LEADING SOURCES OF FRUIT SERVINGS AND THE RELATIONSHIP TO OBESITY IN US CHILDREN FROM NHANES 1999-2002

A Thesis

Presented in Partial Fulfillment of the Requirements for

the Degree Master of Science in the Graduate

School of The Ohio State University

By

Amy Lynn Dyer, B.S.

****

The Ohio State University
2006

Master’s Examination Committee:

Dr. Christopher A. Taylor, Adviser
Dr. Kay N Wolf
Dr. Janelle M. Chiasera

Approved by

Advisor
Graduate Program in Allied Medical Professions
Increasingly, more and more children are becoming overweight. There are several reasons for this increase, one reason being dietary behaviors. Children are under consuming nutrient-dense foods that are lower in calories, such as fruits, vegetables, and milk, and relying on foods that are higher in calories including foods with high amounts of added sugars, such as the case with sweetened beverages. The present study is a descriptive study, that used data from the 1999-1992 National Health and Nutrition Examination Surveys (NHANES), to identify the proportion of children meeting fruit intake recommendations and examine fruit intakes and beverage consumption patterns and their impact on obesity in children ages 2-5 (n=1,521) and 6-11 years old (n=2,098). Approximately 64% of children between the ages of 2-5 and 74% of children between the ages of 6-11 years old did not meet food guide pyramid recommendations for fruit servings. The leading contributors of fruit servings were apples, orange juice, bananas, and apple juice. Children who did not meet fruit recommendations consumed less fruit servings from whole fruit and more from “non-fruit” sources. On average, for both age groups of children who both did and did not meet fruit serving recommendations, about 50% of fruit servings were obtained from whole fruit sources and in between 30-40% of fruit servings were obtained from 100% fruit juice, with a 6-8 times greater amount of fruit servings consumed from whole fruit and fruit than those that did not meet fruit servings. Those children not meeting fruit recommendations had a greater contribution
of fruit from fruit drinks while consuming less fruit drinks than children meeting recommendations. Children who do not meet fruit serving recommendations tend to shift towards being overweight, and as weight status increases towards overweight, children consume more “sweetened beverages” (soft drink and fruit drink), which tend be higher in calories and less nutrient-dense. These findings suggest the importance of encouraging fruit intakes and emphasizing a variety of whole fruit choices in children. Beverages that are more nutrient-dense and lower in calories should be encouraged over sweetened beverages.
DEDICATION

Dedicated to my Dad.

Thanks for all of your love and support
ACKNOWLEDGEMENTS

I would like to first and foremost thank my advisor, Dr. Chris Taylor, for all of his encouragement, support, and patience throughout my experience here at The Ohio State University. Without your expertise and time, this thesis would not have been possible, so thank you for everything and I am greatly appreciative.

I would like to personally thank Dr. Kay Wolf for giving me the opportunity to be a part of the dietetic masters program here at The Ohio State University. It is because of you that I will be an Ohio State alumnus. Thank you for such a wonderful opportunity, I am greatly honored.

I would also like to thank each member of my thesis panel, Dr. Taylor, Dr. Wolf, and Dr. Chiasera, for all of your support and input that went into this thesis. I am greatly appreciative for all of your time during this process.

Finally, I would like to give a very special thanks to my family, especially my father and my fiancé, for being so supportive and motivational throughout my college career. I went through some difficult and emotional times throughout this experience, and whenever I fell, you were both there to pick me up. You are both truly my inspiration. And Dad, without you I would not be the person that I am today, so thank you.
VITA

November 20, 1979 ........................................ Born – Chillicothe, Ohio

2004 ............................................ B.S. Dietetics, Michigan State University

2004-2005 ........................................ Dietetic Internship

The Ohio State University

FIELD OF STUDY

Major Field: Allied Medical Professions
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Dedication</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>v</td>
</tr>
<tr>
<td>Vita</td>
<td>vi</td>
</tr>
<tr>
<td>List of Tables</td>
<td>ix</td>
</tr>
<tr>
<td>List of Figures</td>
<td>x</td>
</tr>
<tr>
<td>Chapters:</td>
<td></td>
</tr>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Background of the Problem</td>
</tr>
<tr>
<td></td>
<td>Significance of the Problem</td>
</tr>
<tr>
<td></td>
<td>Objectives</td>
</tr>
<tr>
<td></td>
<td>Research Approach</td>
</tr>
<tr>
<td></td>
<td>Definition of Terms</td>
</tr>
<tr>
<td>2. Review of Literature</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>The Obesity Epidemic</td>
</tr>
<tr>
<td></td>
<td>The Beverage Problem</td>
</tr>
<tr>
<td></td>
<td>Childhood Obesity and Beverage Consumption</td>
</tr>
<tr>
<td></td>
<td>Nutrient Displacement</td>
</tr>
<tr>
<td></td>
<td>Aggressive Marketing</td>
</tr>
<tr>
<td></td>
<td>Fruit Consumption</td>
</tr>
<tr>
<td>3. Materials and Methods</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>NHANES Overview</td>
</tr>
<tr>
<td></td>
<td>NHANES Data Collection</td>
</tr>
<tr>
<td></td>
<td>Dietary Intake Interview</td>
</tr>
<tr>
<td></td>
<td>Anthropometric Data</td>
</tr>
<tr>
<td></td>
<td>Subjects</td>
</tr>
<tr>
<td></td>
<td>Purpose and Objectives of the Study</td>
</tr>
<tr>
<td></td>
<td>Data Preparation</td>
</tr>
<tr>
<td></td>
<td>Data Analysis</td>
</tr>
</tbody>
</table>
### 4. Leading Sources Of Fruit Servings And Contribution From Whole Fruit and Fruit Juice in US Children from NHANES 1999-2002

- Abstract ................................................................. 40
- Introduction ............................................................... 42
- Methods ................................................................. 44
- Data Analysis ......................................................... 45
- Results ................................................................. 46
- Discussion ............................................................. 49
- Conclusions and Applications ................................. 53

### 5. Discussion and Conclusion ...................................................... 59
- Conclusions ........................................................... 67

References .......................................................................................................................... 69

Appendix A: Additional Results ......................................................................................... 74
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Weight status classifications based on BMI-for-age percentile</td>
</tr>
<tr>
<td>3.2</td>
<td>Beverage categories used for analysis of beverage consumption patterns</td>
</tr>
<tr>
<td>4.1</td>
<td>The most common foods contributing to total fruit serving intakes for children meeting and not meeting fruit serving intake recommendations from the Food Guide Pyramid by age category</td>
</tr>
<tr>
<td>A.1</td>
<td>Beverage consumption patterns for children who met and did not meet fruit serving recommendations by age category</td>
</tr>
<tr>
<td>A.2</td>
<td>Proportion of weight status for US children by BMI-for-age category stratified by age group</td>
</tr>
<tr>
<td>A.3</td>
<td>Mean BMI-for-age percentile by age category and meeting fruit Food Guide Pyramid recommendations</td>
</tr>
<tr>
<td>A.4</td>
<td>Beverage consumption patterns for children by weight classification</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>USDA Food Guide Pyramid</td>
<td>23</td>
</tr>
<tr>
<td>4.1</td>
<td>Proportions of US children who met and did not meet fruit Food Guide Pyramid serving recommendations by age category</td>
<td>55</td>
</tr>
<tr>
<td>4.2</td>
<td>Percent contribution to total fruit servings from each food category by age group and meeting fruit intake recommendations</td>
<td>58</td>
</tr>
<tr>
<td>4.3</td>
<td>Mean intakes of fruit servings from each category by age group and meeting fruit intake recommendations</td>
<td>59</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Background of the Problem

National food consumption surveys, which have been dedicated to assessing the health status of Americans and studying the American diet, have shown there has been a significant increase in the consumption of sweetened beverages in the United States (2). Many studies have shown that sweetened beverage consumption is rising and is a significant contributor to total caloric intake for many individuals, especially children and adolescents (2-4). Sweetened beverage consumption is associated with higher energy intake, which may place children at risk for excess weight gain and obesity (4;5). Sweetened beverages not only contribute to the obesity epidemic, but may also displace more nutrient dense beverages such as milk or 100% fruit juice (fruit juice) (6;7).

The Food Guide Pyramid, developed by the US Department of Agriculture (USDA) and the US Department of Health and Human Services (USDHHS), recommends that children consume 2 to 4 servings of fruits per day (1). These servings may be in the form of whole fruit or fruit juice. Statistics show that children are either at the low end of meeting recommended fruit servings, or not meeting the recommended fruit servings at all. According to the USDA’s 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII), the average number of pyramid servings for fruit
consumed per day for males ages 2-5 was 2.3 servings and for females was 2.2 servings. For both males and females between the ages of 6-11 the average number of pyramid servings for fruit consumed per day was only 1.5 servings (8).

**Significance of the Problem**

Overweight is now the most common medical condition of childhood, with the prevalence having doubled over the past 20 years (9;10). In children, overweight is defined as a BMI for age and sex greater than or equal to the 95th percentile, and at risk for overweight is defined as those inbetween the 85th to 95th percentile BMI for age and sex (11). Approximately 1 of every 6 children is overweight and nearly 1 of every 3 children is at risk for becoming overweight (9). There are several complications that may result from obesity, including high cholesterol, high blood pressure, type 2 diabetes mellitus, coronary plaque formation, and serious psychosocial implications (9).

In the United States, children’s daily food selections are high in added sugars (2-4). Sweetened beverages, such as fruit ades, fruit drinks, and soft drinks, constitute the primary source of added sugar in the diets of children. Each 12-oz serving of a carbonated, sweetened soft drink contains the equivalent of 10 teaspoons of sugar and 150 calories (9). Not only are sweetened beverages associated with an increased risk for obesity due to caloric load and excess energy intake, but these beverages also pose a risk for the development of dental caries and the displacement of more nutrient rich beverages, such as milk or fruit juice (4;6;9). Milk is the primary source for calcium in the diet. Displacement of milk by soft drinks can reduce calcium intake in children, resulting in a decrease in maximal peak bone mass during a critical point of life, adolescence (9).
National studies have shown that consumption of sweetened beverages is increasing drastically (2-4). There have been several reasons for this increase, including larger single-serving package sizes, lower prices, increased national trends toward eating at fast-food and other restaurants that serve soft drinks as the primary beverage, the increasing availability of sweetened beverages and soft drinks in school settings from vending machines or in the school cafeteria, and the use of youth-targeted advertising and marketing by soft drink companies (4;12;13).

There have been several studies dedicated towards examining the relationship between sweetened beverage consumption and childhood obesity (5;14-17). Ludwig et al. (5) studied the relationship of sugar-added beverage intakes to body weight changes in 584 children and concluded that consumption of sugar-sweetened drinks is associated with obesity in children. Berkey et al. (14) conducted a prospective cohort study to evaluate the relationship between BMI changes and intakes of sugar-added beverages, milk, fruit juices, and diet soda in over 10,000 children, and concluded that consumption of sugar-added beverages may contribute to weight gain among adolescents. Using a retrospective cohort design, Welsh et al. (16) examined the association between sweet drink consumption and overweight among 10,904 preschool children between the ages of 2 and 3, and concluded that reducing sweet drink consumption may be 1 strategy to manage the weight of preschool children. Dennison et al. (17) conducted a cross-sectional study to evaluate fruit juice consumption and its effects on growth parameters during early childhood in 223 children and found that the prevalence of overweight children was higher among children who consumed 12 fluid ounces of fruit juice per day.
Objectives

The purpose of this study was to describe fruit intake patterns in two age groups of a nationally representative sample of children, to determine what contribution of the total number of fruit servings is from 100% fruit juice, and to examine the impact of fruit intakes and beverage choices on obesity.

The objectives will be as follows:

1. To determine what percent of children are meeting fruit serving recommendations as defined by the FGP for two sets of age groups, 2-5 years of age and 6-11 years of age.
2. To determine the leading contributors of fruit servings in children who are and are not meeting fruit serving recommendations.
3. To determine the proportion and contribution of fruit servings from whole fruit, fruit juice and other sources.
4. To examine the differences in beverage consumption patterns between children who meet and do not meet FGP recommendations for fruit.
5. To examine the differences in weight status between children who do meet and those who do not meet FGP recommendations for fruit using:
   a. Mean BMI-for-age percentiles for each group
   b. Weight status classifications based on BMI-for-age percentiles.
6. To examine the differences in beverage group consumption by weight categories.
7. To examine the relationship between fruit servings as defined by the food guide pyramid and BMI-for-age.
**Research Approach**

Using data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES), a nationally representative sample of children from two age groups, 2-5 years of age and 6-11 years of age, was analyzed to determine if these groups of children are meeting recommendations for fruit servings as defined by the 1992 Food Guide Pyramid. The percent of children who are meeting fruit recommendations from the Food Guide Pyramid was examined to determine what proportion of total fruit servings came from 100% fruit juice. For those children who were not meeting the recommended 2-4 servings of fruit, further analysis of the data was examined to see if these children were replacing 100% fruit juice with other beverages such as sweetened beverages, soda, etc. Within this same group, weight for height was compared across those who are and are not meeting recommendations for fruit consumption.
Definition of Terms

Added Sugars- white and brown sugar, corn syrup, corn syrup solids, high fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, crystal dextrose, saccharin, and aspartame (3;18)

At Risk For Overweight- those in the 85th to 95th percentile BMI for age and sex (19).

Body Mass Index- a measure of obesity computed by dividing body weight in kilograms by height in meters (20)

BMI Percentile- a measure of growth velocity as plotted on the sex-specific, 2000 CDC BMI-for-age growth charts (11)

Fruit Drinks- any fruit flavored drink that is not made from 100% fruit juice

Fruit Juice- any fruit beverage comprised of 100% fruit juice

Normal Weight- those in the 5th to less than the 85th percentile BMI for age and sex (19).

Overweight- those greater than or equal to the 95th percentile BMI for age and sex (19).

Sweetened Beverages- any sugar containing beverage, or any beverage which contains added sugars (fruit ades, fruit drinks, soft drinks, etc.) (2-5;14)
CHAPTER 2

REVIEW OF LITERATURE

The Obesity Epidemic

Rates of obesity are increasing in the US, which many consider an epidemic (21). In adults, obesity is defined as a Body Mass Index (BMI) of greater than or equal to 30 (20). Obesity is associated with significant health problems, including hypertension, dyslipidemia, type 2 diabetes, heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems, and some cancers, and is an important risk factor for adult morbidity and mortality (22).

There has also been a dramatic increase in the prevalence of childhood overweight over recent decades (9;10). In children, overweight is defined as body mass index (BMI) greater than the 95th percentile for age and sex (11). Results from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) estimated that 16% of children and adolescents ages 6-19 years were overweight; this represented a 45% increase from the overweight estimates of 11% obtained from NHANES III (1988-94). Pediatric overweight has also been associated with increased health risks, such as type 2 diabetes mellitus, hyperinsulinemia, metabolic syndrome, hypertension,
dyslipidemia, respiratory problems, increased stress on weight bearing joints, and mental health, including depression and low self-esteem (10;23-26). Ritchie et al. (23) examined secular changes in the prevalence of pediatric overweight, the current magnitude and scope of pediatric overweight, and the identity of high-risk groups in the United States. Articles published in the last two decades and nationally representative studies of children were included. The criteria included; that the main topic was prevalence of pediatric overweight, study sample was comprised of or included children between the ages of 0 to 18 years, and the study was conducted in the US. There were between 3,000 and 14,000 youths, aged 6 and 19 years, were examined in each of six U.S. national surveys conducted between 1963 and 2000. The results indicated a three-fold increase in the prevalence of pediatric overweight that occurred in recent decades in the United States, which is continuing on to be a trend. Groups particularly at higher risk were African American girls, Hispanic girls and boys, and children from low-income households.

Ogden et al. (26) determined the prevalence and examine the trends of overweight in US children using 4,722 children, from birth through 19 years of age, from the 1999–2000 NHANES. Prevalence estimates of overweight among US children by sex, age group, and race/ethnicity were determined. Overweight among those aged 2 through 19 years was defined as having a sex-specific BMI-for-age at or above the 95th percentile from the 2000 Centers for Disease Control and Prevention (CDC) growth charts. For analysis, children were categorized as non-Hispanic white, non-Hispanic black, Mexican American, or other race or multi-racial. Prevalence of overweight among children in the US increased from previous estimates. The prevalence of overweight was approximately
10% for 2 to 5 years old and approximately 15% for 6 to 11 years old and 12 to 19 years old compared to approximately 7%, 11%, and 7% in the NHANES III (1988-1994). The authors concluded that the prevalence of overweight among non-Hispanic black and Mexican-American adolescents increased more than 10 percentage points between 1988–1994 and 1999–2000.

Strauss et al. (10) investigated recent changes in the prevalence of overweight in 4-to 12-year-old children (n=8,270) who were born to women enrolled in the National Longitudinal Survey of Youth (NLSY). The NLSY was a nationally-representative prospective cohort study conducted from 1986 to 1998. A total of 24,174 growth points were used to determine the prevalence of overweight children and prevalence of overweight and at-risk children. Race/ethnicity, sex, income, and region of residence were also examined. Between 1986 and 1998, overweight increased significantly and steadily among African American, Hispanic, and white children. By 1998, overweight prevalence increased to 21.5%, 21.8% and 12.3% among African Americans, Hispanics, and non-Hispanic whites, respectively. Overweight children were also heavier in 1998 compared with 1986. Overweight increased fastest among minorities and southerners. The number of children with BMI greater than the 85th percentile increased significantly from 1986 to 1998 among African American and Hispanic children (P<.001) and among white children (P=.77).

The Beverage Problem

National surveys, such as the Nationwide Food Consumption Survey (NFCS), the Continuing Surveys of Food Intakes by Individuals (CSFII), and NHANES have been dedicated to assessing the health status of American’s while also studying the American
diet. From these data, there have been several studies analyzing data from these surveys to explore national trends in beverage consumption, which is receiving increased attention due to the large increase in sweetened beverages in the US. These increases have been primarily driven by large increases in sweetened beverages consumed by children and younger adults (2). These patterns indicate that, sweetened beverage consumption, is a significant contributor to total caloric intake for many individuals, especially children and adolescents with potential implications for childhood obesity (2-4).

Nielsen et al. (2) examined American beverage consumption trends between 1977 and 2001. The study was compiled of data on 73,345 individuals, aged ≥ 2 years, from four independent, nationally-representative surveys of the U.S. population. Data was used from the 1977-1978 NFCS, the 1989-1991 and 1994-1996 CSFII and the 1999-2000 NHANES. Beverages that were examined in the study included milk, fruit juices, soft drinks, fruit drinks, coffee, tea, and alcohol (including beer, wine, and liquor). Sweetened beverages included soft drinks and fruit drinks. Between 1977 and 2001, Americans across all age groups increased the proportion of total energy obtained from soft drinks and fruit drinks, while decreasing the proportion of total energy obtained from milk. Overall, energy intake from sweetened beverage consumption increased 135% with a 38% reduction of energy from milk, which accounted for a 278 total calorie increase. The largest drop in milk consumption occurred in the 2- to 18-year olds with a decrease from 13.2% of total energy in 1977 to 8.3% in 2001. Soft drink consumption within this age group increased from 3.0% of calories in 1977 to 6.9% in 2001 fruit drink consumption increased from 1.8 to 3.4% during this time. These trends were associated
with increased proportions of Americans consuming larger portions, more servings per day of sweetened beverages and reductions in the same measures for milk.

The 2005 Dietary Guidelines advise Americans to moderate intake of sugars (18). Guthrie et al. (3) conducted a descriptive study using data from the US Department of Agriculture 1994-1996 CSFII to identify food sources of added sweeteners in the of 15,010 persons aged 2 years and older. Mean intake intakes of total added sweeteners were estimated for all people aged 2 years and older and for 12 age-gender groups. Added sugars were defined as white and brown sugar, corn syrup, corn syrup solids, high fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, crystal dextrose, saccharin, and aspartame. Intakes of added sweeteners exceeded current dietary recommendation levels. Consumption of carbohydrates was equivalent to 82 g of carbohydrate per day from added sweeteners, which was 16% of total energy intake. The leading source of added sweeteners was regular soft drinks, accounting for one third of added sweetener intakes. For both males and females, consumption of added sweeteners was highest in adolescents with 97.7 and 141.8 gram-equivalents. Sugars and sweets, which include table sugar, honey, syrups, candies, jams, jellies, and gelatin desserts, were the leading contributor of added sweeteners for children 2 to 5 years old and were among the top 3 contributors of added sweeteners for all age-gender groups. Fruit drinks accounted for 19.4% of total intakes of added sweeteners among children 2 to 5 years old and 10% of intake in the diets of older children and adolescents.

Similarly, Simone et al. (4) examined the changes in the prevalence of soft drink consumption, amounts consumed, and sources of the soft drink availability among youth.
Dietary intake data from children and adolescents age 6 to 17 years \((n = 11,085)\) in three national surveys were used, including the 1977-1978 NFCS, 1994-96,98 CSFII to examine between-survey changes in soft drink consumption and to identify sources of each soft drink group. Soft drink consumption increased 48% from 37% in 1977-1978 to 56% in 1994-1998 as mean intake of soft drinks more than doubled, from 5 fl oz to 12 fl oz per day. The home environment remained the largest source of children’s soft drink access; however, a large portion of soft drinks were obtained through away-from-home sources, such as restaurants and vending machines.

Troiano et al. (15) assessed secular trends in energy and fat intakes of youths aged 2- to 19-years-old using dietary data from the 24-hours collected for the NHANES I, II, and III. Beverages contributed 20-24% to total energy intakes across all ages, while soft drinks provided 8% of total energy consumed by adolescents. Except for adolescent girls, energy consumption from beverages was generally higher among overweight than nonoverweight youths; soft drink energy contribution was higher among overweight youths than among nonoverweight youths for all groups.

These studies indicate an increase in the consumption of sweetened beverages, which has resulted in an increase in caloric intakes. The exact impact on childhood obesity requires more research. Efforts to decrease nonnutritive sources of energy may be an important approach to counter the rise in overweight prevalence in youth (15).

**Childhood Obesity and Beverage Consumption**

Obesity in children has reached epidemic proportions (10;23;26). There are many factors that contribute to the increase in child and adolescent obesity such as physical inactivity, socioeconomic status, environmental factors, and dietary habits (24).
Children’s dietary habits have shifted away from healthy foods such as fruits, vegetables, whole grains, and milk to a much greater reliance on fast food, processed snack foods, and sugary drinks (9;27;28). These foods tend to be high in fat and/or calories and low in many other nutrients (29). The increase in consumption of sweetened beverages over recent decades may be partly responsible for the obesity epidemic among U.S. children and adolescents (14).

Ludwig et al. (5) studied the relationship of sweetened beverage intakes to body weight changes in children. The 19 month study consisted of 548 ethnically diverse school-children, ages 7 to 11 years, from Boston-area public schools. Linear and logistic regression analyses were used to examine the association between baseline and change in consumption of sugar-sweetened drinks and the difference in measures of obesity. Positive associations were found among sugar-sweetened beverage intakes, weight change, and the prevalence of obesity. Intake of sweetened beverages increased from baseline to follow-up. After adjusting for anthropometric, demographic, dietary and lifestyle variables, for each additional serving of sugar-sweetened soft drinks consumed, both body mass index BMI (p=0.03) and frequency of obesity (p=0.02) increased. Baseline consumption of sugar-sweetened drinks was also independently associated with change in BMI (p=0.02). The author concluded that consumption of sugar-sweetened drinks is associated with obesity in children.

Berkey et al. (14) conducted a prospective cohort study to evaluate the relationship between BMI changes and intakes of sweetened beverages, milk, fruit juices, and diet soda. Sweetened beverages included soda, sweetened ice tea, and noncarbonated fruit drinks. Nine to 14 year old boys and girls that participated in the U.S Growing Up
Today Study provided dietary intake and anthropometric data. Analyses included change in BMI over two 1-year periods among children who completed annual food frequency questionnaires assessing typical past year intakes. When compared to younger children, older children drank less milk and more orange juice, soda, iced tea, and punch. At baseline, children who drank more milk and less diet soda were leaner. Girls who drank more sugar-added beverages were heavier. In children who completed the FFQ all three years, mean milk intake declined significantly each year, and soda intake increased significantly. Intakes of sugar-added beverages and diet soda were significantly associated with weight gains for boys, and girls who reported one daily serving of sugar-added beverages gained significantly more BMI during the year than those who reported none. Girls consuming two, three, or more servings also gained weight. Increasing sugar-added beverages from one year to the next was significantly associated with weight gain in boys. Boys and girls who increased their intakes by two or more servings per day from the previous year experienced significant weight gain. The authors concluded that consumption of sugar-added beverages may contribute to weight gain among adolescents, probably due to their contribution to total energy intake.

Using a retrospective cohort design, Welsh et al. (16) examined the association between sweetened beverage consumption and overweight among 10,904 preschool children. Sweetened beverages included vitamin C-containing juices, other juices, fruit drinks, and sodas. Logistic regression was used to adjust for age, gender, race/ethnicity, birth weight, and intakes of high-fat foods and sweet foods and total calories. At baseline, 8,228 children were normal or underweight, 1,579 were at risk for overweight, and 1,097 children were overweight. Eighty-eight percent of children consumed
sweetened beverages one or more times per day. Normal weight or underweight children who consumed 1 or more sweet drinks per day were 1.3 to 1.5 times as likely to become overweight than those who consumed less than 1 sweetened beverage per day. At baseline, children who were at risk for overweight consumed 1 to 3 or more sweetened beverages per day. Of these, those who consumed 1 to <2 drink per day, 2 to <3 drinks per day, and ≥3 drinks per day were 2.0, 2.0, and 1.8 times as likely to become overweight than those who consumed less than 1 drink per day. Children who were overweight at baseline and consumed 1 to<2, 2 to <3, and ≥3 drinks per day were 2.1, 2.2, and 1.8 times more likely to remain overweight than those who consumed less than 1 sweet drink per day. The authors concluded that reducing sweet drink consumption may be 1 strategy to manage the weight of preschool children.

**Nutrient Displacement**

Trends in beverage consumption among children and adolescents suggest that soft drinks may be replacing more nutritious beverages such as milk and possibly fruit juices. A decrease in milk intake is of concern, especially in the growing years because of the role of calcium in bone formation and bone health and in the prevention of osteoporosis (7). Harnack et al. (6) conducted a study using national data from the 1994 CSFII to determine whether carbonated soft drink consumption is associated with consumption of milk, fruit juice, and the nutrients concentrated in these beverages. Two nonconsecutive days of dietary data were collected using a 1-day recall to obtain information on food and nutrient intake. Children 2 to 18 years of age (n=1,810) were included in the analysis. To predict the odds of low milk and juice consumption by soft drink consumption level, logistic regression analyses was used, and to determine whether intake of select nutrients
varied by soft drink consumption, multiple linear regression modeling was used. Logistic regression analyses was also used to predict the odds of soft drink consumption by race, sex, level of urbanization, region of country, and poverty level. Among preschool-aged children, nearly half were categorized as nonconsumers of soft drinks. Nonconsumers were defined as having not consumed any soft drinks during the 2 days of dietary recall. When compared to school-aged children and adolescence, 35.9% of school-age children and 17.5% of adolescents were categorized as nonconsumers of soft drinks. The majority of children in each of the age categories were nonconsumers of diet soft drinks.

Significant differences by race for preschool-aged and adolescent youth were found. Among school-aged children, whites were more likely than blacks to consume soft drinks, and white adolescents were more likely than blacks to consume 12 oz of soft drink or more per day. Adolescent boys were more likely to consume 12 oz of soft drink or more per day compared with adolescent girls. Among preschool-aged children and adolescents, those residing in central city metropolitan areas were more likely to consume soft drinks compared with those residing in non-central city metropolitan statistical areas. There were no significant differences found in soft drink consumption by region of the country or poverty status. Intake of nutrients, such as calcium, riboflavin, vitamin A, and phosphorus, which are commonly found in milk, and folate and vitamin C, commonly found in fruit juices, were lower among youth in the highest soft drink consumption category compared to those in the lower intake categories. For all age groups, those in the high soft drink consumption category were more likely to consume less than 8 oz milk per day and less than 4 oz fruit juice per day compared to nonconsumers of soft drinks. In all, 12% of preschool-aged children drank an average of 9 oz of soft drink or
more per day, more than one third of school-aged children consumed 9 oz of soft drink or more per day, and almost one fourth of adolescents drank more than 26 oz of soft drink per day. Overall, energy consumption was positively associated with soft drink consumption, and soft drinks displaced milk and fruit juice in the diets of children and adolescents.

Bowman et al. (7) examined trends in beverage consumption and to evaluate the impact of beverage choices on the nutrient intakes in females between the ages of 12 and 19 (n=732) from the 1994-1996 CSFII. Consumption of milk and soda was the main focus of the study, however consumption of sweetened beverages, including fruit drinks, fruit ades, and fruit punches, were also observed. Dietary data was collected on 2 non-consecutive days. Participants were divided into four groups based on milk and soda consumption status; group 1 consumed both milk and sodas, group 2 consumed milk but not soda, group 3 consumed soda but not milk, and group 4 consumed neither milk nor sodas on the day of the survey. Mean energy, nutrient, and beverage intakes were compared. Overall, over the past 3 decades there has been a steady and profound decrease in the percentage of females drinking milk. Mean intakes of caloric beverages, such as sodas, fruit drinks, fruit ades, and fruit punches, almost doubled. Milk intakes decreased with an increase in age, with the 12-year-olds having the highest milk intake and the lowest soda intake, and the 19-year-olds having the lowest milk intake and higher soda intake. At age 13, there was a sharp decrease in milk and sweetened beverages, along with a sharp increase in soda and tea consumption. At age 18 years, intake of fruit juices, sweetened beverages, and tea dropped sharply, as soda consumption remained high. At age 19, except for milk and water, all beverages increased. Milk drinkers who
did not drink sodas drank more milk than those who drank sodas, and those who consumed both soda and milk drank less soda than those who did not drink milk. The authors concluded that a rapid decrease in milk intake during the early adolescent years indicates a need for interventions at this age.

Mrdjenovic et al. (30) conducted a longitudinal study to examine the effects of excessive sweetened drink consumption on daily energy balance and nutrient intake in children. The purpose of the study was to explore the relation between sweetened drink consumption, milk consumption, and intakes of several critical nutrients in children ages 6 to 13 years (n=30) over a 4 to 8 week period. Hypotheses tested included: (1) an excessive consumption of sweetened drinks and juice will result in reduced daily milk intake; (2) the consequence of reduced milk consumption, smaller daily intakes of calcium, phosphorus, magnesium, zinc, and vitamin A will be observed; and (3) children with excessive consumption of sweetened drinks will have higher average daily energy intake and will experience greater weight gain. Data was obtained from an intervention study that was investigating nutritional effects of a low-fat diet in school age children at the Cornell Summer Day Camp in 1997. Beverages were classified into three categories for analysis: milk (fluid milk and milk shakes), pure or fruit juice, and sweetened drink category (carbonated or noncarbonated fruit-flavored drinks like frozen fruit juices diluted with water, fruit punch, Kool-Aid (Kraft Foods, Northfield, Ill) and other powdered drinks, less than fruit juice, soda, Snapple (Snapple Beverage Group, White Plains, NY), or tea). Children's body weights and heights were measured at the end of the first week of camp, in the morning, after a group meeting and before breakfast was served or on the first day when a child joined the study. Body mass index (BMI) was
also calculated. The results showed that excessive sweet drink consumption, defined as greater than 12 ounces per day, displaced milk from children’s diets. Reduced milk consumption resulted in a lower daily intake of calcium, zinc, protein, phosphorus, and magnesium. Children drank significantly less milk on days when they consumed more than 3 glasses (>16 ounces) of sweetened beverage as opposed to when they did not have any. Children who consumed >16 ounces of sweetened drinks per day gained more weight and had a higher energy intake than children who consumed between 6 to 16 ounces of sweetened drinks per day. The author concluded that excess sweetened beverage consumption was associated with milk intake, and may be an important risk factor for childhood obesity and poor nutrition.

**Aggressive Marketing**

Soft drink companies are among the most aggressive marketers in the world, using advertising and many other techniques to increase sales. The major companies target children aggressively through television commercials, advertisements using characters on product labeling, marketing in schools, etc. (31). Commercials broadcast during children’s Saturday morning television programming promote foods predominately high in fat and/or sugar, many of which have relatively low nutritional value. Kotz et al. (12) conducted a study to examine current food advertising during children’s television programs and to assess whether the products advertised are consistent with dietary recommendations for good health. The time period assessed was on three Saturday mornings from 7am to 10:30 am, due to the fact that all major networks reserve this time period for children’s programming. Overall, 997 commercials selling a product and 68 public service announcements aired during the 52.5 hours of children’s
Saturday morning television that were viewed from five major networks (ABC, CBS, NBC, FOX, and Nickelodeon). According to the Child Nutrition Program criteria, if the primary ingredient by weight for a given food is either fat or sugar, the product is placed in the “fats, oils, and sweets” group. Of the 564 food advertisements, which accounted for 56.5% of all advertisements, 43.6% advertised foods classified in the fats, oils, and sweet food group. Within this classified group, 5.6% of the 43.6% were soft drink advertisements.

Harrison et al. (13) conducted another study which also analyzed food advertisements. The objectives were to code food (nutritional content, food type, and eating occasion) and character (cartoon and live action) attributes of food advertisements aired during television programs that were heavily viewed by children, and to evaluate the nutritional content of advertised foods in terms of the nutrition facts label. To obtain a sample of advertisements viewed by children, 40 hours of television programming over a 5 week period were taped. The programs selected had been rated as most popular nationwide among viewers aged 6-11 years in 2002 and 2003. In total, 426 food advertisements aimed at general and child audiences were coded for food and character attributes. For each advertisement, the first 4 food products and the first 4 human characters appearing on-screen were coded, yielding a total sample of 1194 characters and 725 foods. Four independent coders were trained to code. Each advertisement was first coded as being aimed at a child audience (n=201) or a general audience (n=225). Next, advertised foods were coded by type, such as breads and cereals, fruits and vegetables, dairy products, meats, poultry, and fish, candy, sweets, and soft drinks, alcohol, and convenience or fast foods. Finally, verbal or visual health-related messages
in the advertisements were coded as low fat, fiber or bran, vitamins or minerals, low in sodium, partially or completely nonartificial or natural, low in calories, or other. Human characters were coded for apparent gender, age, race, eating behavior, and body size. When characters were shown eating, the eating location was coded as home, in a restaurant, in a car, outside, or elsewhere, and the eating occasion was coded as breakfast, lunch, dinner, snack, or nondiscernible. "Nutrition Facts" label data for advertised foods (n=275) were also analyzed. Variables included serving size, servings per container, calories, calories from fat, total fat, saturated fat, cholesterol, sodium, carbohydrate, fiber, sugar, protein, vitamin A, vitamin C, calcium, iron, and percent of recommended daily values (RDVs) for fat, saturated fat, cholesterol, sodium, fiber, and carbohydrate. Overall, snack, convenience, and fast foods and sweets comprised most of the food advertisements viewed by children. Candy, sweets, soft drinks, and convenience and fast foods were advertised most frequently. Convenience and fast foods, and sweets represented 83% of all advertised foods. There was little representation of fruits and vegetables, dairy foods, meat, poultry, and fish. Advertised foods exceeded Recommended Daily Values (RDVs) for fat, saturated fat, and sodium, and did not provide RDVs for fiber and certain vitamins and minerals. Nutrient-poor, high-sugar foods were especially prevalent in the advertisements aimed at children, with candy, sweets, and soft drinks being the most dominant. The authors noted that there were few health-related messages, possibly because advertisers expect children to be more concerned with food's flavors and colors rather than its disease-fighting properties.

Despite the media's negative influence on children's food choices, other programs, such as school-based nutrition interventions, have been successful at
promoting healthy food choices in the diets of children. Gimme 5: A Fresh Nutrition Concept for Students (32) was one example of such an intervention. Gimme 5 was a 4-year school-based nutrition intervention that included 12 high schools (6 matched pairs) in Louisiana. One school in each pair was randomly assigned to receive the Gimme 5 measurements and intervention components, while the other school served as a control receiving only measurements. There were 2,213 students in total, who were freshman in 1994 and were followed until they were seniors in 1997. The Gimme 5 intervention aimed to increase daily fruit and vegetable consumption by high school students to 5 or more servings through increased awareness and positive attitudes regarding fruits and vegetables along with environmental support through offering more fruits and vegetables in school cafeterias, snack outlets, and in vending machines. The specific components of Gimme 5 addressed behavior change through awareness stimulation, skills training, reinforcement, application, and maintenance. The four components included a school media-marketing campaign that provided messages to increase awareness and promote positive attitudes toward consumption of fruits and vegetables, workshops that included learning strategies such as eating habits, fresh choices which increased the availability, variety, and taste of fruits and vegetables in school meals, and the parental involvement component which provided education and parental support. Overall, the program was a success. After student evaluation, a large number of students had reported awareness of several areas, including giveaways, marketing stations, table tents, posters, marketing stations, and contests, and acceptability of each area was high. Self-efficiency also increased in both groups. The reported daily servings of fruit and vegetables consumed increased by 14% from 1994 to 1996 in the intervention group.
The USDA’s Food Guide Pyramid (FGP) promotes a daily diet based on consumption of a recommended number of servings from each of the five major food groups, with one of those groups being the fruit group (1). It is recommended that children eat a minimum of servings of fruit each day. These servings may be obtained in the form of whole fruit and fruit juice.

Munoz et al. (27) conducted a study to determine the extent to which children are meeting the FGP recommendations, and to identify major food intake patterns along with assessing nutrient intakes associated with those patterns. The study included children between the ages of 2 to 19 years (n=3307). Food intakes were examined using the US Department of Agriculture’s 1989-1991 CSFII. Dietary information was collected by trained interviewers using a 24-hour recall. All foods were categorized into groups based on a method developed by the USDA for disaggregating mixtures into their ingredients and assigning those ingredients into pyramid groups. Gram weights were converted into number of food group servings. Individual intakes were compared with the upper, middle, and lower end of the recommended range for grains, fruits, vegetables and meats depending on the amount of energy consumed. The mean number of servings of each food group was calculated to determine whether children were meeting minimum Pyramid recommendations. Nutrient intakes associated with each pattern of food
consumption were determined. The mean food group intakes were below the minimum recommendations for all food groups except the dairy group for all children, with 16% of children who did not meet any recommendations and only 1% of children who met all the recommendations for pyramid groups. In both males and females, the number of servings from the meat and vegetable groups rose, whereas those from the fruit group declined with age. The percentage of children who met recommendations for each food group was approximately 30% for fruit, grain, dairy, and meat, and approximately 36% for vegetables. Overall, this study showed that children in the US are not meeting national recommendations for food group servings as defined by the FGP.

Brady et al. (33) compared children’s dietary intakes with national recommendations. Dietary information was collected from children between the ages of 7-14 years (n=110) who were enrolled in a longitudinal study of childhood obesity in Alabama. Three day dietary intake data were gathered by trained interviewers using a 24-hour dietary recall. Dietary recalls were analyzed using a food coding database. All foods and ingredients consumed were categorized into the Food Guide Pyramid food groups. Social status and total energy intake were included as control variables in the analysis. A very low proportion of the total sample met the Food Guide Pyramid recommendations, with only 5% meeting fruit group recommendations, and only 9% meeting dairy group recommendations. Consumption of the fruit group did, however, meet the recommendation that half of fruit servings should come from citrus, melon, and berries and the other half from fruit. For the other food groups, approximately 20% met vegetable recommendations, 26% met meat recommendations, and 46% met grain
recommendations. This study showed, overall, that the diet of children in the study sample was not compatible with the Food Guide Pyramid’s recommendations.

The Food Guide Pyramid’s recommendations for 2-4 servings of fruit per day may be obtained in the form of whole fruit and fruit juice. The American Academy of Pediatrics (AAP) has issued recommendations for fruit juice consumption. The AAP advises against the introduction of fruit juice into the diets of infants less than 6 months of age. The AAP also advises limiting fruit juice consumption to 4 to 6 oz/day, which is equivalent to one serving, for children aged 1 to 6 years, and 8-12 oz/day, which is equivalent to 2 servings, for children between the ages of 7 to 18 years (34).

Rampersaud et.al. (28) conducted a study to evaluate fruit juice and beverage intake in children and adolescence. The study consisted of children from birth to 18 years of age (n=10,648), using data from the 1994-1996 CSFII. For evaluation, food intake data was used from a 24-hour-recall for one or two non-consecutive days. Two day average food group records and appropriate weighing factors were used to calculate the mean daily beverage intake. Beverage categories included fruit juice, total carbonated beverages, total fluid milk, and total fruit drinks and ades. In general, mean intakes did not exceed AAP recommendations, with the exception of the 22% of children < 6 months of age who consumed some amount of fruit juice. Only 3% of children ages 6 months to 6 years consumed >6oz/day of fruit juice, and only 1% of children ages 7 to 18 years old consumed >12oz/day of fruit juice. The mean daily intakes of fruit juice aged < 6 months was 0.9 oz., for children 6 months to 6 years was 4.6 oz., and for children 7 to 18 years was 3.4 oz. Overall, for children aged 6 months to 6 years, 73% fell within the AAP recommendations with 9% who consumed >12 oz/day, and for
children and adolescents aged 7 to 18 years, 94% fell within AAP recommendations. At the age of 2, fruit juice consumption peaked, declined steadily, and then plateaued around the age of 7. Mean intake of fluid milk was highest at age 1 with 2 cups/day, and decreased to ¾ cups/day by the age of 18. Intake of carbonated soft drinks increased as children aged, with a dramatic increase beginning around the age of 8. Mean daily intake of fruit drinks exceeded fruit juice and milk at ages 5 and 13, and at age 13, intake of carbonated soft drinks exceeded AAP recommendations for fruit juice consumption.

Although consumption of fruit juice serves as a source of fruit and may contribute nutrients to a child’s diet, it is still important to stay within recommended guidelines regarding amounts consumed in order to prevent overconsumption of excessive calories. Dennison et al. (17) conducted a cross-sectional study to evaluate fruit juice consumption and its effects on growth parameters during early childhood. The study consisted of 116 two-year-old children and 107 five-year-old children and their primary care taker/parent who were scheduled for a nonacute visit at a general primary care health center in New York over a 2-year period. For 168 children, mean dietary intake was calculated from 7 days of written dietary records, entered, and analyzed using the Minnesota Nutrition Data System. Overall, children who consumed 12 fluid ounces of fruit juice per day had a higher energy intake, a shorter stature, and a higher prevalence of obesity. On average, children age 2 consumed 5.9 fluid ounces of fruit juice and 9.8 fluid ounces of milk per day, and children age 5 consumed, on average, 5.0 fluid ounces per day of fruit juice and 11.0 fluid ounces of milk per day. Nineteen children (11%) consumed 12 fluid ounces of fruit juice per day and 4 children (2%) consumed 16 fluid ounces of fruit juice per day. For 2-year-old children energy intake was higher for those who consumed 12 fluid
ounces of fruit juice per day than those who consumed less than 12 fluid ounces per day. Only a small portion of 5-year-old children consumed 12 fluid ounces of juice per day (n=4). Overall, energy intake was higher among children who consumed 12 fluid ounces of fruit juice per day compared to those drinking less. The prevalence of short children was higher among children who consumed excess fruit juice. Forty-two percent of children who consumed 12 fluid ounces of fruit juice per day were short compared with 14% of children who consumed less than 12 fluid ounces of fruit juice per day. The prevalence of overweight children was higher among children who consumed 12 fluid ounces of fruit juice per day. Fifty-three percent of children drinking 12 fluid ounces of fruit juice per day had a BMI at the 75th percentile compared to 32% who consumed less than 12 fluid ounces per day, and 32% of children who consumed 12 fluid ounces of fruit juice per day had a BMI at the 90th percentile compared to 9% of those who consumed less than 12 fluid ounces of fruit juice per day.

Fruit, along with vegetable consumption, is associated with dietary intakes of important vitamins and minerals. Dennison et.al. (35) conducted a study to determine the extent to which young children’s diets met the recommended number of servings/day of “5-A-Day” fruits and vegetables, and to examine the relationship between fruit and vegetable consumption and overall dietary quality. The study included 2 or 5 year olds (n=223), who were scheduled for a non-acute visit, and their parent or primary care taker (PPC), were recruited from a general primary care practice located in New York. A 7-day dietary record was used by the PPC, and dietary data were collected by a registered dietitian. Nutrient calculation and dietary data were entered and analyzed using Nutrition Data System (NDS) software. Daily consumption of fruits, fruit juice, and vegetables
were determined using the standard serving size definitions according to the USDA’s Food Guide Pyramid guidelines. Children’s anthropometric data and demographics, including lifestyle behaviors and dietary habits, were also collected from the PPC. For vitamin intakes, adequate dietary intake was defined as ≥100% RDA for age, marginal intake was ≥67% but <100% RDA for age, and an inadequate intake was defined as < 67% RDA for age. Using AAP recommendations, adequate fiber was defined as ≥ 0.5 g/kg, and inadequate fiber was < 0.5 g/kg. In general, both the 2 and 5-year-old children consumed the same numbers of servings/day of fruit, fruit juices, and vegetables, with approximately 1.8 fruit servings/day. Forty percent of the 2-year-old children and 50% of the 5-year-old children consumed less than two servings/day of fruits and vegetables. Fruit juice contributed significantly to the total fruit servings consumed and to the total number of fruit and vegetable servings consumed, representing 54% of all fruit servings and 42% of all fruit and vegetable servings. Approximately 39% of fruit juice was consumed as mixed fruit juice, 30% was apple juice, 23% was orange juice, 7% was grape juice, and 1% was pear juice. Beta-carotene and vitamin A intakes were strongly correlated with vegetable consumption and with total fruit and vegetable consumption. Potassium and fiber intakes were also strongly correlated with total fruit and vegetable consumption. Vitamin C intake was most strongly correlated with consumption of citrus fruits and citrus fruit juices. Vitamin C was also significantly correlated with non-citrus fruit juice intake due to natural vitamin C and fortification. Both vitamin C and dietary fiber were significantly correlated with total consumption of fruits and vegetables. Ninety-five percent of children consuming 2 or more servings/day of fruits and vegetables met the RDA for vitamin C compared to only 50% of children consuming less
than 2 servings/day of fruits and vegetables. Likewise, children eating less than 2 servings/day of fruits and vegetables were 3 times as likely to not meet the RDA for vitamin A compared to those children consuming ≥ 2 servings/day. Higher intakes of fruit and fruit juices were also associated with reduced intakes of dietary total fat, saturated fatty acids, and cholesterol. This study showed the importance of fruit and vegetable consumption in relation to dietary nutrients. Overall, low intakes of fruits and vegetables were associated with inadequate intakes of vitamin A, vitamin C, and dietary fiber, along with a high intake of total fat and saturated fat.

Another study conducted by Hampl et al. (36) investigated vitamin C intakes in children between the ages of 7-18 (n=2,258) using data from the 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII). Children were stratified by age, 7-12 and 13-18, and gender. Children were then split into three vitamin C consumption groups based on two 24-hour recalls: low (0-30mg), marginal (30.1-59.9 mg), and desirable (>60 mg). The contribution to total vitamin C by each food group was calculated. In children between the ages of 7-12, 12% of boys and 13% of girls had mean vitamin C intakes less than 30mg/day. In children between the ages of 13-18, 14% of boys and 20% of girls had mean vitamin C intakes less than 30mg/day. For both age groups, 21% of boys and 27% of girls consumed between 30mg and 60mg of vitamin C daily. The primary source of vitamin C intake in both age groups was high-vitamin C fruit juice, followed by vitamin C-fortified fruit drinks, which together accounted for more than 40% and 50% of total vitamin C intake in children 7-12 and 13-18, respectively. Apples, oranges, bananas, and orange juice accounted for 5 out of the 11 most frequently reported vegetables and fruits consumed. Daily consumption of fruits and vegetables, on average, was four servings.
Children with low vitamin C intake had the lowest intakes of fruits and vegetables. Children with desirable vitamin C intake had greater intakes of fruits and vegetables. There was also a relationship between intake of citrus fruits and vitamin C consumption. Children with desirable vitamin C intake consumed about one serving of citrus fruit daily, and children in the low and marginal vitamin C intake categories consumed less than 1/5 of a serving of citrus fruit daily.

Fruit consumption has been shown to be a nutritious component to the diet of children (35). Fresh fruits are not only low in dietary fat, but they are also full of important dietary nutrients, including both vitamins and minerals. Previous studies have shown that children are under consuming the recommended amount of fruit servings as defined by the Food Guide Pyramid (27;33;35). Further research examining fruit and beverage consumption and their impacts on obesity would be important for parents and health care professionals to better understand the barriers, and to encourage consumption of fruit, especially in the form of whole fruit, for adequate nutrient intake in children.
NHANES Overview

The National Center for Health Statistics (NCHS), Division of Health Examination Statistics (DHES), is a part of the Centers for Disease Control and Prevention (CDC). The CDC has conducted a series of health and nutrition surveys since the 1960's to assess the health status of Americans. The National Health and Nutrition Examination Surveys (NHANES) were conducted periodically between 1971 and 1994. The most recent NHANES, which began in 1999, has become a continuous national nutrition monitoring survey. Approximately 7,000 individuals of all ages are interviewed in their homes each year. Of those interviewed, approximately 5,000 individuals complete the health examination component of the survey.

The Division of Health and Nutrition Examination Surveys (DHANES) is one of the survey divisions at NCHS. The Division consists of four branches, including an analysis branch, an informatics branch, an operations branch, and a planning branch. The analysis branch coordinates NHANES data analysis activities, the informatics branch carries out NHANES informatics research and development, the operations branch
carries out NHANES data collection activities, and the planning branch coordinates planning activities for all NHANES interview, laboratory, and examination components. NHANES is composed of several objectives, which include: to study selected diseases and analyze risk factors for these diseases by monitoring trends in the prevalence, awareness, treatment and control of selected diseases, to study the relationship between diet, nutrition and health, to explore emerging public health issues and new technologies, to establish a national probability sample of genetic material for future genetic research, and to establish and maintain a national probability sample of baseline information on health and nutritional status.

The NHANES survey design is a stratified, multistage probability sample of the civilian non-institutionalized U.S. population. NHANES 1999-2002 included oversampling of low-income persons, adolescents, the elderly, pregnant women, African Americans and Mexican Americans. There are various stages of sample selection. These include: selection of Primary Sampling Units (PSUs) which are counties or small groups of counties, segments within PSUs which may include a block or group of blocks containing a cluster of households, households within segments, and one or more participants within selected households. A total of 15 PSUs were visited during a twelve-month time period.

**NHANES Data Collection**

To begin data collection, households are identified for inclusion in the NHANES sample. An advance letter was then mailed to each address informing the occupant(s) that an NHANES interviewer will visit their home. Trained household interviewers visited the home of potential participants, recruit potential participants, and administer
screening questionnaires. A computer-assisted personal interview (CAPI) system was used to record data from the interview. During the home visit, participants were scheduled for the comprehensive health examination at the mobile examination center (MEC) visit.

The health examinations were conducted in the MECs. A small number of survey participants receive a health examination in their homes if they are unable to travel to the MEC. There are three MECs that are equipped for use in NHANES, and each MEC consists of four large, inter-connected trailer units. The MEC equipment and data collection systems were checked and calibrated prior to the start of survey data collection to ensure quality data. MECs were open five days per week with two examination sessions conducted daily. The examinations required up to three hours to complete.

**Dietary Intake Interview**

During the examinations, the dietary interview component was administered to all examinees that were eligible. The dietary intake data are used to estimate total intake of energy, nutrients, and non-nutrient food components from foods and beverages that were consumed 24-hours prior to the interview. Proxy respondents were permitted for survey participants less than six years of age, and assisted interviews were completed with survey participants 6-11 years of age. Trained, college-educated dietary interviewers, who were also bilingual, collected all dietary interview data.

Data was collected using an automated data collection process known as the computer-assisted dietary interview (CADI). The CADI interface includes instructions for recording information about foods, such as brand names and food preparation methods and food amount options. The multiple pass 24-hour dietary interview format
was used to collect detailed information about all foods and beverages. The interview passes included a quicklist in which respondents were asked to recall all foods and beverages consumed in a 24-hour period the day before the interview, time and place where each food was eaten along with the occasion, details about each food eaten including the amount consumed, and a final review in which foods were reviewed with the respondent in chronological order. Any additional foods remembered during the process were added to the record as well as modifications for reported foods.

The US Department of Agriculture (USDA) Food and Nutrient Database for Dietary Studies (FNDDS) were used to code and report the dietary intake data for NHANES 1999-2002. The FNDDS is a database which includes nutrient values and Food Guide Pyramid (FGP) servings for reference 100 gram food portions. Nutrients and FGP data are provided per as the amounts provided by each food as well as cumulative totals per day. Nutrient intakes reported in their respective files do not include those obtained from dietary supplements.

**Anthropometric Data**

Body measurements were recorded for all examinees by a trained examiner in the MEC. If an examinee had to leave the MEC early and was unable to complete the Body Measurement Component, weight and standing height or recumbent length were measured. To minimize data entry errors, weight, height, and recumbent length were collected electronically from the measuring instruments. Data were evaluated by comparisons to age- and gender-specific references to identify outliers and data reording errors. Recumbent length and standing height were compared for agreement among 24-
28 month old children. When these data were determined to be implausible or erroneous, the values were set to system missing.

To obtain BMI percentiles, standing height for 24-47 months of age were used if provided, and if not provided, recumbent length was used.

**Subjects**

NHANES 1999-2002 included 21,004 individuals over the age of 2 months. A nationally representative sample of children, 2 to 11 years-old, with dietary intake data from the 1999-2002 NHANES was used for the analysis. Children were grouped into categories of 2-5 and 6-11 years of age.

**Purpose and Objectives of the Study**

The purpose of this study was to describe fruit intake patterns in two age groups of a nationally representative sample of children and determine what contribution of the total number of fruit servings is from fruit juice, and to examine the impact of fruit intakes and beverage choices on obesity. The objectives were:

1. To determine what percent of children are meeting fruit serving recommendations as defined by the FGP for two sets of age groups, 2-5 years of age and 6-11 years of age.

2. To determine the leading contributors of fruit servings in children who are and are not meeting fruit serving recommendations.

3. To determine the proportion and contribution of fruit servings from whole fruit, fruit juice and other sources.

4. To examine the differences in beverage consumption patterns between children who meet and do not meet FGP recommendations for fruit.
5. To examine the differences in weight status between children who do meet and those who do not meet FGP recommendations for fruit using:

c. Mean BMI-for-age percentiles for each group
d. Weight status classifications based on BMI-for-age percentiles.

6. To examine the differences in beverage group consumption by weight categories.

7. To examine the relationship between fruit servings as defined by the food guide pyramid and BMI-for-age.

Data Preparation:

Data were available from NCHS. The public use files from NCHS were downloaded from the website and entered into SPSS for preparation and analysis. Some variables required recoding or categorization to provide useful information for the current study. Children between the ages of 2-5 years old were recoded to a 2-5 year old age group, and children between the ages of 6-11 years old were recoded to a 6-11 year old age group.

Sex, age, height and weight data for each child was provided in NHANES. Data was exported to Epi Info (version 3.2.2, CDC, Atlanta, GA) to obtain body mass index (BMI)-for-age percentiles based on the 2000 CDC growth charts. BMI-for-age percentiles were used to classify children into levels of overweight based on current Center for Disease Control (CDC) guidelines (11) as shown in the table below.
Classification | BMI Percentile
----------------|---------------------
Normal weight | 5th %-85th %
At Risk for overweight | 85th %-95th %
Overweight | ≥ 95th %

Table 3.1: Weight status classifications based on BMI-for-age percentile (11)

To examine the contribution of beverage choices to fruit servings as well as their contribution to obesity, beverages reported in the food intake data were recoded into categories. The food code database was searched to identify milk beverages, 100% fruit juice, fruit drinks (ie. ades and fruit punch), coffee & tea, soft drinks, sugar-free soft drinks, vegetable juice, and water. Analysis was conducted using the pooled contribution of the items within each category to examine the daily contribution of these groups to dietary intakes and childhood obesity.

<table>
<thead>
<tr>
<th>Beverage group</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Whole Milk, 2% Milk, 1% Milk, Skim Milk</td>
</tr>
<tr>
<td>Fruit Juice (100%)</td>
<td>Apple Juice, Orange Juice, Grape Juice, etc.</td>
</tr>
<tr>
<td>Fruit Drinks</td>
<td>Fruit Ades (Gatorade, Powerade, etc.), Includes any beverage with “added sugars” that is not 100% fruit juice (ie: Fruit Punch, Tang, etc.).</td>
</tr>
<tr>
<td>Soft Drink</td>
<td>Coke, Pepsi, etc.</td>
</tr>
<tr>
<td>Diet Soda</td>
<td>Diet Coke, Diet Pepsi, etc.</td>
</tr>
<tr>
<td>Vegetable Juice</td>
<td>V8, Tomato Juice, etc.</td>
</tr>
<tr>
<td>Tea &amp; Coffee</td>
<td>All tea’s and coffee, regular and decaff</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
</tr>
</tbody>
</table>

Table 3.2: Beverage categories used for analysis of beverage consumption patterns
Total FGP servings per day were recoded to identify children who are and are not meeting federal recommendations. Children consuming <2 servings of fruit were recoded as not meeting fruit serving recommendations based on the 1992 FGP for young children.

**Data Analysis**

To determine the proportion of children meeting minimum fruit intake recommendations, frequency analyses were conducted by age group on fruit servings recoded to "met" or "not met" fruit servings recommendation. The contribution to total fruit serving intakes by age a category for each food was determined using the following formula (36):

$$\frac{\sum \text{total fruit servings from each food}}{\sum \text{total fruit servings from all foods}}.$$  

To determine what percent of fruit servings were obtained from fruit juice, the sum of fruit servings from all of the foods that we recoded to the fruit juice group divided by the sum of all fruit servings in NHANES sample was calculated. Foods contributing at least 1% to total fruit intakes were considered leading contributors to fruit intakes, using previous research as a guide (36). To determine differences in beverages consumed, frequency analyses were conducted to obtain grams of each beverage category consumed by age group and meeting fruit FGP recommendations.

Differences in BMI-for-age percentiles and weight categories were tested using a two-way ANOVA and Chi Square, respectively, by age group and meeting fruit FGP recommendations. Frequency analyses were used to determine the differences in beverage consumption by weight status. Finally, a Pearson correlation was conducted to
compare fruit FGP servings to BMI-for-age percentiles to determine the relationship between fruit intakes and obesity.

SPSS Complex Samples (version 14.0, Chicago, IL) was used to conduct analysis of the NHANES sample. This software allows for the correction for the over-sampling of hard-to-reach population, which results in a nationally-representative sample. When increasing the sample to a national scale, SPSS Complex Samples is also essential to provide appropriate standard errors for statistical analyses.
CHAPTER 4

LEADING SOURCES OF FRUIT SERVINGS AND CONTRIBUTION FROM
WHOLE FRUIT AND FRUIT JUICE IN US CHILDREN
FROM NHANES 1999-2002

Abstract

Objective: To identify the proportion of children meeting fruit intake recommendations and examine fruit intakes and beverage consumption patterns in children.


Subjects/setting: A nationally-representative sample of children ages 2-5 (n=1,521) and 6-11 years old (n=2,098).

Statistical analyses: Data were weighted to account for the complex sampling design. Descriptive statistics were conducted to identify proportions of children meeting fruit intake recommendations and identify food contributing to fruit serving intakes.

Results: Approximately 64% of children between the ages of 2-5 and 74% of children between the ages of 6-11 years old did not meet food guide pyramid recommendations for fruit servings. The leading contributors of fruit servings were apples, orange juice, bananas, and apple juice. Children who did not meet fruit recommendations consumed
less fruit servings from whole fruit and more from "non-fruit" sources. Approximately half of all fruit servings were obtained in the form of whole fruit in both age groups. Children who met fruit serving recommendations consumed more 100% fruit juice and children who did not meet fruit serving recommendations consumed more fruit drinks and other sources.

Applications/Conclusions: Few children are meeting fruit intake recommendations, and a considerable proportion of fruit is derived from fruit juice and non-fruit sources. Nutrition professionals should encourage fruit intakes to increase the proportion meeting fruit intake recommendations and emphasize whole fruit choices to obtain maximum benefits from the food they consume.
LEADING SOURCES OF FRUIT SERVINGS AND CONTRIBUTION FROM
WHOLE FRUIT AND FRUIT JUICE IN US CHILDREN
FROM NHANES 1999-2002

Introduction

Overweight is now the most common medical condition of childhood, as the prevalence has doubled over the past 20 years (9;10). Approximately one of every six children is overweight with nearly one-third children at risk for becoming overweight (9). In the US, children’s food practices are low in fruits and high in added sugars (2-4). These intake patterns are a public health concern because excess sugar consumption is associated with greater energy intake, which may place children at risk for excess weight gain and obesity (4;5). Furthermore, there are several complications that often may result from the obesity, including high cholesterol, high blood pressure, type 2 diabetes mellitus, coronary plaque formation, and serious psychosocial implications (9).

National nutrition monitoring surveys and food consumption surveys, which have been dedicated to assessing the health status of Americans and studying the American diet, have documented a decline in fruit intakes with a significant increase in the consumption of sweetened beverages in the US (2). Fruits are an important part of the diet because they are naturally low in fat and cholesterol and are a good source for dietary fiber, vitamins and minerals (35). Low intakes of fruits have been associated with inadequate intakes of vitamin A, vitamin C, and dietary fiber, along with a high intake of total fat and saturated fat. The Food Guide Pyramid (FGP) recommends that children consume 2 to 4 servings of fruits per day (1) that can be derived from whole fruit or 100% fruit juice (fruit juice). Several reports indicated that children are not meeting
recommended fruit servings (8;27;33;35). Munoz et.al (27) reported that only 30% of children between the ages of 2 - 19 years from national data were meeting fruit FGP recommendations.

Research also suggests that sweetened beverage consumption, such as fruit drinks and soft drinks, is rising (2-4). Larger single-serving package sizes, lower prices, increased national trends toward reliance on fast-food and other restaurants that serve soft drinks as the primary beverage, the increasing availability of sweetened beverages and soft drinks in school settings from vending machines or in the school cafeteria, and the use of youth-targeted advertising and marketing by soft drink companies have been linked to this rise in consumption (4;12;13). Sweetened beverages are a significant contributor to total caloric intake and added sugars which may place children at risk for excess weight gain and obesity (2-5). Furthermore, these beverages not only contribute to the obesity epidemic, but may also displace more nutrient-dense beverages such as milk or fruit juice, and also pose a risk for the development of dental caries (4;6;7;9).

To examine food selection behaviors and beverage consumption patterns of US children, this study examined the percentage of 2-5 and 6-11 year-olds are meeting fruit serving recommendations as defined by the FGP for children and adolescents, compared which foods contribute to total fruit servings for children who are and are not meeting fruit serving recommendations and identified the proportion of fruit servings obtained from 100% fruit juice.
Methods

The Centers for Disease Control and Prevention (CDC) conducted a series of health and nutrition monitoring surveys since the 1960's to assess the health and nutritional status of Americans. The National Health and Nutrition Examination Surveys (NHANES I, II and III) were conducted periodically between 1971 and 1994. The most recent NHANES, which began in 1999, has become a continuous national nutrition monitoring survey. Data were collected through a multi-staged, stratified sample from the 50 US states and Washington DC. Demographic information were collected during an in-home interview while dietary intake, laboratory, health history questionnaires and physical examination data were collected during scheduled visits to the mobile examination center (MEC). More information about the survey design and data collection procedures are provided elsewhere (36).

A nationally representative sample of children from the 1999-2002 NHANES from two age groups, 2-5 years (n=1,521) and 6-11 years of age (n=2,098), who completed a 24-hr recall, were included in the analyses. Public use data files were downloaded from the National Center for Health Statistics (NCHS) website and imported into SPSS for preparation. Dietary intakes were assessed using the multi-pass 24-hr food recall method during the MEC visit. All foods were coded using an 8-digit numerical code. Food Guide Pyramid servings for the quantity of food reported was based on USDA’s Food & Nutrient Database for Dietary Studies (FNDDS) (37). Twenty-four hour recall data provided nutrient and FGP serving data for individual foods as well as total nutrient and FGP intakes for the day of recall. Children consuming fruit intakes
greater than three standard deviations above the mean were excluded from the analyses due to the improbable nature of these intakes.

Some variables required recoding or categorization prior to analysis. Children were classified into a 2-5 year old age group and a 6-11 year old age group. Total fruit FGP servings per day were recoded to identify children who are and are not meeting federal recommendations. Children consuming < 2 servings of fruit were recoded as not meeting fruit serving recommendations based on the Food Guide Pyramid for Young Children (1). To examine the contribution of beverage choices to fruit servings and differences in beverage consumption patterns in children, beverages reported in the food intake data were recoded into discrete categories.

Foods were classified into categories to describe the role of food groups in total fruit intakes. The food code database was searched to identify whole fruits, fruit juice, and fruit drinks (ie. ades and fruit punch); all other foods were coded as other fruit sources to identify camouflaged foods that contain fruit servings. Analysis was conducted using the pooled contribution of the items within each category to examine the daily contribution of these groups to total fruit serving intakes.

**Data Analysis**

Frequency analyses were used to determine the proportion of children meeting fruit intake recommendations. To identify differences in which foods were contributing the greatest amounts to total fruit servings between children meeting and not meeting fruit intake recommendations, the contribution to total fruit serving intakes by each food was determined using the following formula (36):

\[
\frac{\sum \text{total fruit servings from each food}}{\sum \text{total fruit servings from all foods}}.
\]
Foods contributing at least 2% to total fruit intakes were considered leading contributors to fruit intakes, using previous research as a guide (36). A similar procedure was used to determine the proportion of fruit servings obtained from whole fruit, fruit juice, fruit drinks and other foods.

Due to the complex, multi-staged sampling design used in NHANES data collection, SPSS Complex Samples (version 14.0, SPSS Inc, Chicago, IL) was used to conduct analyses. This software was required to correct for the over-sampling techniques employed to ensure inclusion of hard-to-reach population, which included Mexican Americans, African Americans, young children, adolescents, low-income individuals, pregnant women, and the elderly. Data were weighted using the appropriate weights provided by the CDC to provide a nationally-based sample, while also providing adjusted standard errors for statistical analyses.

Results

The percent of children between the ages of 2-5 and 6-11 years who are meeting fruit serving recommendations as defined by the FGP are displayed in Figure 4.1. Of all children ages 2- to 11-years-of-age (n = 3,619), 70% did not meet food guide pyramid recommendations for fruit servings, with approximately 64% and 74% of children between the ages of 2 -5 years (n=923) and 6-11 years old (n=1,473), respectively, that did not meet fruit intake recommendations. The average number of fruit servings consumed was 1.8 servings for the younger children, and 1.4 servings for the older children.

To identify the foods contributing to fruit intakes in children’s diets, the leading contributors of fruit servings in children who did meet and did not meet the
recommendations for fruit servings are provided in Table 4.1. For young children who did not meet the fruit serving recommendations, the foods contributing the most to total fruit serving intakes were raw apples (12.5%), orange juice (11.8%), raw bananas (10%), and apple juice (9.8%). Furthermore, eight out of the 18 leading contributors of fruit servings were juices, which accounted for approximately 35%. Three of the remaining contributors were "non-fruit" sources, such as fruit drinks, fruit punch, and orange breakfast drinks, accounting for 5% of fruit intakes. Similarly, the leading contributors of fruit servings in young children who did meet the fruit intake recommendation were orange juice (12.5%), apple juice (11%), raw apples (8.2%), and raw bananas (7.1%). However, those meeting fruit intake recommendation reported more whole fruit (7 out of the 17 leading contributors) and eight were obtained from fruit juice. There were no "non-fruit" sources, such as fruit drinks or snacks.

In the older children, the leading sources of fruit servings for children not meeting the fruit intake recommendations were orange juice (13.2%), raw apples (11.2%), raw bananas (5.8%), and apple juice (5.2%). Six of the 20 top sources of fruit servings were obtained from juice, representing approximately 25% of total fruit intakes, while four were obtained from non-fruit sources (9% of total fruit intakes). Only half of the foods were obtained in the form of whole fruit, providing 31% of total fruit servings. In older children who met fruit intake recommendations, the leading contributors for fruit servings were orange juice (12.4%), raw apples (8.8%), apple juice (8.8%), and raw watermelon (7.7%). Within this group, ten out of the 19 top contributors of fruit servings were obtained from fruit juice, nine were whole fruit sources and non-fruit sources were not among the leading sources of fruit servings. In comparison, older children who did not
met recommendations for fruit servings had a greater contribution of fruit servings from juice and non-fruit sources, while children who met fruit serving recommendations had a higher contribution of their fruit servings in the form of whole fruit.

Figures 4.2a and 4.2b present the proportion of fruit servings obtained from various food sources. In younger children who did not meet fruit recommendations, half of fruit servings were derived from whole fruit and 34% of total fruit servings from fruit juice while 54% were obtained from whole fruit in the children meeting fruit recommendations. Approximately 16% of all fruit servings were attributed to fruit drinks (9.8%) and other sources (6.4%). Among young children who met fruit recommendations, 39% of fruit servings were obtained from fruit juice, whereas only 7% came from non-fruit sources. Older children who did not meet fruit recommendations obtained 46% of their fruit servings from whole fruit and 30% from fruit juice, while older children who met fruit intake recommendations obtained 55% and 39% of fruit servings from whole fruit and fruit juice, respectively.

In comparison, in all children who did not meet fruit serving recommendations there was a 2 to 4 times greater contribution of fruit drinks and other sources than those who met fruit recommendations. The contribution of fruit drinks and other food sources servings also increased with age. Approximately 16% of fruit servings in the 2-5 year olds who did not meet fruit serving recommendations were attributed to fruit drinks and other sources, whereas 24% of fruit servings in the 6-11 year olds who did not meet fruit serving recommendations were attributed to fruit drinks and other sources.

Mean fruit servings derived from food categories are presented in Figures 4.3a and 4.3b. Young children who met fruit serving recommendations consumed more total
fruit servings from each of the food and beverage categories. These children consumed four-fold greater amounts of fruit servings from whole fruit and fruit juice when compared to younger children who did not meet fruit serving recommendations. Consumption of fruit drinks and other sources was also slightly higher in younger children who met fruit serving recommendations. Similar patterns were observed in older children, with those who met fruit serving recommendations consuming more total fruit servings from each of the food and beverage categories. These children also consumed about a four-fold greater amount of fruit servings from whole fruit and fruit juice than children who did not meet fruit serving recommendations. Furthermore, mean fruit servings obtained from fruit drinks and other food sources were slightly higher in older children who met fruit serving recommendations.

**Discussion**

A total of 3,619 children from the 1999-2002 NHANES were divided into two age group categories for analysis, ages 2-5 years (n= 1,521) and ages 6-11 years (n=2,098) to examine fruit and sweetened beverage intakes. The information gathered in this descriptive study provided valuable information regarding beverage trends and obesity in children in relation to fruit servings as defined by the FGP (1). As a whole, consumption of fruit intakes were low in US children and a considerable proportion of fruit was derived from fruit juice and non-fruit sources. Children who met fruit serving recommendations obtained fruit servings more in the form of whole fruit and fruit juice, while children who did not meet fruit serving recommendations obtained had a greater reliance fruit drinks and other sources to support insufficient fruit intakes.
A large proportion of children are not meeting recommendations for fruit servings as defined by the Food Guide Pyramid. Of the total number of children between the ages of 2-11, 70% did not meet food guide pyramid recommendations for fruit servings, with approximately 64% and 74% of younger and older children, respectively, not meeting minimum recommendations for fruit servings. Mean fruit servings consumed was under the USDA’s Food Guide Pyramid recommendations of a minimum of 2 servings, with 1.8 servings for the younger children, and 1.4 servings for the older children; this estimate is likely conservative due to the exclusion of children with fruit intakes greater than three standard deviations above the mean for fruit intake. These findings were similar to previous studies (27;33;35).

Munoz et.al (27) reported that children between the ages of 2 -19 years (n=3,307) from the USDA’s 1989-1991 Continuing Surveys of Food Intakes by Individuals (CSFII) had mean servings from all food groups except the dairy group were below the minimum recommendations, with only 30% percent of children meeting fruit intake recommendations. Similarly, comparisons of the dietary intakes of 110 children between the ages of 7-14 years with FGP recommendations resulted in a very small proportion that met the FGP recommendations for fruit (5%) or milk group (9%) recommendations (33). Dennison et.al. (35) determined the extent to which young children’s diets include the recommended numbers of servings/day of “5-A-Day” fruit and vegetables in 2-year-old children (n=116) and 5-year-old children (n=107). Both the 2-year-old and 5-year-old children consumed the same numbers of servings/day for fruit, fruit juices, and vegetables (0.8 and 0.7 fruit servings/day, 1.0 and 0.8 juice servings/day, and 2.2 and 2.1 total fruit and vegetable servings/day, respectively). Forty percent of the 2-year-old
children and 50% of the 5-year-old children consumed less than two servings per day of both fruits and vegetables combined, which is under the current “5-A-Day” recommendations.

When examining the leading sources of fruit servings, both the younger and older children obtained a considerable proportion of total fruit servings from apples, bananas, orange juice, and apple juice, regardless of meeting or not meeting fruit serving recommendations. Furthermore, about half of fruit servings were obtained from fruit juice among both age groups and those achieving recommendations. In comparison, children who did not met recommendations for fruit servings in both age groups obtained more fruit servings from juice, non-fruit sources, and fruit drinks. Children are consuming so few fruit sources that the non-fruit sources, such as fruit drinks, become contributor for fruit servings. Those children who met fruit servings consumed more of their fruit servings in the form of whole fruit. Similarly, fruit juice contributed significantly to the total fruit servings consumed, representing 54% of all fruit servings, and both apple juice and orange juice were common sources of fruit juice, with 30% and 23%, respectively (35). Our data are similar to previous reports that apples, oranges, bananas, and orange juice accounted for 5 out of the 11 most frequently reported vegetables and fruits consumed in 7-18 year-old children (n=2,258) from the 1994-1996 CSFII.

On average, for both age groups of children who both did and did not meet fruit serving recommendations, about 50% of fruit servings were obtained from whole fruit sources and in between 30-40% of fruit servings were obtained from 100% fruit juice, with a 6-8 times greater amount of fruit servings consumed from whole fruit and fruit
than those that did not meet fruit servings. Fruit has been shown to be an excellent source for nutrients (35;36). Low intakes of fruits and vegetables were associated with inadequate intakes of vitamin A, vitamin C, and dietary fiber (35). Hampl et.al. (36) reported children with desirable vitamin C intake had greater intakes of fruits and vegetables. Although both whole fruit and fruit juice contain important vitamins and minerals, fruit juice is higher in calories per serving than whole fruit, and only whole fruit contains fiber, with the exception of orange juice containing pulp.

In comparison, children who did not meet fruit serving recommendations as defined by the food guide pyramid obtained 2 to 4 times more fruit servings from fruit drinks and other sources while consuming half as many servings from fruit drinks. The contribution of fruit drinks and other food sources servings was higher in older children, from 16% in younger children to 24% in older children, with little difference in the mean number of servings from fruit drinks and other sources. In children who did not meet fruit serving recommendations, Intakes of total fruit, whole fruit, and fruit juice were lower in older children that did not meet fruit recommendations, which resulted in an increasing the proportion of fruit servings obtained from fruit drinks. A similar study by Rampersaud et al. (28) reported a greater reliance on sweetened beverages that also increased with age. Furthermore, intake of carbonated soft drinks increased as children aged, with a dramatic increase beginning at the age of eight years-old and exceeded the American Academy of Pediatrics recommendations for fruit juice consumption by the age of 13. Furthermore, the leading sources of added sweeteners in children from the 1994-1996 CSFII were regular soft drinks, accounting for one third of added sweetener
intakes (3). Fruit drinks accounted for 19.4% of total intakes of added sweeteners among children 2 to 5 years old and 10% of intake in the diets of older children and adolescents.

Because of the nature of the data used, there are some limitations to the current study. The data were collected by the CDC, cleaned and released as public-use data files; therefore, the investigators are limited to only data available to address the specific research question. Furthermore, the data used herein are based on self-report, which represents the potential for error and recall bias. Finally, the reliance on a single 24-hr recall is not ideal to assess dietary habits; many limitations are involved in using 24-hour recalls in assessing the intakes of individuals but they can be useful in assessing large populations.

Conclusions and Applications

In general, children are not meeting recommendations for fruit servings, with a considerable proportion of fruit coming from juice and non-fruit sources. Fruits are an important source of vitamins and minerals in the diet. Fruit juice, which is higher in calories per serving than whole fruit, is being consumed more often than whole fruits which are lower in calories and contain fiber. Children are consuming more sweetened beverages, such as fruit drinks, which are high in added sugars, which contribute to extra calories in the diets of children. This increase in extra calories may contribute to overweight in children. Not only are sweetened beverage intakes increasing and contributing to excess caloric intake in children’s diets, but they may also be displacing more nutrient dense beverages such as fruit juice and milk. Nutrition professionals should encourage fruit intakes to meet FGP recommendations and emphasize a variety of
whole fruit choices. Beverages that are more nutrient-dense and lower in calories should be encouraged over sweetened beverages.
Figure 4.1: Proportions of US children who met and did not meet fruit Food Guide Pyramid serving recommendations by age category.
<table>
<thead>
<tr>
<th>Age (^1)</th>
<th>Food (^2)</th>
<th>not met fruit FGP</th>
<th>met fruit FGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>Cum Tot</td>
<td>%</td>
</tr>
<tr>
<td>2-5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPLE, RAW</td>
<td></td>
<td>12.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>ORANGE JUICE, CANNED/BOTTLED/CARTON, UNSWEETENED</td>
<td></td>
<td>11.8%</td>
<td>24.3%</td>
</tr>
<tr>
<td>BANANA, RAW</td>
<td></td>
<td>10.0%</td>
<td>34.2%</td>
</tr>
<tr>
<td>APPLE JUICE</td>
<td></td>
<td>9.8%</td>
<td>44.0%</td>
</tr>
<tr>
<td>FRUIT JUICE BLEND, 100% JUICE, W/ VITAMIN C</td>
<td></td>
<td>4.0%</td>
<td>48.1%</td>
</tr>
<tr>
<td>APPLE JUICE, W/ ADDED VITAMIN C</td>
<td></td>
<td>3.5%</td>
<td>51.6%</td>
</tr>
<tr>
<td>GRAPES, RAW, NS AS TO TYPE</td>
<td></td>
<td>2.9%</td>
<td>54.5%</td>
</tr>
<tr>
<td>PEACH, RAW</td>
<td></td>
<td>2.5%</td>
<td>57.0%</td>
</tr>
<tr>
<td>FRUIT DRINK (INCLUDE FRUIT PUNCH &amp; FRUIT ADE)</td>
<td></td>
<td>2.4%</td>
<td>59.4%</td>
</tr>
<tr>
<td>ORANGE, RAW</td>
<td></td>
<td>2.1%</td>
<td>61.5%</td>
</tr>
<tr>
<td>FRUIT JUICE, NFS (INCLUDE MIXED FRUIT JUICES)</td>
<td></td>
<td>1.7%</td>
<td>63.2%</td>
</tr>
<tr>
<td>ORANGE JUICE, FROZEN, UNSWEETENED, RECONST W/ WATER</td>
<td></td>
<td>1.6%</td>
<td>64.8%</td>
</tr>
<tr>
<td>FRUIT PUNCH/DRINK/ADE W/ VIT C ADDED (INCL HI-C)</td>
<td></td>
<td>1.6%</td>
<td>66.4%</td>
</tr>
<tr>
<td>APPLESACUCE, STEWED APPLES, UNSWEETENED (INCL FRESH)</td>
<td></td>
<td>1.6%</td>
<td>68.0%</td>
</tr>
<tr>
<td>STRAWBERRIES, RAW</td>
<td></td>
<td>1.4%</td>
<td>69.4%</td>
</tr>
<tr>
<td>GRAPE JUICE, UNSWEETENED</td>
<td></td>
<td>1.4%</td>
<td>70.8%</td>
</tr>
<tr>
<td>GRAPE JUICE, UNSWEETENED, W/ ADDED VITAMIN C</td>
<td></td>
<td>1.3%</td>
<td>72.0%</td>
</tr>
<tr>
<td>ORANGE BREAKFAST DRINK</td>
<td></td>
<td>1.1%</td>
<td>73.1%</td>
</tr>
<tr>
<td>WATERMELON, RAW</td>
<td></td>
<td>--</td>
<td>73.1%</td>
</tr>
<tr>
<td>CANTALOUE (MUSKMELON), RAW (INCLUDE MELON, NFS)</td>
<td></td>
<td>--</td>
<td>73.1%</td>
</tr>
<tr>
<td>RAISINS (INCLUDE CINNAMON-COATED RAISINS)</td>
<td></td>
<td>--</td>
<td>73.1%</td>
</tr>
</tbody>
</table>

Table 4.1: The most common foods contributing to total fruit serving intakes for children meeting and not meeting fruit serving intake recommendations from the Food Guide Pyramid by age category

Continued
Table 4.1 continued

<table>
<thead>
<tr>
<th>Age</th>
<th>Food</th>
<th>not met fruit FGP</th>
<th>met fruit FGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>Cum Tot</td>
</tr>
<tr>
<td>6-11  years</td>
<td>ORANGE JUICE, CANNED/BOTTLED/CARTON, UNSWEETENED</td>
<td>13.2%</td>
<td>13.2%</td>
</tr>
<tr>
<td></td>
<td>APPLE, RAW</td>
<td>11.2%</td>
<td>24.4%</td>
</tr>
<tr>
<td></td>
<td>BANANA, RAW</td>
<td>5.8%</td>
<td>30.2%</td>
</tr>
<tr>
<td></td>
<td>APPLE JUICE</td>
<td>5.2%</td>
<td>35.4%</td>
</tr>
<tr>
<td></td>
<td>ORANGE, RAW</td>
<td>5.1%</td>
<td>40.4%</td>
</tr>
<tr>
<td></td>
<td>ORANGE BREAKFAST DRINK</td>
<td>3.2%</td>
<td>43.7%</td>
</tr>
<tr>
<td></td>
<td>FRUIT DRINK (INCLUDE FRUIT PUNCH &amp; FRUIT ADE)</td>
<td>3.2%</td>
<td>46.8%</td>
</tr>
<tr>
<td></td>
<td>STRAWBERRIES, RAW</td>
<td>2.1%</td>
<td>48.9%</td>
</tr>
<tr>
<td></td>
<td>ORANGE JUICE, NFS</td>
<td>2.1%</td>
<td>50.9%</td>
</tr>
<tr>
<td></td>
<td>APPLESAUCE, STEWED APPLES, NS AS TO ADDED SWEETENER</td>
<td>2.0%</td>
<td>53.0%</td>
</tr>
<tr>
<td></td>
<td>GRAPES, RAW, NS AS TO TYPE</td>
<td>2.0%</td>
<td>54.9%</td>
</tr>
<tr>
<td></td>
<td>CANTALOUPE, RAW (INCLUDE MELON, NFS)</td>
<td>1.9%</td>
<td>56.8%</td>
</tr>
<tr>
<td></td>
<td>FRUIT JUICE BLEND, 100% JUICE, W/ VITAMIN C</td>
<td>1.8%</td>
<td>58.7%</td>
</tr>
<tr>
<td></td>
<td>FRUIT JUICE, NFS (INCLUDE MIXED FRUIT JUICES)</td>
<td>1.7%</td>
<td>60.4%</td>
</tr>
<tr>
<td></td>
<td>FRUIT LEATHER (INCLUDE FRUIT ROLL-UP)</td>
<td>1.5%</td>
<td>61.9%</td>
</tr>
<tr>
<td></td>
<td>FRUIT PUNCH/DRINK/ADE W/ VIT C ADDED (INCL HI-C)</td>
<td>1.4%</td>
<td>63.3%</td>
</tr>
<tr>
<td></td>
<td>ORANGE JUICE, FROZEN, UNSWEETENED, RECONST W/ WATER</td>
<td>1.3%</td>
<td>64.6%</td>
</tr>
<tr>
<td></td>
<td>APPLE JUICE, W/ ADDED VITAMIN C</td>
<td>1.2%</td>
<td>65.7%</td>
</tr>
<tr>
<td></td>
<td>GRAPE JUICE, UNSWEETENED, W/ ADDED VITAMIN C</td>
<td>1.1%</td>
<td>66.9%</td>
</tr>
<tr>
<td></td>
<td>APPLESAUCE, STEWED APPLES, UNSWEETENED (INCL FRESH)</td>
<td>1.0%</td>
<td>67.8%</td>
</tr>
<tr>
<td></td>
<td>WATERMELON, RAW</td>
<td>--</td>
<td>67.8%</td>
</tr>
<tr>
<td></td>
<td>GRAPE JUICE, UNSWEETENED</td>
<td>--</td>
<td>67.8%</td>
</tr>
<tr>
<td></td>
<td>GRAPE JUICE, NS AS TO ADDED SWEETENER</td>
<td>--</td>
<td>67.8%</td>
</tr>
<tr>
<td></td>
<td>GRAPEFRUIT JUICE, CANNED, BOTTLED, CARTON, UNSWEET</td>
<td>--</td>
<td>67.8%</td>
</tr>
<tr>
<td></td>
<td>FRUIT SMOOTHIE DRINK, W/ FRUIT ONLY</td>
<td>--</td>
<td>67.8%</td>
</tr>
</tbody>
</table>

1Analyses included children ages 2-5 years (n=923 not met, n=598 met) and 6-11 years (n=1,473 not met, n=625 met)

2Data represent the proportion of total fruit servings obtained from each food, stratified by age category and stratification by meeting fruit Food Guide Pyramid recommendations.
Figure 4.2a,b: Percent contribution to total fruit servings from each food category by age group and meeting fruit intake recommendations.
Figure 4.3a,b: Mean intakes of fruit servings from each category by age group and meeting fruit intake recommendations.
CHAPTER 5

DISCUSSION

A total of 3,619 children from the 1999-2002 NHANES were divided into two age group categories for analysis, ages 2-5 (n=1,521) and ages 6-11 (n=2,098) to examine fruit and sweetened beverage intakes. The information gathered in this descriptive study provided valuable information regarding beverage trends and obesity in children in relation to fruit servings as defined by the Food Guide Pyramid (FGP) (1;1). As a whole, consumption of fruit intakes were low in US children and a considerable proportion of fruit was derived from fruit juice and non-fruit sources. Children who met fruit serving recommendations obtained fruit servings more in the form of whole fruit and fruit juice, while children who did not meet fruit serving recommendations obtained had a greater reliance fruit drinks and other sources to support insufficient fruit intakes.

A large proportion of children are not meeting recommendations for fruit servings as defined by the FGP. Of the total number of children between the ages of 2-11, 70% did not meet food guide pyramid recommendations for fruit servings, with approximately 64% and 74% of younger and older children, respectively, not meeting minimum recommendations for fruit servings. Mean fruit servings consumed was below the USDA’s FGP recommendations of a minimum of 2 servings, with 1.8 servings for the
younger children, and 1.4 servings for the older children; this estimate is likely conservative due to the exclusion of children with fruit intakes greater than three standard deviations above the mean for fruit intake. These findings were similar to previous studies (27,33,35). Munoz et al. (27) reported that children between the ages of 2-19 years (n=3,307) from the USDA’s 1989-1991 Continuing Surveys of Food Intakes by Individuals (CSFII) had mean servings from all food groups except the dairy group were below the minimum recommendations, with only 30% percent of children meeting fruit intake recommendations. Similarly, comparisons of the dietary intakes of 110 children between the ages of 7-14 years with FGP recommendations resulted in a very small proportion that met the FGP recommendations for fruit (5%) or milk group (9%) recommendations (33). Dennison et al. (35) determined the extent to which young children’s diets include the recommended numbers of servings/day of “5-A-Day” fruit and vegetables in 2-year-old children (n=116) and 5-year-old children (n=107). Both the 2-year-old and 5-year-old children consumed the same numbers of servings/day for fruit, fruit juices, and vegetables (0.8 and 0.7 fruit servings/day, 1.0 and 0.8 juice servings/day, and 2.2 and 2.1 total fruit and vegetable servings/day, respectively). Forty percent of the 2-year-old children and 50% of the 5-year-old children consumed less than two servings per day of both fruits and vegetables combined, which is under the current “5-A-Day” recommendations.

When examining the leading sources of fruit servings, both the younger and older children obtained a considerable proportion of total fruit servings from apples, bananas, orange juice, and apple juice, regardless of meeting or not meeting fruit serving recommendations. Furthermore, about half of fruit servings were obtained from fruit
juice among both age groups and those achieving recommendations. In comparison, children who did not meet recommendations for fruit servings in both age groups obtained more fruit servings from juice, non-fruit sources, and fruit drinks. Children are consuming so few fruit sources that the non-fruit sources, such as fruit drinks, become contributor for fruit servings. Those children who met fruit servings consumed more of their fruit servings in the form of whole fruit. Similarly, fruit juice contributed significantly to the total fruit servings consumed, representing 54% of all fruit servings, and both apple juice and orange juice were common sources of fruit juice, with 30% and 23%, respectively (35). Our data are similar to previous reports that apples, oranges, bananas, and orange juice accounted for 5 out of the 11 most frequently reported vegetables and fruits consumed in 7-18 year-old children (n=2,258) from the 1994-1996 CSFII. Similarly to our data, which showed fruit juice as a major contributor to fruit servings, Dennison et.al (35) found that fruit juice contributed significantly to the total fruit servings consumed and to the total number of fruit and vegetable servings consumed, representing 54% of all fruit servings and 42% of all fruit and vegetable servings.

On average, for both age groups of children who both did and did not meet fruit serving recommendations, about 50% of fruit servings were obtained from whole fruit sources and in between 30-40% of fruit servings were obtained from fruit juice, with a 6-8 times greater amount of fruit servings consumed from whole fruit and fruit than those that did not meet fruit servings. Fruit has been shown to be an excellent source for nutrients (35;36). Low intakes of fruits and vegetables were associated with inadequate intakes of vitamin A, vitamin C, and dietary fiber (35). Hampl et.al. (36) reported
children with desirable vitamin C intake had greater intakes of fruits and vegetables. Although both whole fruit and fruit juice contain important vitamins and minerals, fruit juice is higher in calories per serving than whole fruit, and only whole fruit contains fiber, with the exception of orange juice containing pulp.

In comparison, children who did not meet fruit serving recommendations as defined by the food guide pyramid obtained 2 to 4 times more fruit servings from fruit drinks and other sources while consuming half as many servings from fruit drinks. The contribution of fruit drinks and other food sources servings was higher in older children, from 16% in younger children to 24% in older children, with little difference in the mean number of servings from fruit drinks and other sources. In children who did not meet fruit serving recommendations, Intakes of total fruit, whole fruit, and fruit juice were lower in older children that did not meet fruit recommendations, which resulted in an increasing the proportion of fruit servings obtained from fruit drinks. A similar study by Rampersaud et al. (28) reported a greater reliance on sweetened beverages that also increased with age. Furthermore, intake of carbonated soft drinks increased as children aged, with a dramatic increase beginning at the age of eight years-old and exceeded the American Academy of Pediatrics recommendations for fruit juice consumption by the age of 13. Furthermore, the leading sources of added sweeteners in children from the 1994-1996 CSFII was regular soft drinks, accounting for one third of added sweetener intakes (3). Fruit drinks accounted for 19.4% of total intakes of added sweeteners among children 2 to 5 years old and 10% of intake in the diets of older children and adolescents.

Young children who did not meet fruit recommendations consumed nearly twice the amount of fruit drinks than fruit juice by gram weight than young children who did
meet fruit recommendations. Younger children met recommendations consumed almost
twice the amount of fruit juice when compared to younger children who did not meet
fruit serving recommendations. Older children not meeting recommendations consumed
much less fruit juice than older children who met fruit servings for fruit
recommendations. In comparison, children who did not meet fruit recommendations
consumed more sweetened beverages, such as fruit drinks and soft drinks, by gram
weight than those children who did meet fruit recommendations. Children who did meet
fruit recommendations consumed more fruit juice by gram weight. Once again, this trend
increased with age. Older children increased sweetened beverage consumption much
more by gram weight compared to the younger children.

Sweetened beverage consumption continues to increase (2). There have been
several reasons for this increase, including larger single-serving package sizes, lower
prices, increased national trends toward eating at fast-food and other restaurants that
serve soft drinks as the primary beverage, the increasing availability of sweetened
beverages and soft drinks in school settings from vending machines or in the school
cafeteria, and the use of youth-targeted advertising and marketing by soft drink
companies (4;12;13). Kotz et al. (12) examined current food advertising during children’s
television programs and assessed whether the products advertised are consistent with
dietary recommendations for good health. Of the 564 food advertisements, which
accounted for 56.5% of all advertisements, 43.6% advertised foods classified in the fats,
oils, and sweet food group. Within this classified group, 5.6% of the 43.6% were soft
drink advertisements. Similarly, Harrison et al. (13) also analyzed food advertisements
during television programs that were heavily viewed by children. Overall, snack,
convenience, and fast foods and sweets comprised most of the food advertisements viewed by children. Candy, sweets, soft drinks, and convenience and fast foods were advertised most frequently. Convenience and fast foods, and sweets represented 83% of all advertised foods. There was little representation of fruits and vegetables, dairy foods, meat, poultry, and fish. Advertised foods exceeded Recommended Daily Values (RDVs) for fat, saturated fat, and sodium, and did not provide RDVs for fiber and certain vitamins and minerals. Nutrient-poor, high-sugar foods were especially prevalent in the advertisements aimed at children, with candy, sweets, and soft drinks being the most dominant.

Despite the media’s negative influence on children’s food choices, other programs, such as school-based nutrition interventions, have been successful at promoting healthy food choices in the diets of children. Gimme 5: A Fresh Nutrition Concept for Students was one example of such an intervention, which aimed to increase daily fruit and vegetable consumption by high school students to 5 or more servings per day (32). Four components of the program included a school media-marketing campaign that provided messages to increase awareness and promote positive attitudes toward consumption of fruits and vegetables, workshops that included learning strategies such as eating habits, fresh choices which increased the availability, variety, and taste of fruits and vegetables in school meals, and the parental involvement component which provided education and parental support. Overall, the program was a success. After student evaluation, a large number of students had reported awareness of several areas, including giveaways, marketing stations, table tents, posters, marketing stations, and contests, and acceptability of each area was high. Self-efficacy also increased in both groups. The
reported daily servings of fruit and vegetables consumed increased by 14% from 1994 to 1996 in the intervention group.

The increase in consumption of sweetened beverages is of concern because of the possibility that these beverages may be displacing nutrient-dense beverages such as milk and fruit juice. Harnack et al. (6), using national data from the 1994-1996 CSFII to analyze children 2 to 18 years of age (n=1,810), reported energy consumption was positively associated with soft drink consumption, and soft drinks displaced milk and fruit juice in the diets of children and adolescents. Intake of nutrients, such as calcium, riboflavin, vitamin A, and phosphorus, which are commonly found in milk, and folate and vitamin C, commonly found in fruit juices, were lower among youth in the highest soft drink consumption category compared to those in the lower intake categories. For all age groups, those in the high soft drink consumption category were more likely to consume less than 8 oz milk per day and less than 4 oz fruit juice per day compared to non-consumers of soft drinks. Similarly, Mrdjenovic et al. (30) examined the effects of excessive sweetened drink consumption on daily energy balance and nutrient intake in children ages 6 to 13 years (n=30). The results showed that excessive sweet drink consumption, defined as greater than 12 ounces per day, displaced milk from children’s diets. Reduced milk consumption resulted in a lower daily intake of calcium, zinc, protein, phosphorus, and magnesium.

When differences in obesity, using BMI-for-age, between children who meet and children who do not meet food guide pyramid recommendations for fruit servings were examined, within both age group categories, children who did not meet fruit serving recommendations tend to shift towards being overweight than at risk for overweight.
Children who did meet fruit serving recommendations tend to shift towards being more at risk for overweight than overweight. The percentage of children for both at risk for overweight and overweight was greater in the older children. In comparison, 24% of children between the ages of 2-5 were at risk for becoming overweight whereas 34% of children between the ages of 6-11 were at risk for becoming overweight. Likewise, approximately 22% of children between the ages of 2-5 were overweight, whereas one-third of older children were overweight.

The differences in beverage group consumption by weight categories were also examined. In comparison, as weight status increased from normal weight to overweight, children within both age group categories consumed more soft drink and fruit drink. The differences by age were also evident, with 6-11 year olds consuming more soft drinks and fruit drinks than the 2-5 year olds. Several studies have shown a relationship between sweetened beverage consumption and obesity in children (5;14;16). Ludwig et al. (5) studied the relationship of sugar-added beverage intakes to body weight changes in 548 schoolchildren between the ages of 7 and 11. Positive associations were found among sugar-sweetened beverage intakes, weight change, and the prevalence of obesity.

Likewise, Berkey et al. (14) conducted a prospective cohort study to evaluate the relationship between BMI changes and intakes of sugar-added beverages, milk, fruit juices, and diet soda in over 10,000 9 to 14 year old boys and girls. Girls who drank more sugar-added beverages were heavier. Intakes of sugar-added beverages and diet sodas were significantly associated with weight gains for boys, and girls who reported one daily serving of sweetened beverages significantly increased their BMI during the year than those who reported none. Girls consuming two, three, or more servings also
gained weight. Increasing sugar-added beverages from one year to the next was significantly associated with weight gain in boys. Boys and girls who increased their intakes by two or more servings per day from the previous year experienced significant weight gain. Welsh et al. (16) examined the association between sweetened beverage consumption and overweight among 10,904 preschool children. Children who were at risk for overweight consumed 1 to 3 or more sweetened beverages per day. Of these, those who consumed 1 to <2 drink per day, 2 to <3 drinks per day, and ≥3 drinks per day were 2.0, 2.0, and 1.8 times as likely, respectively, to become overweight than those who consumed less than 1 drink per day. Children who were overweight at baseline and consumed 1 to <2, 2 to <3, and ≥3 drinks per day were 2.1, 2.2, and 1.8 times more likely to remain overweight than those who consumed less than 1 sweet drink per day.

The relationship between fruit servings as defined by the food guide pyramid and BMI-for-age was examined. There was no significant relationship found between BMI percentile and age.

**Conclusions**

In general, children are not meeting recommendations for fruit servings, with a considerable proportion of fruit are coming from juice and non-fruit sources. Fruits are an important source of vitamins and minerals in the diet. Fruit juice, which is higher in calories per serving than whole fruit, is being consumed more often than whole fruits which are lower in calories and contain fiber. Children are consuming more sweetened beverages, such as fruit drinks, which are high in added sugars, which contribute to extra calories in the diets of children. This increase in extra calories may contribute to overweight in children. Not only are sweetened beverage intakes increasing and
contributing to excess caloric intake in children's diets, but they may also be displacing more nutrient dense beverages such as fruit juice and milk. Milk is an important source of calcium in a child's diet, needed for the growth and development of strong bones. Nutrition professionals should encourage fruit intakes and emphasize whole fruit choices. Beverages that are more nutrient-dense and lower in calories should be encouraged over sweetened beverages. The media should put emphasis on healthy food choices when aiming marketing advertisements at children.
LIST OF REFERENCES


APPENDIX A

ADDITIONAL RESULTS

Beverage consumption patterns by children who meet and did not meet fruit recommendations are presented in Table A.1. Younger children who did not meet fruit recommendations consumed the most from coffee and tea, fruit drinks, milk, and soft drinks, consuming nearly twice the amount of fruit drinks than fruit juice. Younger children who did meet recommendations drank more fruit drinks, fruit juice, milk, and soft drinks. Children in this category consumed almost twice the amount of fruit juice when compared to the 2-5 year old children who did not meet fruit serving recommendations. Older children who did not meet fruit recommendations drank mostly coffee and tea, fruit drinks, and soft drinks, while those who met fruit recommendations consumed mostly fruit drink and soft drinks. Older children not meeting recommendations consumed much less fruit than those who met fruit servings for fruit recommendations.

There were no significant differences in obesity, using BMI-for-age percentile (P=0.380) or weight categories (P=0.734) between children who met and children who did not meet food guide pyramid recommendations for fruit servings.
Of children ages 2-5 who did not meet fruit recommendations as defined by the Food Guide Pyramid, 76% were normal weight, 11% were at risk for overweight, and 13% were overweight while of those who did meet fruit recommendations, 78% were normal weight, 13% were at risk for overweight, and 9% were overweight (Table A.2). The mean BMI-for-age percentile was 58.3 for children who did not meet food guide pyramid recommendations for fruit, and 58.6 for children who did meet food guide pyramid recommendations for fruit (Table A.3).

Of children ages 6-11 who did not meet fruit recommendations as defined by the food guide pyramid, 68% were normal weight, 15% were at risk for overweight, and 17% were overweight. Of children ages 6-11 who did meet fruit recommendations as defined by the food guide pyramid, 65% were normal weight, 19% were at risk for overweight, and 16% were overweight (Table A.2). Of children ages 2-5, the mean BMI-for-age
percentile was 64.3 and 66.3 for children who did and did not meet food guide pyramid recommendations for fruit, respectively (Table A.3). Within both age group categories, children who did not meet fruit serving recommendations tend to shift towards being overweight than at risk for overweight, and children who did meet fruit serving recommendations tend to shift towards being more at risk for overweight than overweight. The percentage of children for both at risk for overweight and overweight was greater in the older children, as one-quarter of younger children were at risk for becoming overweight, whereas 34% of older children were at risk for becoming overweight. Likewise, approximately 22% of children between the ages of 2-5 were overweight whereas 33% of children between the ages of 6-11 were overweight.

<table>
<thead>
<tr>
<th>Age</th>
<th>Weight Category</th>
<th>not met fruit FGP</th>
<th>met fruit FGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5 years</td>
<td>Normal Weight</td>
<td>76.3</td>
<td>77.8</td>
</tr>
<tr>
<td></td>
<td>At-risk for overweight</td>
<td>11.1</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Overweight</td>
<td>12.6</td>
<td>9.3</td>
</tr>
<tr>
<td>6-11 years</td>
<td>Normal Weight</td>
<td>67.6</td>
<td>64.8</td>
</tr>
<tr>
<td></td>
<td>At-risk for overweight</td>
<td>15.4</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td>Overweight</td>
<td>17.0</td>
<td>16.4</td>
</tr>
</tbody>
</table>

Table A.2: Proportion of weight status for US children by BMI-for-age category stratified by age group

<table>
<thead>
<tr>
<th>Age</th>
<th>not met fruit FGP</th>
<th>met fruit FGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5 years</td>
<td>Mean 58.3</td>
<td>Mean 58.6</td>
</tr>
<tr>
<td></td>
<td>SE 1.5</td>
<td>SE 1.3</td>
</tr>
<tr>
<td>6-11 years</td>
<td>Mean 64.3</td>
<td>Mean 66.3</td>
</tr>
<tr>
<td></td>
<td>SE 1.3</td>
<td>SE 1.7</td>
</tr>
</tbody>
</table>

Table A.3: Mean BMI-for-age percentile by age category and meeting fruit Food Guide Pyramid recommendations

75
The differences in beverage group consumption by weight categories are presented in Table A.4. Children between the ages of 2-5 who were in the normal weight category consumed approximately 302 grams of vegetable juice and 255 grams of fruit drink. Children between the ages of 2-5 who were in the at risk for overweight category consumed approximately 355 grams of diet soda, 282 grams of fruit drink, 247 grams of milk, and 241 grams of soft drink. Children between the ages of 2-5 who were in the overweight category consumed approximately 344 grams of fruit drink, 253 grams of diet soda, and 231 grams of soft drink. Children between the ages of 6-11 who were in the normal weight category consumed approximately 319 grams of soft drink, 312 grams of coffee and tea, and 299 grams of fruit drink. Children between the ages of 6-11 who were in the at risk for overweight category consumed approximately 369 grams of coffee and tea, 347 grams of soft drink, and 335 grams of fruit drink. Children between the ages of 6-11 who were in the overweight category consumed approximately 393 grams of coffee and tea, 374 grams of soft drink, and 341 grams of fruit drink. In comparison, as weight status was greater from normal weight to overweight, as children within both age group categories consumed more soft drink and fruit drink. This trend was also present with age, as 6-11 year olds consumed more soft drink and fruit drink than the 2-5 year olds.

The relationship between fruit servings as defined by the food guide pyramid and BMI-for-age was examined. There was no significant relationship found between BMI percentile and age (R=0.027, P=0.184).
<table>
<thead>
<tr>
<th>Age</th>
<th>Beverage</th>
<th>Normal Weight</th>
<th>At-risk for Overweight</th>
<th>Overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grams</td>
<td></td>
<td>grams</td>
<td></td>
</tr>
<tr>
<td>2-5 years</td>
<td>coffee and tea</td>
<td>215.7</td>
<td>219.1</td>
<td>190.4</td>
</tr>
<tr>
<td></td>
<td>diet soda</td>
<td>123.1</td>
<td>355.0</td>
<td>252.8</td>
</tr>
<tr>
<td></td>
<td>fruit drink</td>
<td>255.0</td>
<td>282.2</td>
<td>343.6</td>
</tr>
<tr>
<td></td>
<td>Fruit juice</td>
<td>202.8</td>
<td>183.0</td>
<td>186.8</td>
</tr>
<tr>
<td></td>
<td>milk</td>
<td>210.1</td>
<td>247.0</td>
<td>215.3</td>
</tr>
<tr>
<td></td>
<td>soft drink</td>
<td>219.4</td>
<td>240.7</td>
<td>230.5</td>
</tr>
<tr>
<td></td>
<td>vegetable juice</td>
<td>301.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>water</td>
<td>143.3</td>
<td>163.1</td>
<td>101.2</td>
</tr>
<tr>
<td>6-11 years</td>
<td>coffee and tea</td>
<td>311.5</td>
<td>368.8</td>
<td>392.5</td>
</tr>
<tr>
<td></td>
<td>diet soda</td>
<td>291.2</td>
<td>310.3</td>
<td>263.3</td>
</tr>
<tr>
<td></td>
<td>fruit drink</td>
<td>298.9</td>
<td>335.2</td>
<td>340.9</td>
</tr>
<tr>
<td></td>
<td>Fruit juice</td>
<td>237.6</td>
<td>290.4</td>
<td>216.3</td>
</tr>
<tr>
<td></td>
<td>milk</td>
<td>233.3</td>
<td>270.9</td>
<td>244.1</td>
</tr>
<tr>
<td></td>
<td>soft drink</td>
<td>318.5</td>
<td>346.5</td>
<td>373.8</td>
</tr>
<tr>
<td></td>
<td>vegetable juice</td>
<td>95.9</td>
<td>60.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>water</td>
<td>93.6</td>
<td>158.5</td>
<td>165.0</td>
</tr>
</tbody>
</table>

Table A.4: Beverage consumption patterns for children by weight classification