will contact you again in three months/one year (depending on the baby's age). If you have any questions please contact us at (732) 932-2766.

SUMMARY OF EVENTS:
____
____
____
____

EMERGENCY CONTACTS for the Home Visitors:

(732) 932-2766 **and/or** **John Worobey, Ph.D. (732) 932-6517**
RING Project Office **Principal Investigator**

Appendix E: *24- to 48-Hour Dietary Recall*

Subject #: ____________________ Date: ____________________

Directions:

Please complete 2 full days (all meals and snacks).

Indicate Brands if not generic (e.g Tropicana, Dannon, Doritos, Skippy's PB).
List all ingredients if homemade (e.g.Type of oil used, what vegetables, beef broth or chicken broth).

Dry cereals should be indicated as cups (not in ounces)

Method of Preparation		**Quantities**
* fresh	* raw	* ounces (e.g. 3 oz of meat = size of a deck of cards)
* frozen	* panfried	* # of pieces (e.g. 8 grapes)
* fried	* steamed	* teaspoon
* baked	* grilled	* tablespoon
* canned	* hard-cooked/boiled	* cups (1 cup = 8 oz).

~ Typical day(s): Yes ☐ No ☐

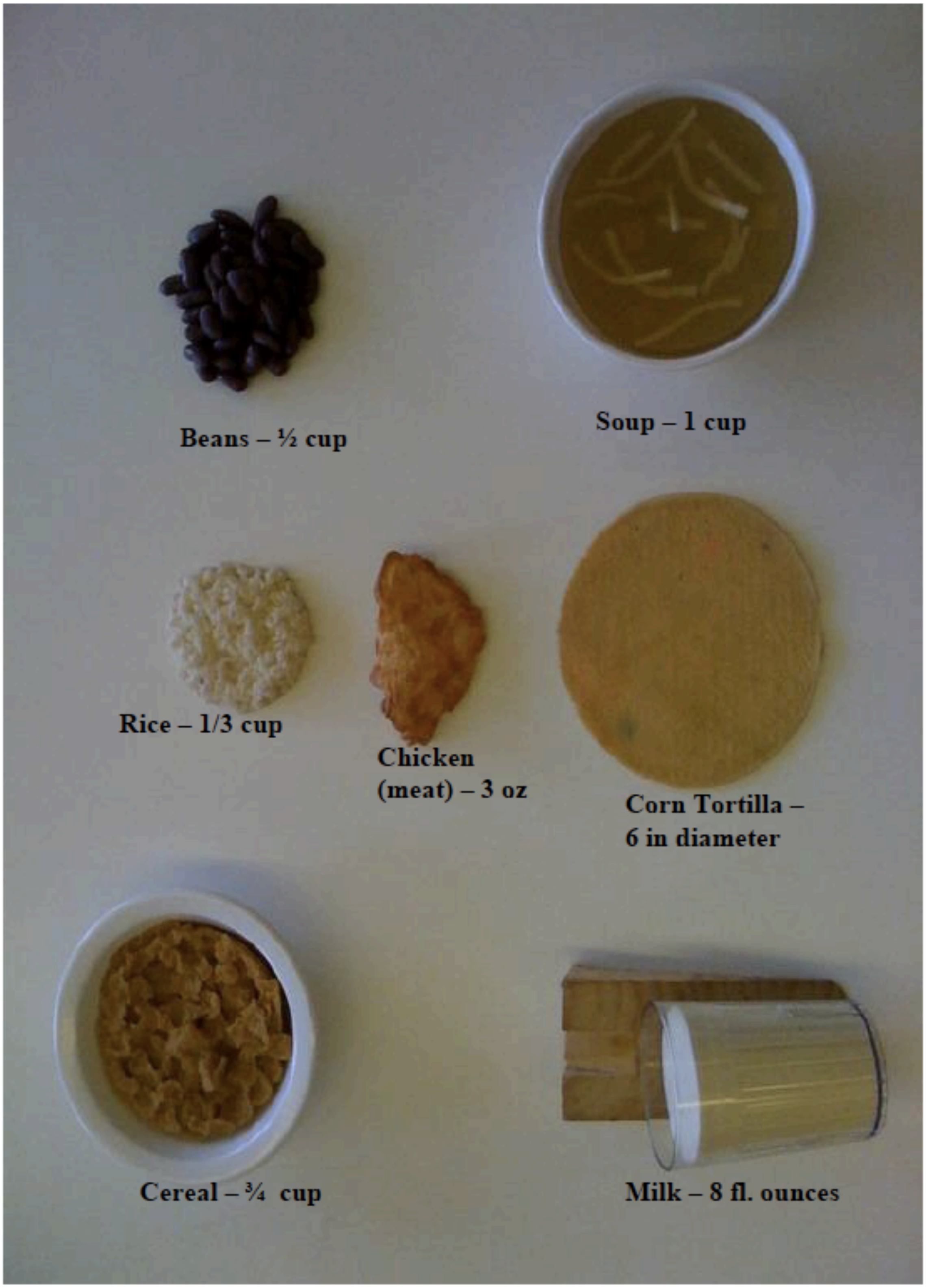
~ 12 mos: Does Infant still receive formula? ________

~ Do you add anything to the formula? ______________________________

~ Type/brand of Formula? ______________

Time	Type of food/drink	Description	Preparation	Amount
*******	*******	***Example***	*******	*******
8:00 AM	*Bagel*	*Cinnamon Raisin*	*Toasted*	*half*
Noon	*Chicken*	*Leg and thigh*	*fried*	*1 each*
	100 % Juice	*Tropicana OJ*		*6 oz*
4:00 PM	*Soup*	*Chicken broth*	*Homemade*	*3/4 cup*
		Carrots		*1 Tbsp*
		Potatoes		*1.5 Tbsp*
		Meat only, chicken		*1 oz*
*******	*******	*******	*******	*******

Appendix F: *Food Models*



Appendix G: *Receipt*

Recibí $30 del proyecto RING por mi participación en la ____ visita a mi casa/I received $30 from the RING project because of my participation in the _____ home-visit.

______________________ _ __________________

Fecha/Date Firma/Signature