The Association Between Household Food Security and Dental Caries in Young Children

THESIS

Presented in Partial Fulfillment of the Requirements for the Degree Master of Science in the Graduate School of The Ohio State University

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2014

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Abstract

PURPOSE: The purpose of this project is to determine if there is an association between dental caries in children ages 2-4 and household food security status by examining the prevalence of child dental caries and household food security status among 94 children.

METHODS: This IRB-approved pilot study was conducted from April-May, 2014, at Nationwide Children's Hospital in Columbus, Ohio. Participants were the parents of young children (ages 2-4) who were current Dental Clinic patients or Dental Surgery Center patients (n=94). Children were examined for dental caries and parents were administered a food security questionnaire.

RESULTS: Dental Clinic patients included those with dental caries (n=19) and those without dental caries (n=28). All Dental Surgery Center patients had dental caries (n=47). Dental caries were present in 69% of children. Of 94 households in the sample, 69% (n=65) were found food secure and 31% (n=29) food insecure. No significant association was found between household food security and dental caries (p=0.6110). The odds of having dental caries was higher for food secure households than food insecure households (OR=1.27). The significant predictors of having dental caries, found from the univariable logistic regressions, were distance to a grocery store (p=0.0486), age of child

(p=0.0192), whether the child drinks water (p=0.0155), whether the child drinks other drinks besides water (p=0.0252), whether the child drinks juice (p=0.0378), daily drink consumption besides water (p=0.0005), does the child snack on starchy foods (p=0.0161), does the child snack on vegetables (p=0.0148), does the child snack on sugary foods (p=0.0030), and daily water consumption (p<0.0001). In the multivariable model, age was included to adjust for exposure time to dental caries and daily water consumption was included due to being a highly significant factor that affects dental caries in young children. After adding age to the model, the effect of daily water consumption remains significant (p<0.0001).

CONCLUSION: Daily water consumption was deemed a statistically significant variable that affects dental caries prevalence in young children. A main limitation of this study was the small sample size; especially the limited number of patients without dental caries. A future study may look at a larger sample size and include more patients without dental caries in the sample population.

Dedicated to my Dad. You have always inspired me to pursue my dreams. I imagine that you are drinking a Manhattan right now and listening to the Rolling Stones as you watch over me. You are always in my heart and I am so proud to be your daughter. I will always remember to “be happy and don’t worry, everything will work out”. I love you Dad!

Acknowledgements

A special thanks to Dr. Paul Casamassimo, my advisor, for providing me with this research opportunity that turned into one of the most rewarding learning experiences of my life. This project has helped me to understand my career aspirations and there are no words to describe my gratefulness! Dr. C's encouragement and guidance have been unmatched. I would also like to thank Dr. Amanda Bird, my advisor, for her endless kindness and support. Dr. Bird is one of the nicest people I've ever met and she has helped me throughout the past two years countless times. I would also like to thank the other members of my committee, Dr. Tanya Mathew and Dr. Irene Hatsu. Dr. Mathew is a very caring person who has taught me about research and about life. Her enthusiasm and positive encouragement motivated me to work hard and be a better researcher. Dr. Hatsu was brand new to Ohio State when I asked her to be a part of my committee. She has provided invaluable feedback to this project and I would have been lost on several occasions if it weren't for her help. I am so glad that she became a part of this project. I would also like to recognize the biostatisticians, Greg Young and Jenny Ogden, for their biostatistical support in this project.

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CHAPTER 1: Review of Literature

Dental Caries

Dental caries (also known as tooth decay or dental cavities) among infants and toddlers continues to escalate throughout the United States. Early Childhood Caries (ECC) is the most common chronic childhood disease [1] and continues to increase among young children, despite an overall decrease in older age groups of children. From the 1970s to 1990s, the dental caries rate in children as a whole decreased, but recent data from the 2007 report by the Centers for Disease Control and Prevention shows that this trend is inverted [2]. From 1988-1994 to 1999-2004, dental caries prevalence in children ages 2-5 increased by 4% (24% to 28%). The NHANES report from 2000 shows that caries increased by 2% (40% to 42%) for ages 2-11; 80% of dental caries is seen in 25% of children, mainly children from low-income households [3].

Definition

ECC is a severe form of tooth decay that affects the primary teeth of infants and young children up to 70 months of age [4]. Tooth decay is the result of a sticky film on teeth called plaque that is overcome with bacteria, which comes from eating carbohydrate-containing foods and drinks. Bacteria metabolizes the available sugar (from foods and drinks consumed) and converts fermentable carbohydrates into acid byproducts, like

lactic acid. The acidic plaque infiltrates the tooth surface resulting in bacterial demineralization. When bacterial demineralization continues to occur overtime, eventually the hard, outer layer of the tooth, called the tooth enamel, is destroyed and cavitation of the tooth occurs [5]. A white spot lesion and discoloration of the enamel are signs of the early stage of a cavity. A cavity will likely develop if the tooth continues to be exposed to this unfavorable environment. Good oral hygiene and exposure to fluoride may help prevent the tooth from developing a cavity.

Dental caries and health

In young children, ECC has been associated with negative long-term effects like stunted growth, diabetes and heart disease [6]. Good oral health is beneficial from the start of life because the human mouth is important in many bodily functions, such as eating, communicating and breathing. In addition, psychological factors related to good oral health, like a positive self-image from a healthy mouth, are significant in a society that places importance on appearance. Preventing dental caries is cost-effective as shown by an interventional study that focused on the prevention of early childhood dental caries through a dental health education program [7]. In Kowash et al, mothers were visited at home where they were taught basic caries prevention, like brushing infants' teeth, which demonstrated better "benefit-costs" results as well as being more financially favorable (compared to other prevention programs). ECC can negatively impact children's growth and development, nutrition, speech, sleeping, and overall quality of life. However, focusing on the preventative measures has proven to be an effective way of reducing

dental caries incidence. A study that looked at the long-term effectiveness of a nutritional program in reducing ECC found significant results from its intervention in the number of children with reduced lesions as well as a reduced number of those with severe lesions [8]. Feldens et al discussed that future studies should focus greatly on the prevention of dental caries, rather than controlling the severity after the onset of dental caries, because of the positive results and cost effectiveness of the program.

Household food security

Factors related to dental caries may be cultural, social, or behavioral factors [9]. For instance, individuals can be affected by social and cultural factors (cultural norms, values) that impact individuals eating behavior, which indirectly affects dental caries. However, dental caries can be reduced or prevented through eating healthy foods and maintaining a healthy lifestyle; thus, social, cultural, and behavioral factors have the potential to prevent dental caries if individuals, families, and communities are willing to lead healthier lifestyles. Eating balanced meals and having healthy food accessible may not be feasible for people at all times and this type of situation describes a person who experiences food insecurity. Food insecurity in children especially can lead to detrimental effects; young children do not have control over their diet or household food security. Despite many studies that have looked at nutrition-related factors and dental caries (like cariogenic-based diets), studies have not examined the area of food security and child tooth decay. It is possible that children from food insecure households experience a

greater prevalence of dental caries compared to children from food secure households. Due to the limited information available, this relationship is unclear.

Access to food is a human right that involves access to enough nutritious and safe food in order to survive and feed oneself in dignity [10]. Despite this right being in place that should protect people from food insecurity, malnutrition and hunger, these are still issues worldwide. Food security status can have detrimental effects at an individual level, community level, national level, and global level. Household food security may involve a wide variety of experiences, from not having enough food to eat on occasion, to suffering serious malnutrition. In order to figure out how many people suffer from food insecurity, government agencies, such as the United States Department of Agriculture in particular, use specific measuring tools to approximate the food security status among U.S. households. Households with children had a substantially higher rate of food insecurity (20.0%) compared to those without children (11.9%) according to data from the December, 2012, *Current Population Survey Food Security Supplement* [11].

Definition

According to the USDA [12], food security in a household is defined as when all household members have access to enough food (and resources) at all times to lead an active, healthy life. By contrast, food insecurity means that there is a lack of, or limited amount of, food (and resources); some or all household members do not have access to enough foods at all times for an active, healthy life. Food security has two ranges of

severity: high food security (no problems or limitations to food access) and marginal food security (one or two reports, usually related to anxiety, but no indication of food access or food intake issues). Food insecurity has two ranges of severity: low food security (reduced quality of diet, but no indication of reduced food intake) and very low food security (multiple indications of reduced food intake, reduced quality of diet, lacking variety in diet - not by choice).

Measuring Tools

The U.S. Household Food Security Survey Module (U.S. HFSSM) is the validated, reliable survey tool used to measure household food security status in the U.S. Validity of food security surveys is measured by comparing food insecurity results with demographic, social, and economic factors associated with food insecurity [13]. The U.S. HFSSM adopted its questions from the "core food security module" which was developed in 1992 from other modules already developed, including, the Community Childhood Hunger Identification Project (CCHIP) and the Radimer/Cornell hunger scale, developed in the 1980s-90s, which comprised the core food security module [14, 15].

The U.S. HFSSM (core food security module) consists of 10 questions related to adult's food security experiences within the past 12 months; an additional 8 questions related to children's food security experiences (for households with children) within the past 12 months, for a total of 18 questions. Other questions related to food security, food sufficiency, food expenditures, use of food programs, and coping mechanisms can be

found in the CPS Food Security Supplements. A shortened version of the core food security module consists of 6 questions, which is used in surveys that cannot implement the 18-question or 10-question survey. The shortened version while reasonably reliable is less precise and does not measure the most severe levels of food insecurity and does not ask about conditions of children in the household. All of these survey tools are available on the USDA website [16].

Food Insecurity Worldwide

Approximately one billion people in the world experience food insecurity [17], which is about 1 in 7 people who do not have enough food at all times to lead an active, healthy life, globally [18]. If people who experience undernourishment (vitamin/mineral deficiencies) are included in this population as well, then two billion people experience food insecurity. Although not readily used, the term - *hidden hunger* is hunger that involves vitamin and mineral deficiencies not physically apparent or obvious in people [19]. Bangladesh, China, the Democratic Republic of Congo, Ethiopia, India, Indonesia and Pakistan are among the countries that experience the highest prevalence of food insecurity, and account for the majority of the world's undernourished population.

Food Insecurity in the U.S.

In the U.S., 17.6 million households (14.5% of the U.S. population) experienced food insecurity at some time during the year in 2012 [20]. The prevalence of food insecurity in the U.S. has been predominantly the same since 2008, according to the USDA's

Economic Research Service (ERS) food security reports conducted in 2012. In 2001, food insecure households in the U.S. increased, continued to increase from 2002-2004, then decreased and leveled out from 2005-2007 [21]. From 2003-2004, the prevalence of food insecurity in the U.S. increased by 0.7% (11.2% to 11.9%) [22]. Food insecurity status of U.S. households in 2012 was 14.5% (8.8% low food security; 5.7% very low food security). Nationally, from 2011-2012 food insecurity prevalence was not statistically significant (14.9% to 14.5%) because sampling variation may have caused this change. Food insecurity status of U.S. households with children in 2012 was 20.0% (10.0% food insecurity among adults only; 8.8% low food security among children; 1.2% very low food security among children). From 2011-2012, food insecurity status among U.S. households with children did not show a statistically significant increase (1.0% to 1.2%).

Food Insecurity in Ohio

In Ohio, the prevalence of food insecurity is marginally higher than reported nationally. In 2002, Ohio was ranked 30th in the nation for overall most food insecure (29 other states more food insecure) and in 2012, Ohio ranked 10th in the nation for most food insecure (9 other states more food insecure). Information relating to the actual cost of food in Ohio relative to the cost of food in other states was used to create a pricing index in 2012, which compared the cost of food in Ohio to the cost of food across the U.S. *Map the Meal Gap 2012* showed that Ohio's ratio of "cost-of-food in the state to the national average" was 0.925 times lower than the national average [23]. Thus, despite the cost of

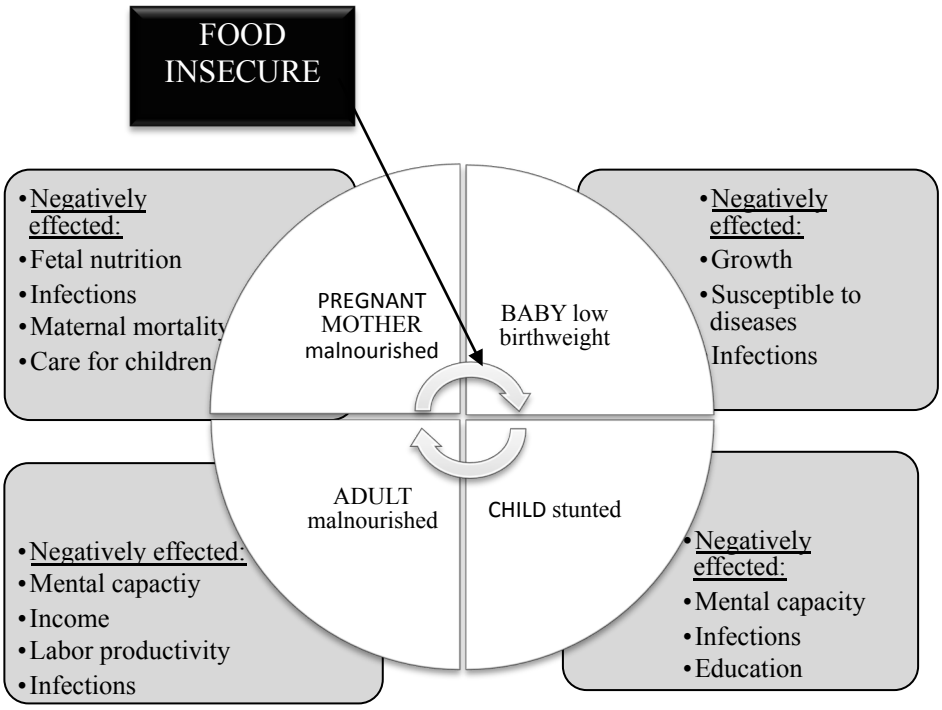
food in Ohio being lower than the national average, Ohio was still ranked 10th for the most food insecure in 2012. In addition, an estimated two million (n=2,083,240) Ohioans, or 18.1%, of the state's population (n=11,536,182) were food insecure in 2012. In comparison to the state of Ohio, Franklin County (Columbus, Ohio) had a food insecurity rate of 17.3% in 2012. Looking at Ohio's prevalence rates (average of a 3-year period) of 2000-2002 compared to 2010-2012, food insecurity increased by 6.3% (9.8% to 16.1%), a statistically significant change [24].

Food Insecurity is a Cycle

Food insecurity is a harsh cycle that continues to impact high-risk groups. Being food insecure can lead to adverse results for an individual or community. Looking at this cycle at the individual level can be compared to looking at under nutrition throughout the life cycle. For example, a malnourished woman who experiences food insecurity can become pregnant, give birth to a low birth weight child, who then grows up a malnourished child, experiences stunted growth in adolescence, and then develops into a malnourished adult and eventually a malnourished old person [25]. Hypothetically, an adult who experiences food insecurity will be less efficient at work, receive a lower income, and then purchase cheap, low nutrient dense, high calorie food which leads to children in the household eating these low nutrient dense, high calorie foods. As a result, an entire household actually suffers nutritional consequences due to food insecurity and may experience other ravages from poor nutrition as well. The cycle continues and worsens with every new

generation. Figure 1 below shows a modified version of the nutrition life cycle that was adapted from the ACC/SCN (2000) *Fourth Report on the World Nutrition Situation*.

Figure 1: Nutrition Life Cycle



Prevention of Food Insecurity

The USDA has nutrition assistance programs that help prevent food insecurity. For example, the Supplemental Nutrition Assistance Program (SNAP) is a program that

provides financial assistance (through monthly assistance via an electronic debit card) to low-income individuals and households in order to purchase nutritious foods. A large proportion of people who can benefit from SNAP are children, but adults and elderly can receive the benefits as well (qualifying criteria is based on income and resources, not age). Unlike SNAP, the Special Supplemental Nutrition for Women, Infants, and Children (WIC) Program is available to only a certain population, which, as the name implies, is women, infants and children (specifically pregnant women, breastfeeding women, non-breastfeeding postpartum women, infants, and children age 0-5). The Food and Nutrition Service provides funds to state agencies to pay for WIC services and foods. WIC is a national program and applicants must have low income to qualify (≤185% federal poverty). WIC aims to improve the nutritional health status of high risk (for receiving adequate nutrition), low-income mothers and children by providing vouchers for nutritious food and offering nutrition education or other social and health services free of charge [26, 27]. According to the USDA, 1999, WIC serves more than eight million participants per month. SNAP has been shown to improve food insecurity by reducing the likelihood of being food insecure by 30% and reducing the chance of being very food insecure by 20% [28].

Dental Caries and Food Insecurity

Health Outcomes

Poor pediatric oral health often results in high cost hospitalizations due to dental problems. Children with dental caries are more likely to have a recurrence of dental

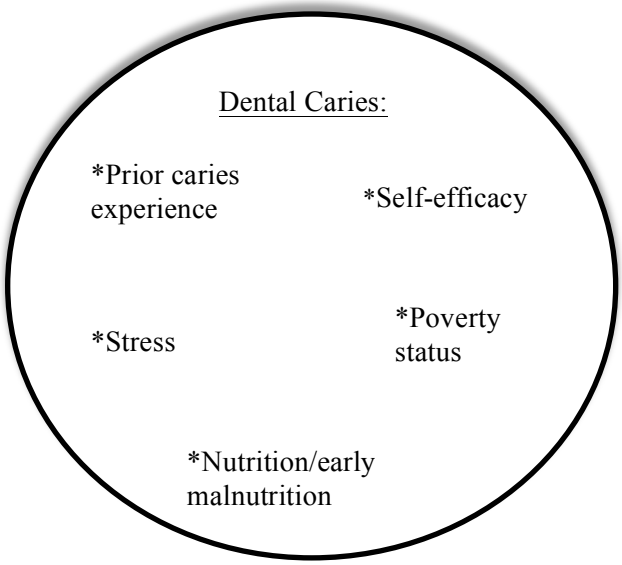
caries, which in turn leads to more dental visits, more costly procedures, and a higher toll on the health care system [29]. Similarly, children who experience food insecurity have greater chances of having stomach aches, headaches, fair to poor health, and being hospitalized since birth than food secure children [30, 31].

PEM (protein energy malnutrition) impacts 25% of children in the world and is associated with food insecurity. PEM is apparent in wasting, stunting, and underweight status, which are physical signs of poor nutrition in children. Reduced food intake leads to PEM, and reduced dietary quality can lead to micronutrient deficiencies; these are frequent events that food insecure households endure. PEM can be evaluated using a child's weight and height: weight-for-height Z-score (WHZ); height and age: height-for-age Z score (HAZ); weight and age: weight-for-age Z-score (WAZ). The Z-scores will determine which children are in the normal range versus those at risk for wasted or who are wasted (WHZ $\leq$1), those at risk for stunted or stunted (HAZ $\leq$1), and those at risk for underweight or underweight (WAZ $\leq$1) [32, 33, 34, 35, 36, 37, 38].

Factors Associated with Dental Caries

Figure 2 below shows the factors associated with dental caries.

Figure 2: Factors Associated with Dental Caries



Prior caries experience

ECC is a risk factor for future dental caries and ECC can lead to facial cellulitis, tooth loss or dental abscess. Long-term effects of ECC can negatively impact other areas of a child's life, such as an increase in school absences (related to tooth pain) and poorer academic performance.

Stress

In a study that evaluated how parental stress can impact children's oral health, Quinonez et al found that parents of young children with dental caries reported higher parental

stress. Parents under stress are less apt to spend time practicing good oral hygiene on their children or themselves [39, 40, 41].

Nutrition/ Early Malnutrition

Nutritional makeup of food, frequency of consumption of certain foods (namely sugary foods), composition of food, and the combination of foods plus order of eating foods, influence dental caries outcome [42]. One "moderate" malnutrition episode in infancy can lead to future dental caries. A longitudinal study that observed Peruvian children for several years (age <1 year old until 4 years old), found that children who were wasted (acute malnutrition) and stunted (past malnutrition) had a considerably higher average number of decayed teeth, extractions, and filled primary teeth at the age of 4 [43].

Poverty status

Preschoolers who live in poverty are 2-3 times more impacted by dental caries than preschoolers not in poverty, according to NHANES III 1986-1994 data [44].

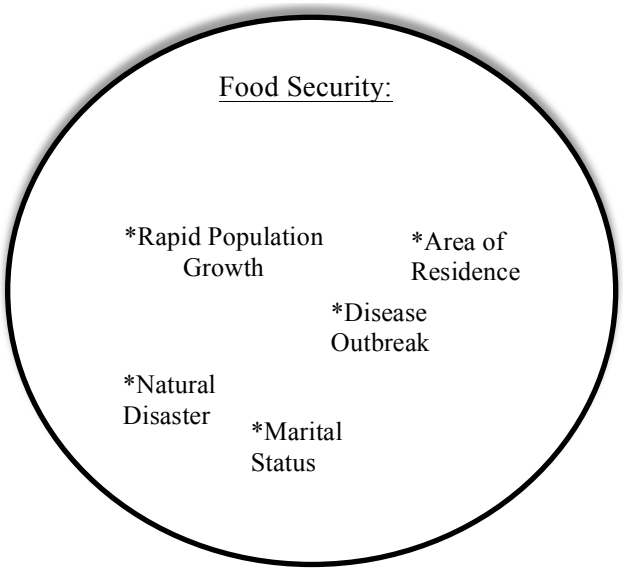
Self-efficacy

By definition, self-efficacy is confidence in the ability to perform self-care related to oral health behavior. Self-efficacy has been found to be a significant predictor of oral health behavior (poor self-efficacy is associated with greater dental caries) [45].

Factors Associated with Food Security

Figure 3 below shows the factors associated with food security; descriptions of each confounder follow this figure.

Figure 3: Factors Associated with Food Security



Marital status

The USDA reported the prevalence of food insecurity by selected households in 2012, which shows that all single parent households were above the national average for food insecurity (~15%). Over 35% of all single mother households were food insecure, greater than 20% than the national average of food insecure households.

Rapid population growth

A growth in the population often increases the demand for food, which in turn results in use of more land and water. By 2050, the demand for food is estimated to be twice as much due to population and economic growth. Africa experienced its first major drought about four decades ago; from around that time until the year 2000, the population more than doubled and is estimated to have increased 40% more by 2015. The population in Africa continues to grow while people continue to be negatively impacted by other factors (like prevalence of HIV/AIDS disease, low education, limited contraception) and food insecurity increases [46].

Natural disaster/outbreak of disease:

Infectious disease outbreaks can occur after a natural disaster; clean water can become contaminated with toxins/feces, crops can be destroyed, farming activity ceased, thus a scarcity of food ensues and food insecurity is a high risk. Floods can be detrimental in any area of the world. Droughts in Africa have caused the most severe famine in certain regions and seem to be getting worse and more frequent. Africa has experienced a drought about once per decade, for instance: droughts from 1973-74, 1984-85, 1987, 1992-94, 1999-2000 occurred.

Area of residence

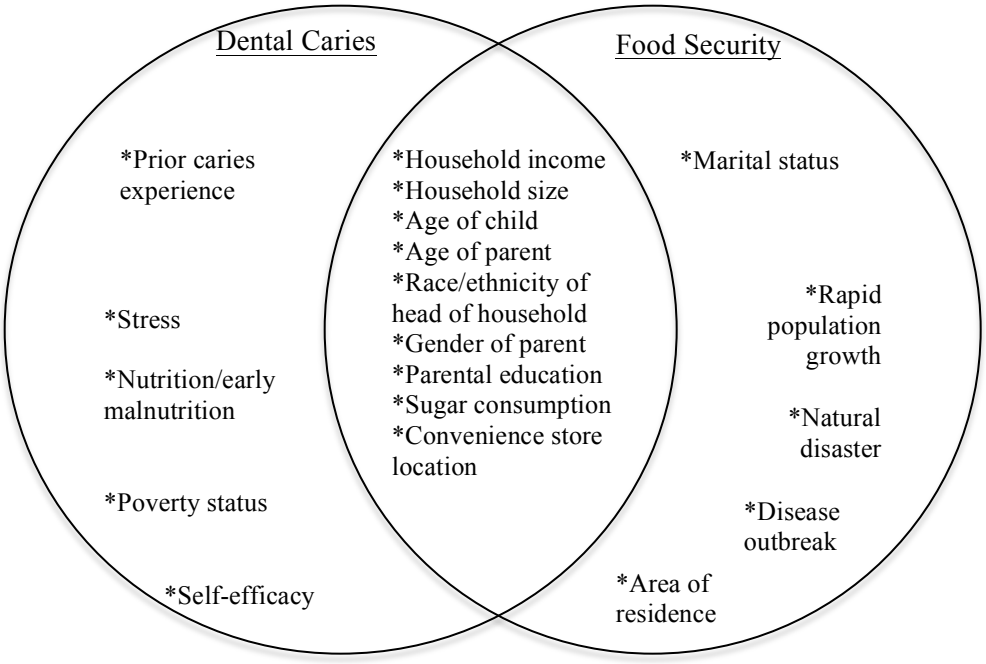
Living in a rural area has been associated with a higher chance of food insecurity. For instance, in Africa (except Uganda), people experience food insecurity because the poor

live in rural areas where there is little to no rainfall; when a climate change occurs, it is very difficult to find safe, adequate food to eat.

Factors Associated with Dental Caries and Food Security

Figure 4 below shows the factors associated with both dental caries and food security (common confounders); descriptions of each common confounder follow this figure.

Figure 4: Factors Associated with Dental Caries and Food Security



Household income

According to the USDA, in 2012, 41% of households below the federal poverty line were food insecure. About fourteen percent of households with incomes below 185% of the poverty line experienced very low food security in 2011, which was 8.5% higher than the national average (5.7%) [47]. Living in poverty may lead to unhealthy feeding practices and frequent consumption of low cost, poor nutrient, calorie dense food that does not provide a balanced diet; buying nonnutritious food may be a coping mechanism used by low income parents. Lower income households may experience lower meal frequency and a limited variety of foods in the diet. On the other hand, a small proportion of higher income households experience food insecurity as well. The 1995-1997 Current Population Survey responses showed that approximately 20% of food insecure households had midrange or higher incomes [48, 49]. A study that looked at food insecurity in higher income households found that about 5% of the food insecure households with high incomes experienced a household composition change the year before. This proportion of households consisted of the highest income households, which led Nord and Brent to believe that a composition change in the house largely contributed to other family problems, like limited food availability and not qualifying for a food assistance program [50]. Oral health quality of life can be negatively impacted by monthly household income [51]. Mitrakuk et al evaluated parental capability on children's oral health care and found a significant association between monthly income and dental caries; a lower monthly income is correlated with a poorer oral health [52].

Household size

Children part of larger families (≥3 children) experienced the highest prevalence and severity of food insecurity, over 15%, compared to children from smaller families (1 or 2 children), according to the USDA-ERS report for 2010-2011. Food insecure households with only 1 child had the smallest prevalence and severity of low food security, less than 8%, and very low food security, less than 2% [53].

Age of child

Younger children in food insecure households have been found to experience higher rates of hospitalization, iron deficiency anemia, behavioral problems (among 3 year olds), and lower math achievement (in kindergarten). Food insecurity tends to affect different household members at various levels with adults usually experiencing the most severe effects of food insecurity. Among U.S. food insecure households with children in 2006-2007, 12% of children experiencing the effects of food insecurity were age 0-4 years; this proportion basically stayed the same for 2010-2011, although a slight decrease of 0.3% (12% to 11.7%) occurred. Children age 0-4 years had the lowest prevalence and severity rate of food insecurity, around 6%, compared to all other children. In young children, dental care is the most common unmet health need; with children under age 6 receiving less than 50% of dental care services than children age 6-12 receive. When risk factors for tooth decay are not addressed in children with cavities already present, tooth decay often advances with age. Over a three-year period, from age 2 to 5 years old, dental caries prevalence increases by 33% (11% to 44%) [54].

Age of parent

In the U.S., young adults had low serum concentrations of lycopene, carotene, vitamins C, E, and their intakes of vitamins B-6, C, folate, iron, magnesium, zinc and protein were significantly below the RDA recommendation (< 50% of RDA) [55]. Elderly people had lower intakes of vitamin B-6, iron, zinc, magnesium, and energy needs according to NHANES III and Nutrition Survey in the state of New York [56].

Race/ethnicity of head of household

Households considered very low in food security consisted of 5.7% of the U.S. population in 2011; Black, non-Hispanic households were 4.8% higher (10.5%) and Hispanic households were 2.6% higher (8.3%) than the national average (5.7%).

Gender of parent

Females living alone experienced one of the greatest increases in very low food security prevalence from 2010-2011; food insecurity (low food security and very low food security) among this group was higher than the national average in 2011 and 2012. Females are the most predisposed to the effects of food insecurity in developing countries because of lower accessibility and control over resources than males [57]. Women in Africa and Asia make up the majority of small-scale farmers, yet they lack control over agricultural production and land ownership, which in turn makes them more susceptible to food insecurity. Of single parent households in 2012, most children lived with mothers; mothers' dental caries status is a strong predictor of child oral health, where

children with dental caries have mothers with poorer oral health versus children without any caries [58].

Parental education

Children with mothers of a lower education status (less than high school) are more likely to have dental caries. One study found that ECC incidence was 40% in preschool children with lower educated mothers versus 10% in preschool children of higher educated mothers [59]. Likewise, a low education level in women was associated with increased hunger in the U.S. [60].

Sugar consumption

Frequent consumption of simple carbohydrates (mostly in the form of dietary sugars) is significantly associated with increased dental caries risk [61]. A questionnaire-based cross-sectional study that looked at children's oral health found that a higher sugar consumption is associated with mothers of young children who are less educated and have a lower income [62].

Convenience store location

Being within close proximity to a convenience store has been associated with high dental caries [63] and food insecurity. Fruits and vegetables are more costly and less readily available at convenience store locations, compared to grocery stores [64]. Lower income

families are more likely to shop at convenience stores for reasons like transportation (i.e. may not own a car, therefore walk to nearest store).

Specific Aims

The purpose of this research is to evaluate the association between household food security and dental caries in young children. The association of food security with social determinants of health and the commonality of these with dental caries prompted this study of the relationship between early childhood caries and food security (see figure 4). Studies that focus on improving child tooth decay may benefit from this research and incorporate educational material to help teach parents about the importance of food security and proper nutrition. Below are aims that motivate this research:

1. Using a questionnaire-based design, determine if a significant association exists between household food security status and dental caries in children ages 2-4, specifically, in a high-risk population
2. Examine if any nutrients collected from the 24-hour dietary recall are correlated with food security status

CHAPTER 2: Methods

A cross-sectional questionnaire-based design was used to conduct this IRB-approved pilot study from April – May, 2014 at the Dental Clinic and the Dental Surgery Center (DSC) at the Nationwide Children's Hospital (NCH) in Columbus, Ohio. NCH – IRB approved this study on March 25, 2014. The questionnaire in this study was newly developed using validated sources (see Appendix A for the questionnaire).

Participants included parents or legal guardians of children (age 2-4) from the Dental Clinic (n=47) and the DSC (n=47). Patients from the clinic included those with dental caries and those without dental caries; patients from the DSC included only those with dental caries. Data was collected using a questionnaire, completed in a face-to-face interview with the participant. Interviews were used to collect the 24-hour dietary recall and capture child dietary intake, quality of the diet, and child dietary behaviors.

Recruitment

Participants were recruited inside the Dental Clinic waiting room and the DSC waiting room. They received a verbal explanation of the study, which included defining food security and describing the 24-hour dietary recall (collected by interviewing each

participant individually). In addition, a study information sheet was handed to the participant (Appendix B).

Parents from the DSC who were non-English speaking but still participated (n=2), used an interpreter to translate the questionnaire during the interview. Verbal consent to participate was acquired first, then each participant was assigned a unique identifier and parent/child information was collected and recorded in the subject identification log (Appendix C).

Study Questionnaire

The study coordinator went through each page of the questionnaire before issuing it to participants. Participants answered certain sections of the questionnaire independently through written self-report. These included parent demographics (section A), food security (section B), and child demographics (section D). However, participants who requested that questions be read aloud to them (n=3) were provided this service by the study coordinator.

Parent Demographics – section A

Parent demographic information included gender, age, race, Hispanic or Latino status, marital status, education level, and employment status. Parents also answered questions regarding monthly income (household), household size (subdivided into the number of adults and the number of children living in the household), where groceries were

purchased from most often, distance from home to the grocery store, car ownership, and area of residence.

Food Security – section B

Following this section, parents answered 18 food security questions, adapted from the U.S. Household Food Security Survey Module, which were used to determine household food security status. Questions 14-23 were related to the food insecurity experiences of the adults in the household; questions 24-31 were related to the child.

Child Demographics – section D

Parents had been instructed verbally (also written directions were provided on this page) to skip the 24-hour dietary recall and move on to section D. The study coordinator completed section C with the participant after section D. Child demographic information collected included gender, age, race, Hispanic or Latino status, and past medical history (any medical problem(s) or handicapped condition(s) were recorded here).

24-Hour Dietary Recall – section C

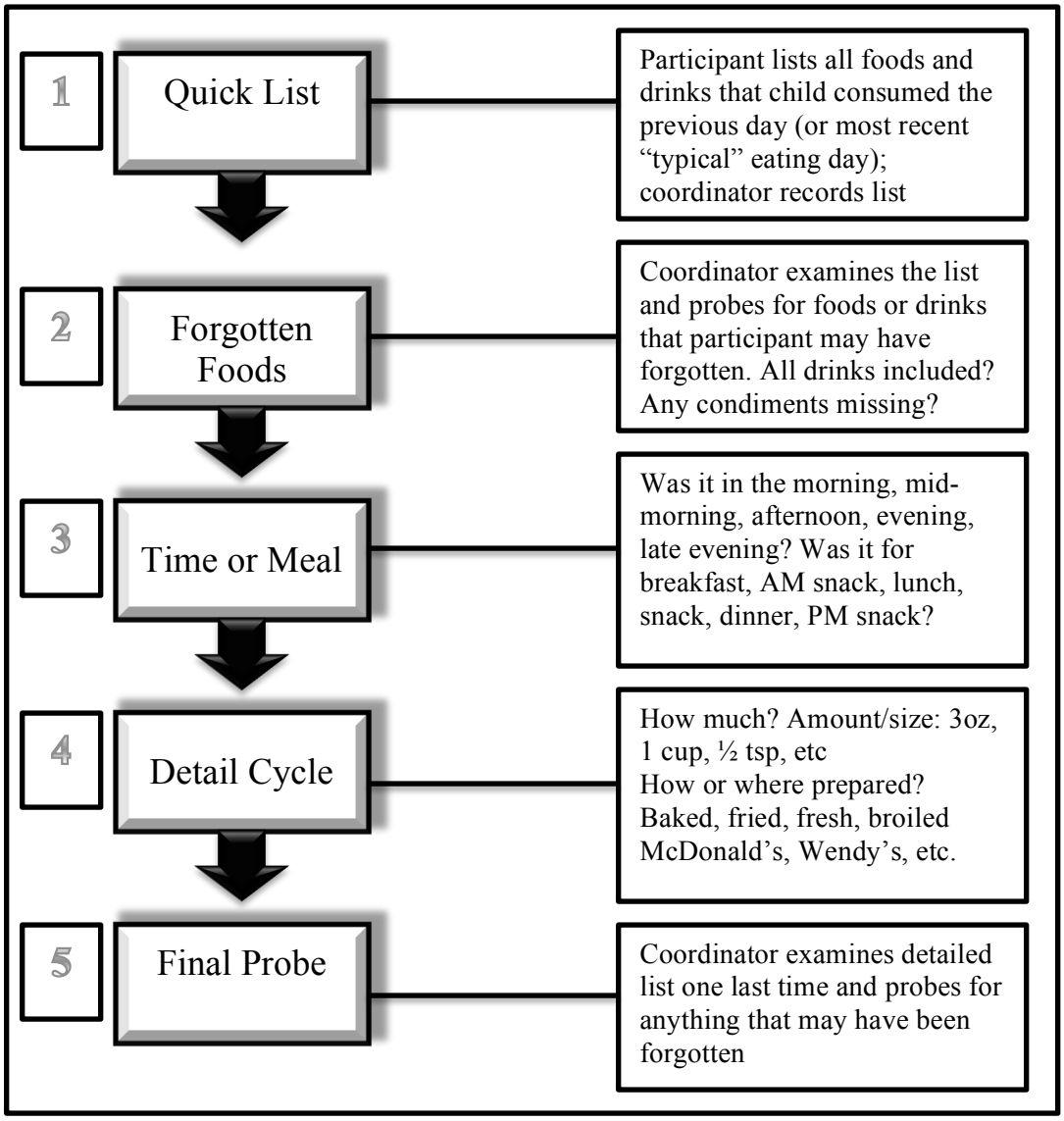
Parents reported back to the study coordinator after answering the child demographic questions. The 24-hour dietary recalls were collected in an interview between the coordinator and participant and were conducted in the waiting rooms or outside the waiting rooms in a quiet place nearby (the hallway). The template used for the dietary

recall was adapted from a validated baseline/pretest document used by Florida International University.

Multiple-Pass Method

Prior to study commencement, the study coordinator was trained in how to conduct a dietary recall using the USDA Multiple-Pass Method. The Multiple-Pass Method involves five steps. Figure 5 below exemplifies how the Multiple Pass Method was used in this study.

Figure 5: Multiple Pass Method



Dietary Recall Training

In addition, the coordinator received in-person experience and dietary recall training at the NCH – Center for Healthy Weight and Nutrition from registered dieticians. Dietary recall information collected included everything that the child had to eat and drink over a period of 24-hours that the parent listed and described. Specifically, parents listed and described all food/drink items, starting from when the child first woke up right until before going to bed the previous day. However, if the previous day did not reflect a "typical" day of eating/drinking for the child, then the most recent "typical" day was recalled (instead of the previous day) and the same process described was used.

Dietary Behavior

In addition, parents answered several questions about the child's typical dietary behaviors. Daily dietary behavior questions asked parents about water consumption (yes/no), source of water (bottled/tap/both), and frequency of consumption (1-2 times/2-3 times/3-4 times/continuously). Also, questions were asked about other drinks beside water, the types of drinks, and how frequently these drinks were consumed. Parents answered questions regarding the types of snacks consumed and the frequency of snacking. These nutrition-related questions were adapted and modified from the Dental Clinic – O.S.C.A.R. form and collected and recorded by the study coordinator on the 24-hour dietary recall page. Table 1 below shows these dietary behavior questions.

Table 1: Child Dietary Behaviors

Item	Related to	Dietary Behavior Question	Option Choices
1	Water	*Does the child drink water?*	Yes/ No
2	Water	*What is the source of water?*	Bottled/ Tap/ Both
3	Water	*How frequently (times per day) is water consumed?*	1-2 times/ 2-3times/ 3-4 times/ Continuously
4	Other Drinks	*Does the child drink other drinks besides water?*	Yes/ No
5	Other Drinks	*What are the types of drinks that the child mostly has? (choose all that apply)*	Milk/ Chocolate milk/ Juice/ Pop/ Kool-Aid/ Sugar-free drink/ Other
6	Other Drinks	*How frequently (times per day) does the child drink other drinks? (choose all that apply)*	1-2 times/ 2-3times/ 3-4 times/ Continuously
7	Nap/Night Drinks	*Does the child drink at nap time and/or nighttime?*	Yes/ No
8	Nap/Night Drinks	*What are the types of drinks that the child mostly has at this time? (choose all that apply)*	Water/ Milk/ Chocolate milk/ Juice/ Pop/ Kool-Aid/ Sugar-free drink/ Other
9	Snacking	*Does the child snack?*	Yes/ No
10	Snacking	*What are the types of snacks that the child mostly has?(choose all that apply)*	Fruit/ Starch/ Dairy/ Meats/ Vegetables/ Sugary/ Other
11	Snacking	*How frequently (times per day) does the child snack? (choose all that apply)*	1-2 times/ 2-3times/ 3-4 times/ Continuously

O.S.C.A.R. Form for Dental Caries

The O.S.C.A.R. form is completed by the dental hygienist and the patient's caregiver during the dental clinic appointment. Also, the form includes the Caries Risk Assessment

tool, which shows the number of carious teeth. Each patient's tooth chart (part of the O.S.C.A.R. form) was evaluated to determine dental caries status; the dental caries and dental watches* were recorded in the Subject Identification Log (under "Dental Caries (Y/N); #" and "Dental Watches (Y/N); #"). See Appendix D for the tooth chart (brief instructions are included in order to read this hypothetical patient tooth chart).

*Dental watches are early dental caries marked by white decalcification but no cavitation

Gift Card Receipt

All sections of the questionnaire were checked for completeness by the study coordinator so that no questions were left unanswered. Participant involvement concluded when the gift card receipt form was completed; thereupon participants received either a Wal-Mart or Kroger gift card in the amount of $15.00.

Data input – REDCap

Study data (parent demographics, food security, and child demographics) that was collected through the completed participant questionnaires (paper-based) was entered into the software program REDCap (Research Electronic Data Captured) version 5.5.5. REDCap is a web-based application that is used for managing surveys. Data collected from the 24-hour dietary recall was entered into a nutrition software program (explained in the following paragraph) and not entered into REDCap. The NonPHI instance of REDCap, through The Ohio State University Medical Center, was used due to the restriction of non-hospital employees being able to access the regular REDCap

application. Therefore, entering the DOB (date of birth) and the date of enrollment (located on the subject identification log) was not permitted. Patient age in years was used instead of birthdate for the purposes of this study, this level of detail did not make a difference and using this application made data entry sufficient and decreased the chance of error when entering data. Data from REDCap was exported to SAS/STAT software, version 9.3, for statistical analyses.

NutriBase Professional

Study data collected from the completed participant questionnaires (paper-based) was entered into the NutriBase 11 Professional Nutrition and Fitness Software©, 8-day trial version (a free trial that permitted the use of Nutribase© for eight consecutive days). Nutribase© is an application that can be used by anyone (commonly used by fitness and nutrition professionals) for nutrition and fitness help or as a marketing tool. For the purposes of this study, NutriBase© was used to analyze the 24-hour dietary recalls from the partipants and provided the nutrient data for each participant's food record. NutriBase© allows users the ability to select which nutrients are to be generated. Macronutrients and micronutrients were selected on NutriBase© first. Then all foods/drinks from a participant's food record were entered into the "food log" area of NutriBase©. Finally, nutrient data was generated and accessed through the "summary report" form and an Excel spreadsheet. All of the participants' nutrient data that was generated was compiled into a single Excel spreadsheet for statistical analyses.

Study Population

Parents of patients at the Dental Clinic and DSC participated in this study by completing a questionnaire and in-person interview. Prospective participants were recruited based on the age of the child; inclusion and exclusion criteria had to be met prior to entering this study. Inclusion criteria included children ages 2, 3, or 4 who were healthy enough to receive routine dental care. Also, parents/legal guardians had to be English-speaking and participation was limited to once. When a parent had more than one child who qualified, then only one child was chosen at random and all answers to the questionnaire and interview were based on that child. Exclusion criteria included parents/legal guardians who were not the main caretakers and/or could not provide detailed information about the child's dietary intake/eating habits. Any child with medical problem(s) and/or handicap problem(s) was excluded, with the exception of a mild problem or a condition that did not affect the results of this study. For example, a child with seasonal allergies (no medications) was included versus a child who had severe medical problems and took medicine daily.

Sample Size Calculation

The Center for Clinical and Translational Science (CCTS) at The Ohio State University approved coverage for biostatistical support throughout this study. Biostatisticians, Greg Young and Jenny Ogden, from the Center for Biostatistics, provided these statistical services. Sample size (n=94) was calculated using PASS[12] (Power Analysis & Sample Size Software) [135]. The sample size calculation was based on the responses to the U.S.

Household Food Security Survey Module (section B) from the questionnaire and the division of patients into two groups, defined as "food secure" or "food insecure". It was anticipated that these groups would be of roughly equal size in the sample. This 50:50 ratio assumption can be justified based on this being a pilot study. Based on investigator experience, 40% of the patients seen in the dental clinic have dental caries by age 4. A dental caries rate of 25% in the food secure group was assumed. Calculating sample size based on two independent proportions using PASS[12], 47 patients per group would yield 80% power to detect a rate of 53% in the food insecure group (two-sided test, $\alpha = 0.05$). Initially, the study population included patients from the dental clinic only. However, the study population changed to include patients from the dental surgery center as well. Therefore, based on the estimates provided (equal sized groups of food secure and food insecure), the sample size had to have patients with dental caries from the dental surgery center (n=47) and patients with dental caries from the dental clinic (n=19); and patients without dental caries from the dental clinic (n=28). The DSC patients were included in the study population because participant recruitment is more feasible and participant retention is more likely. The amendment was submitted to the Nationwide Children's Hospital – IRB and approved on April 7, 2014. See Appendix E for the amendment.

Statistical Analysis

Parent and child demographics, as well as 24-hour dietary recall characteristics across dental caries (Yes (presence of caries) versus No (absence of caries)) were compared using univariate logistic regression. Fisher's exact test was used to test significance for

two variables from the dietary recall, which were “does the child drink water” and “does the child drink other drinks besides water”, due to small cell counts. All variables were presented as counts and percentages by dental caries (table 2, 3, 4). In order to account for small cell counts, a few variables were adjusted from the questionnaire. Those included parent’s race, parent’s education, monthly income (household), child’s race, daily water consumption, and daily drink consumption (drinks besides water). Household food security status was determined using the coding responses and assessment tool from the USDA’s Food Security Survey Module. Based on questions from the survey, a raw score was calculated and a household was labeled food secure or food insecure based on this score. See Appendix F for the coding responses. To assess the relationship of dental caries to the various demographic variables, univariate logistic regression was used to first assess each predictor. Before fitting the final model, multicollinearity among the predictor variables was checked. A final multivariable was fit to the data and the predictors used were age of child and daily water consumption. All analyses were run using SAS/STAT software, version 9.3.

CHAPTER 3: Results

The study sample included 96 children (age 2-4), but 2 children were excluded (1 child had severe medical problems; 1 child's parent had an incomplete questionnaire), thus a total of 94 children were included in the analysis. There were 65 patients (69%) with dental caries (current or past) and 29 patients (31%) without dental caries. Of the 65 patients with dental caries, 18 (28%) were from the Dental Clinic and 46 (72%) were from the DSC. Of the 29 patients without dental caries, 29 (100%) were from the dental clinic and 0 patients were from the DSC. The hypothesis that there is an association between food security and dental caries was assessed and the results from the univariable model indicated no significant association between the two (p-value = 0.61). The odds ratio indicates that the odds of having dental caries are 1.27 times higher for households that are food secure than for households that are food insecure. Because food security was not significant, it was not used as a predictor in the final multivariable model. See Table 2 below.

Table 2: Child Dental Caries

	Dental Caries			
	Yes	**No**	**OR (95% CI)***	**p value**
# of Patients	65 (69%)	29 (31%)		
Location				
Dental Clinic	18 (28%)	29 (100%)		
DSC	46 (72%)	0		
Food Security				
Food Secure	46 (71%)	19 (66%)	1.27(0.50, 3.24)	0.6110
Food Insecure	19 (29%)	10 (34%)	1.00 (REF)	
*Estimated odds ratios for having dental caries, 95% confidence intervals and p-values also indicated.				

Child Demographics

Overall in the study, mean age was 3.2 years (standard deviation=3.8). Specifically, of the 65 patients with dental caries, 8 (12%) were age 2, 27 (42%) were age 3, and 30 (46%) were age 4. Of the 29 patients without dental caries, 10 (34%) were age 2, 13 (45%) were age 3, and 6 (21%) were age 4. There were 41 females (44%) and 53 males (56%) in this study. Of patients with dental caries, 30 (46%) were females and 35 (54%) were males. Of patients without dental caries, 11 (38%) were females and 18 (62%) were males. Overall, 50% of the patients were white, 20% were black, 6% were Hispanic or Latino, and 30% were "Other" (included African descent, Arabian, Asian, biracial, Somalia descent). Within the cohort of patients with dental caries: 54% (n=35) were White, 15% (n=10) were black, 8% (n=5) were Hispanic or Latino, and 31% (n=20) were other. For patients without dental caries, 41% (n=12) were white, 31% (n=9) were black, 4% (n=1) was Hispanic or Latino, and 28% (n=8) were other. Sixty-five children total had dental caries in this study, 11 (17%) had medical problems and 54 (83%) had no

medical problems. Of the 29 children without dental caries, 4 (14%) had medical problems and 25 (86%) had no medical problems. See Table 3 below.

Table 3: Child Demographics by Dental Caries

	Dental Caries			
	Yes	**No**	**OR (95% CI)***	**p value***
Child Demographics				
Age				0.0192
2	8 (12%)	10 (34%)	REF	
3	27 (42%)	13 (45%)	2.60 (0.83, 8.13)	
4	30 (46%)	6 (21%)	6.25 (1.74, 22.43)	
Sex				0.4586
Female	30 (46%)	11 (38%)	1.40 (0.57, 3.43)	
Male	35 (54%)	18 (62%)	REF	
Ethnicity				0.4598
Hispanic/Latino	5 (8%)	1 (4%)	2.29 (0.26, 20.54)	
Not Hispanic/Latino	59 (92%)	27 (96%)	REF	
Race				0.2215
White	35 (54%)	12 (41%)	2.63 (0.86, 8.00)	
Black	10 (15%)	9 (31%)	REF	
Other	20 (31%)	8 (28%)	2.25 (0.67, 7.61)	
Medical Problems				0.7024
Yes	11 (17%)	4 (14%)	1.27 (0.37, 4.39)	
No	54 (83%)	25 (86%)	REF	

Data are number of patients (%). *Estimated odds ratios for having dental caries, 95% confidence intervals and p values also indicated.

Parent Demographics

The mean age of parents of children with dental caries was 29.35 (sd= 8.24); parents mean age was 30.72 (sd= 6.32) for those with children without dental caries. Of the 94 parents in this study, 83 were females (88.3%) and 11 were males (11.7%). Parents of children with caries were: 58 (89%) female and 7 (11%) male. Parents of children without caries were: (86%) females and 4 (14%) males. Race and ethnicity distributions

for parents of children with caries are as follows: 60% Hispanic/Latino, 92% not Hispanic/Latino, 65% white, 20% black, 15% other (included African descent, Arabian, Asian, biracial, Somalia descent). Parents of children without caries had the following race and ethnicity: 3% Hispanic/Latino, 97% not Hispanic/Latino, 45% white, 31% black, 24% other. Among parents of children with caries, 52% (n=34) were single, 38% (n=25) were married, 5% (n=3) were divorced/widowed, and 5% (n=3) were in a domestic partnership /separated. Parents of children without dental caries were as follows: 41% (n=12) were single, 45% (n=13) were married, 10% (n=3) were divorced/widowed, and 3% (n=1) was in a domestic partnership/separated. Parents of children with dental caries had the following education levels: 49% (n=32) had some high school or a GED, 37% (n=24) had 1-2 years of college education, and 14% (n=9) had graduated college. In comparison, parents with children without dental caries, 28% (n=8) had some high school or a GED, 52% (n=15) had 1-2 years of college education, and 21% (n=6) had graduated college. Among parents of children with dental caries, 24 (37%) were not working, 13 (20%) were working part-time, 25 (38%) were working full-time, and 3 (5%) were on disability. Among parents of children without dental caries, 6 (21%) were not working, 8 (28%) were working part-time, 12 (41%) were working full-time, and 3 (10%) were on disability. See Table 4 below.

Table 4: Parent Demographics by Dental Caries

	Dental Caries			
	Yes	**No**	**OR (95% CI)***	**p value***
Count	65 (69%)	29 (31%)		
Location				
Dental Clinic	18 (28%)	29 (100%)		
Dental Surgery Center	46 (72%)	0		
Food Security				0.6110
Secure	46 (71%)	19 (66%)	1.27 (0.50, 3.24)	
Insecure	19 (29%)	10 (34%)	REF	
Parent Demographics				
Age mean ± sd	29.35 ± 8.24	30.72 ± 6.32	0.98 (0.93, 1.03)	0.4272
Sex				0.6743
Female	58 (89%)	25 (86%)	1.33 (0.36, 4.94)	
Male	7 (11%)	4 (14%)	REF	
Ethnicity (Head of Household)				0.4490
Hispanic/Latino	5 (60%)	1 (3%)	2.33 (0.26, 20.92)	
Not Hispanic/Latino	60 (92%)	28 (97%)	REF	
Race (Head of Household)				0.2047
White	42 (65%)	13 (45%)	2.26 (0.72, 7.13)	
Black	13 (20%)	9 (31%)	1.01 (0.28, 3.66)	
Other	10 (15%)	7 (24%)	REF	
Marital Status				0.6312
Single	34 (52%)	12 (41%)	1.47 (0.58, 3.77)	
Married	25 (38%)	13 (45%)	REF	
Divorced/Widowed	3 (5%)	3 (10%)	0.52 (0.09, 2.95)	
Other (Domestic Partnership/Separated)	3 (5%)	1 (3%)	1.56 (0.15, 16.53)	
Education (Head of Household)				0.1542
Some high school/GED	32 (49%)	8 (28%)	2.67 (0.73, 9.70)	
1-2 years college	24 (37%)	15 (52%)	1.07 (0.32, 3.61)	
Graduated college	9 (14%)	6 (21%)	REF	
Employment				0.3730
Not working	24 (37%)	6 (21%)	2.46 (0.70, 8.64)	
Working part-time	13 (20%)	8 (28%)	REF	
Working full-time	25 (38%)	12 (41%)	1.28 (0.42, 3.92)	
On disability	3 (5%)	3 (10%)	0.62 (0.10, 3.82)	

Data are number of patients (%). *Estimated odds ratios for having dental caries, 95% confidence intervals and p values also indicated. ** Due to small cell counts or no cell count, significance testing was not performed.

Household Demographics

Seven questions relating to the household were asked which included monthly household income, number of adults living in the household (age 18 and older), number of children living in the household (age 17 and younger), where groceries were mostly purchased from (grocery store or a convenience store), the distance from home to the grocery store,

whether the household owns a car (yes or no), and the geographical area of the area of residence (urban, rural, or suburban). See Table 5 below.

Table 5: Household Demographics by Dental Caries

	Dental Caries			
	Yes	**No**	**OR (95% CI)***	**p value***
Monthly Household Income				0.5086
Less than $2,000	44 (68%)	16 (55%)	1.65 (0.35, 7.71)	
$2,001 - $4,000	16 (25%)	10 (34%)	0.96 (0.19, 4.92)	
Greater than $4,000	5 (8%)	3 (10%)	REF	
# of children in household				0.2268
Less than or equal to 2	41 (63%)	22 (76%)	REF	
Greater than 2	24 (37%)	7 (24%)	1.84 (0.69, 4.94)	
# of adults in household				0.1582
Less than or equal to 2	50 (77%)	26 (90%)	REF	
Greater than 2	15 (23%)	3 (10%)	2.60 (0.69, 9.80)	
Groceries purchased				**
Convenience/Corner store	0	1 (3%)	**	
Grocery store	65 (100%)	28 (97%)	**	
Distance to grocery store				0.0486
Less than 1 mile	13 (20%)	4 (14%)	REF	
Between 1-5 miles	34 (52%)	23 (79%)	0.46 (0.13, 1.57)	
More than 5 miles	18 (28%)	2 (7%)	2.77 (0.44, 17.46)	
Own a car				0.8414
Yes	55 (85%)	25 (86%)	REF	
No	10 (15%)	4 (14%)	1.14 (0.33, 3.98)	
Geographical Area				0.1107
Urban	42 (65%)	24 (83%)	REF	
Rural	18 (28%)	2 (7%)	5.14 (1.10, 24.10)	
Suburban	5 (8%)	3 (10%)	0.95 (0.21, 4.34)	

Data are number of patients (%). *Estimated odds ratios for having dental caries, 95% confidence intervals and p values also indicated. ** Due to small cell counts or no cell count, significance testing was not performed.

Child Dietary Behaviors

The significant predictors of dental caries from the univariable logistic regressions were distance to a grocery store (p-value = 0.05), age of child (p-value = 0.02), whether the child drinks water (p-value = 0.02), daily water consumption (p-value < 0.0001), whether the child drinks other drinks besides water (p-value = 0.03), whether the child drinks juice (p-value = 0.04), daily drink consumption besides water (p-value = 0.0005), does the child snack on starchy foods (p-value = 0.02), does the child snack on vegetables (p-value = 0.01) and does the child snack on sugary foods (p-value = 0.003). Due to the small number of patients without dental caries, the multivariable model was limited to two predictors. Four multivariable models were built (table 6, 7, 8, and 9) including four different predictors: daily water consumption, sugary snacks (daily), daily drink consumption (besides water), and juice consumption (daily). Age was included in each of these four models in order to adjust for exposure time to dental caries. Each multivariable model indicates that after adjusting for age, the effect of the other predictor remains significant. Each model has an estimated odds ratio, 95% confidence interval and p-value for the final multivariable model for dental caries (n=94). See Tables 6, 7, 8, 9 and 10 below.

Table 6: Child Dietary Behaviors by Dental Caries

	Dental Caries			
	Yes	No	OR (95% CI)*	p value*
24-hour Dietary Recall				
Does the child drink water				0.0155
Yes	53 (82%)	20 (100%)	**	
No	12 (18%)	0	**	
Source of water				0.9402
Bottled	22 (42%)	11 (38%)	1.20 (0.43, 3.32)	
Tap	20 (38%)	12 (41%)	REF	
Both	11 (21%)	6 (21%)	1.10 (0.32, 3.75)	
Daily water consumption				< 0.0001
0-4 times	40 (62%)	3 (10%)	13.87 (3.80, 50.64)	
Continuously	25 (38%)	26 (90%)	REF	
Does the child drink other drinks besides water				0.0252
Yes	65 (100%)	25 (89%)	**	
No	0	3 (11%)	**	
Types of drinks child mostly has				
Milk	42 (65%)	14 (48%)	1.96 (0.81, 4.76)	0.1386
Chocolate Milk	17 (26%)	3 (10%)	3.07 (0.82, 11.45)	0.0951
Juice	48 (74%)	15 (52%)	2.64 (1.06, 6.58)	0.0378
Pop	15 (23%)	0	**	**
Kool-Aid	13 (20%)	6 (21%)	0.96 (0.32, 2.84)	0.9384
Sugar-Free Drink	11 (17%)	1 (3%)	5.70 (0.70, 46.46)	0.1037
Other	19 (29%)	12 (41%)	0.59 (0.24, 1.46)	0.2494
Daily drink consumption (besides water)				0.0005
0-4 times	23 (35%)	22 (76%)	REF	
Continuously	42 (65%)	7 (24%)	5.74 (2.13, 15.46)	
Does the child drink at night				0.6610
Yes	26 (40%)	13 (45%)	REF	
No	39 (60%)	16 (55%)	1.22 (0.50, 2.95)	
Types of drinks child mostly has at night				
Milk	10 (15%)	4 (14%)	1.14 (0.33, 3.98)	0.8414
Chocolate Milk	6 (9%)	2 (7%)	1.37 (0.26, 7.25)	0.7090
Juice	3 (5%)	0	**	**
Pop	2 (3%)	0	**	**
Kool-Aid	1 (2%)	1 (3%)	0.44 (0.03, 7.25)	0.5639
Sugar-Free Drink	3 (5%)	0	**	**
Other	0	1 (3%)	**	**
Does the child snack				0.5639
Yes	64 (98%)	28 (97%)	2.29 (0.14, 37.85)	
No	1 (2%)	1 (3%)	REF	
Types of snacks child mostly has				
Fruit	33 (51%)	13 (45%)	1.27 (0.53, 3.06)	0.5949
Starch	27 (42%)	20 (69%)	0.32 (0.13, 0.81)	0.0161
Dairy	19 (29%)	8 (28%)	1.08 (0.41, 2.87)	0.8707
Meats	3 (5%)	4 (14%)	0.30 (0.06, 1.45)	0.1348
Vegetables	1 (2%)	4 (14%)	0.10 (0.92)	0.0418
Sugary	50 (77%)	13 (45%)	4.10 (1.62, 10.42)	0.0030
Other	0	0	**	**
Daily snack consumption				0.5011
1-2 times	19 (30%)	10 (36%)		
2-3 times	24 (38%)	9 (32%)	1.43 (0.39, 5.27)	
3-4 times	13 (20%)	3 (11%)	2.00 (0.54, 7.39)	
Continuously	8 (13%)	6 (21%)	3.25 (0.63, 16.79)	

Table 7: Daily Water Consumption

Predictor	Odds Ratio*	95% CI	p value
Child's Age			0.0082
2	REF		
3	4.03	(0.88, 18.39)	
4	13.19	(2.53, 68.76)	
Daily water consumption			<0.0001
0-4 times	21.11	(4.86, 91.19)	
Continuously	REF		

*Estimated odds ratios for having dental caries

Table 8: Sugary Snacks

Predictor	Odds Ratio*	95% CI	p value
Child's Age			0.0282
2	REF		
3	3.49	(1.01, 12.05)	
4	5.96	(1.57, 22.66)	
Sugary snacks			0.0057
Yes	4.15	(1.51, 11.41)	
No	REF		

*Estimated odds ratios for having dental caries

Table 9: Daily Drink Consumption

Predictor	Odds Ratio*	95% CI	p value
Child's Age			0.0031
2	REF		
3	10.67	(1.90, 59.84)	
4	24.33	(3.85, 153.66)	
Daily drink consumption (besides water)			0.0004
0-4 times	REF		
Continuously	16.21	(3.50, 75.01)	
*Estimated odds ratios for having dental caries			

Table 10: Juice Consumption

Predictor	Odds Ratio*	95% CI	p value
Child's Age			0.0177
2	REF		
3	2.43	(0.75, 7.87)	
4	6.78	(1.80, 25.53)	
Juice			0.0314
Yes	2.94	(1.10, 7.87)	
No	REF		
*Estimated odds ratios for having dental caries			

Dietary Nutrients

Table 11 displays descriptive statistics of the 24-hour dietary recall showing the dietary nutrients that were measured. Table 12 displays descriptive statistics by food security as well as the associated p-values based on the Wilcoxon rank-sum test. At the alpha = 0.05 level, there were no statistical differences in the 54 dietary characteristics between food secure and food insecure. Table 13 displays descriptive statistics by dental caries as well

as the associated p values based on the Wilcoxon rank-sum test. There were two significant dietary variables, caffeine and vitamin A IU, where p = 0.02 and 0.03, respectively. Thus, we can say that there is a significant difference in caffeine and vitamin A IU between the patients with dental caries and the patients without dental caries. See Tables 11, 12, and 13 below (each table continues onto the following page).

Table 11: Dietary Nutrients Measured

	n	mean ± sd	median	Q1, Q3	(min, max)
Calories	94	1578.48 ± 445.32	1527	1275, 1805	(727, 3574)
Protein (g)	94	57.05 ± 19.90	56	43, 66	(20, 116)
Calories/Protein	94	231.94 ± 81.54	223	177, 270	(81, 471)
% Calories/Protein	94	14.82 ± 4.16	14	12, 16	(7, 31)
Carbs (g)	94	224.70 ± 70.74	219	177, 259	(92, 589)
Starch (g)	94	22.62 ± 26.25	18	0, 36	(0, 143)
Sugars (g)	94	105.74 ± 45.27	102	76, 128	(0, 305)
Fiber (g)	94	11.61 ± 7.31	10	8, 14	(0, 54)
Calories/Carb	94	865.32 ± 275.04	845	676, 1011	(368, 2300)
% Calories/Carb	94	54.92 ± 7.55	55	49, 60	(39, 72)
Fat (g)	94	52.74 ± 19.22	51	40, 63	(16, 122)
Saturated Fat (g)	94	18.33 ± 7.85	18	14, 22	(0, 44)
Trans Fat (g)	94	0.89 ± 1.25	1	0, 1	(0, 8)
Mono Fat (g)	94	9.47 ± 7.38	7.5	5, 12	(0, 41)
Poly Fat (g)	94	4.87 ± 4.30	4	2, 7	(0, 22)
Omega3 (g)	94	0.13 ± 0.37	0	0, 0	(0, 2)
Omega6 (g)	94	1.96 ± 2.98	1	0, 3	(0, 14)
Calories/Fat	94	481.22 ± 173.39	464	364, 580	(149, 1088)
% Calories/Fat	94	30.28 ± 6.44	30	26, 35	(14, 47)
Cholesterol (mg)	94	157.36 ± 119.77	119	85, 185	(0, 698)
Water (fl oz)	94	34.20 ± 12.28	33	24, 41	(12, 74)
Caffeine (mg)	94	5.07 ± 16.90	0	0, 0	(0, 115)
Vitamin A (MCG RAE)	94	356.41 ± 253.71	321	170, 490	(0, 1246)
Vitamin A IU	94	3570.89 ± 3030.40	2660	1833, 4000	(244, 16297)
Vitamin B1 (mg)	94	0.91 ± 0.54	1	1, 1	(0, 2)
Vitamin B2 (mg)	94	1.41 ± 0.80	1	1, 2	(0, 5)
Vitamin B3 (mg)	94	12.53 ± 7.91	12	7, 18	(0, 35)
Vitamin B5 (mg)	94	2.65 ± 1.59	2	2, 3	(0, 9)

Continued

Table 11 Continued

Vitamin B6 (mg)	94	1.05 ± 0.77	1	1, 2	(0, 3)
Choline (mg)	94	112.07 ± 91.57	92	53, 136	(0, 497)
Folate (mcg)	94	236.05 ± 161.28	206	122, 330	(0, 686)
DFE Folate (mcgDFE)	94	267.38 ± 255.36	209	37, 423	(940, 1141)
Vitamin B12 (mcg)	94	3.81 ± 2.47	3	2, 5	(0, 13)
Vitamin H (mcg)	94	5.51 ± 28.44	0	0, 0	(0, 228)
Vitamin C (mg)	94	120.91 ± 93.36	92	53, 172	(3, 418)
Vitamin D (IU)	94	88.91 ± 110.61	54	11, 118	(0, 711)
Vitamin D2 + D3 (mcg)	94	1.52 ± 1.93	1	0, 2	(0, 8)
Vitamin E (IU)	94	4.50 ± 5.74	3	1, 6	(0, 36)
Vitamin K1 (mcg)	94	15.74 ± 32.73	7	3, 13	(0, 225)
Calcium (mg)	94	866.88 ± 379.92	829	611, 1075	(106, 1916)
Chloride (mg)	94	22.16 ± 112.43	0	0, 0	(0, 717)
Magnesium (mg)	94	109.04 ± 50.56	105	78, 128	(15, 279)
Phosphorous (mg)	94	708.37 ± 306.70	688	522, 849	(101, 1631)
Potassium (mg)	94	1363.01 ± 555.12	1275	973, 1607	(201, 2962)
Sodium (mg)	94	2527.76 ± 1168.67	2423	1966, 3020	(311, 9001)
Chromium (mcg)	94	0.44 ± 2.59	0	0, 0	(0, 21)
Copper (mg)	94	0.22 ± 0.42	0	0, 0	(0, 1)
Fluoride (mcg)	94	106.83 ± 156.83	32	15, 124	(0, 821)
Iodine (mcg)	94	3.41 ± 20.93	0	0, 0	(0, 187)
Iron (mg)	94	11.30 ± 5.32	10	7, 15	(2, 28)
Manganese (mg)	94	2.33 ± 13.64	1	0, 1	(0, 133)
Molybdenum (mcg)	94	0.53 ± 3.18	0	0, 0	(0, 26)
Selenium (mcg)	94	39.56 ± 25.73	32	21, 57	(5, 117)
Zinc (mg)	94	6.09 ± 3.43	6	3, 8	(1, 19)

Table 12: Dietary Nutrients by Food Security Status

	Food Secure (n = 65)		Food Insecure (n = 29)		
	mean ± sd	(min, max)	mean ± sd	(min, max)	P value*
Calories	1592.51 ± 458.59	(889, 3574)	1547.03 ± 420.10	(727, 2596)	0.8864
Protein (g)	56.58 ± 19.05	(24, 116)	58.10 ± 21.99	(20, 113)	0.8638
Calories/Protein	230.14 ± 78.26	(96, 471)	235.97 ± 89.76	(81, 461)	0.9187
% Calories/Protein	14.55 ± 3.60	(7, 26)	15.41 ± 5.21	(10, 31)	0.9443
Carbs (g)	227.06 ± 77.40	(92, 589)	219.41 ± 53.75	(109, 311)	1.0000
Starch (g)	22.94 ± 27.74	(0, 143)	21.90 ± 23.01	(0, 89)	0.8059
Sugars (g)	105.62 ± 47.72	(0, 305)	106.03 ± 40.00	(54, 208)	0.9447
Fiber (g)	11.45 ± 6.63	(0, 47)	11.97 ± 8.77	(4, 54)	1.0000
Calories/Carb	876.15 ± 300.75	(368, 2300)	841.03 ± 208.89	(426, 1209)	0.8864
% Calories/Carb	54.82 ± 7.50	(39, 71)	55.14 ± 7.80	(42, 72)	0.8350
Fat (g)	53.23 ± 16.95	(16, 104)	51.66 ± 23.86	(16, 122)	0.4881
Saturated Fat (g)	18.40 ± 7.19	(0, 44)	18.17 ± 9.29	(4, 43)	0.5758
Trans Fat (g)	0.91 ± 1.23	(0, 8)	0.86 ± 1.30	(0, 5)	0.4727
Mono Fat (g)	9.02 ± 6.38	(0, 28)	10.48 ± 9.31	(0, 41)	0.8443
Poly Fat (g)	4.94 ± 4.32	(0, 22)	4.72 ± 4.32	(0, 18)	0.8599
Omega3 (g)	0.15 ± 0.40	(0, 2)	0.07 ± 0.26	(0, 1)	0.3347
Omega6 (g)	1.95 ± 2.84	(0, 13)	1.97 ± 3.31	(0, 14)	0.7611
Calories/Fat	486.14 ± 154	(151, 950)	470.21 ± 213.23	(149, 1088)	0.4731
% Calories/Fat	30.68 ± 6.19	(14, 47)	29.38 ± 7.01	(17, 42)	0.4097
Cholesterol (mg)	164.08 ± 129.82	(0, 698)	142.31 ± 93.73	(31, 404)	0.4806
Water (fl oz)	34.55 ± 11.59	(14, 69)	33.41 ± 13.89	(12, 74)	0.4728
Caffeine (mg)	3.15 ± 12.11	(0, 88)	9.38 ± 24.19	(0, 115)	0.3096
Vitamin A (MCG RAE)	367.62 ± 237.50	(0, 1130)	331.31 ± 289.70	(6, 1246)	0.2464
Vitamin A IU	3868.97 ± 3263.33	(424, 16297)	2902.79 ± 2343.45	(244, 12211)	0.1553
Vitamin B1 (mg)	0.97 ± 0.56	(0, 2)	0.79 ± 0.49	(0, 2)	0.1586
Vitamin B2 (mg)	1.52 ± 0.81	(0, 5)	1.17 ± 0.71	(0, 2)	0.0993
Vitamin B3 (mg)	12.46 ± 7.42	(0, 34)	12.69 ± 9.04	(0, 35)	0.7343
Vitamin B5 (mg)	2.80 ± 1.68	(0, 9)	2.31 ± 1.34	(0, 5)	0.1970
Vitamin B6 (mg)	1.03 ± 0.71	(0, 3)	1.10 ± 0.90	(0, 3)	0.8241

Continued

Table 12 Continued

Choline (mg)	118.43 ± 94.49	(0, 497)	97.83 ± 84.47	(0, 390)	0.2033
Folate (mcg)	231.38 ± 141.22	(0, 589)	246.52 ± 201.63	(9, 686)	0.8097
DFE Folate (mcgDFE)	261.17 ± 231.14	(0, 957)	281.31 ± 306.90	(0, (1141)	0.6072
Vitamin B12 (mcg)	3.88 ± 2.52	(0, 13)	3.66 ± 2.39	(0, 9)	0.6233
Vitamin H (mcg)	7.97 ± 33.99	(0, 228)	0 ± 0	(0, 0)	0.0981
Vitamin C (mg)	116.65 ± 92.41	(4, 391)	130.48 ± 96.41	(3, 418)	0.3659
Vitamin D (IU)	89.25 ± 118.33	(1, 711)	88.17 ± 92.90	(0, 338)	0.9967
Vitamin D2 + D3 (mcg)	1.38 ± 1.77	(0, 8)	1.83 ± 2.25	(0, 8)	0.5299
Vitamin E (IU)	4.77 ± 6.29	(0, 36)	3.90 ± 4.30	(0, 14)	0.7820
Vitamin K1 (mcg)	14.72 ± 27.11	(0, 198)	18.03 ± 43.24	(0, 225)	0.5131
Calcium (mg)	912.86 ± 369.32	(233, 1916)	763.83 ± 389.52	(106, 1913)	0.0574
Chloride (mg)	32.05 ± 134.34	(0, 717)	0 ± 0	(0, 0)	0.1816
Magnesium (mg)	109.05 ± 49.61	(15, 279)	109.03 ± 53.52	(21, 252)	0.7876
Phosphorous (mg)	722.88 ± 294.23	(230, 1631)	675.86 ± 336.10	(101, 1438)	0.6273
Potassium (mg)	1361.23 ± 544.31	(395, 2962)	1367 ± 588.50	(201, 2678)	0.5194
Sodium (mg)	2502.28 ± 1253.94	(311, 9001)	2584.86 ± 968.27	(668, 4903)	0.4292
Chromium (mcg)	0.63 ± 3.11	(0, 21)	0 ± 0	(0, 0)	0.2507
Copper (mg)	0.22 ± 0.41	(0, 1)	0.24 ± 0.44	(0, 1)	0.7860
Fluoride (mcg)	103.66 ± 153.96	(0, 821)	113.93 ± 165.64	(0, 603)	0.8895
Iodine (mcg)	4.94 ± 25.08	(0, 187)	0 ± 0	(0, 0)	0.1816
Iron (mg)	11.14 ± 5.13	(3, 28)	11.66 ± 5.81	(2, 24)	0.7619
Manganese (mg)	2.95 ± 16.40	(0, 133)	0.93 ± 0.65	(0, 2)	0.9141
Molybdenum (mcg)	0.77 ± 3.81	(0, 26)	0 ± 0	(0, 0)	0.2507
Selenium (mcg)	41.34 ± 26.37	(5, 117)	35.59 ± 24.20	(5, 107)	0.3989
Zinc (mg)	6.34 ± 3.09	(1, 15)	5.52 ± 4.08	(1, 19)	0.1366

*p-value is based on the Wilcoxon rank-sum test

Table 13: Dietary Nutrients by Dental Caries Status

	Yes (n = 65)		No (n = 29)		
	mean ± sd	(min, max)	mean ± sd	(min, max)	p-value*
Calories	1614.60 ± 464.82	(889, 3574)	1497.52 ± 393.72	(727, 2607)	0.2937
Protein (g)	55.95 ± 18.16	(24, 116)	59.52 ± 23.50	(20, 113)	0.6100
Calories/Protein	226.89 ± 73.73	(96, 471)	243.24 ± 97.29	(81, 461)	0.5959
% Calories/Protein	14.26 ± 3.76	(7, 31)	16.07 ± 4.76	(11, 29)	0.0987
Carbs (g)	230.37 ± 76.16	(92, 589)	212 ± 55.89	(109, 362)	0.2918
Starch (g)	24.20 ± 27.69	(0, 143)	19.07 ± 22.75	(0, 87)	0.4343
Sugars (g)	109.95 ± 49.56	(0, 305)	96.31 ± 32.54	(41, 168)	0.2047
Fiber (g)	11.22 ± 6.25	(0, 47)	12.48 ± 9.33	(2, 54)	0.7557
Calories/Carb	888.06 ± 296.48	(368, 2300)	814.34 ± 215.53	(426, 1384)	0.2702
% Calories/Carb	54.95 ± 7.77	(39, 72)	54.83 ± 7.16	(43, 67)	0.9772
Fat (g)	54.86 ± 20.24	(16, 122)	48 ± 16.05	(23, 92)	0.0957
Saturated Fat (g)	19.03 ± 8.58	(0, 44)	16.76 ± 5.71	(4, 32)	0.3525
Trans Fat (g)	0.78 ± 0.91	(0, 4)	1.14 ± 1.79	(0, 8)	0.8254
Mono Fat (g)	9.55 ± 8.13	(0, 41)	9.28 ± 5.49	(0, 20)	0.5345
Poly Fat (g)	4.82 ± 4.66	(0, 22)	5 ± 3.43	(0, 14)	0.2872
Omega3 (g)	0.15 ± 0.40	(0, 2)	0.07 ± 0.26	(0, 1)	0.3347
Omega6 (g)	2.31 ± 3.34	(0, 14)	1.17 ± 1.73	(0, 8)	0.3299
Calories/Fat	499.63 ± 181.89	(149, 1088)	439.97 ± 147.27	(214, 850)	0.0951
% Calories/Fat	30.78 ± 7.05	(14, 47)	29.14 ± 4.75	(20, 37)	0.1692
Cholesterol (mg)	139.60 ± 95.52	(0, 509)	197.17 ± 156.25	(31, 698)	0.1049
Water (fl oz)	33.74 ± 12.56	(14, 74)	35.24 ± 11.77	(12, 64)	0.3528
Caffeine (mg)	7.14 ± 19.97	(0, 115)	0.45 ± 2.06	(0, 11)	0.0170
Vitamin A (MCG RAE)	319.17 ± 212.19	(0, 871)	439.90 ± 316.93	(34, 1246)	0.1364
Vitamin A IU	3039.83 ± 2305.56	(424, 12043)	4761.21 ± 4028.59	(244, 16297)	0.0252
Vitamin B1 (mg)	0.95 ± 0.54	(0, 2)	0.83 ± 0.54	(0, 2)	0.3038
Vitamin B2 (mg)	1.49 ± 0.83	(0, 5)	1.24 ± 0.69	(0, 3)	0.1780
Vitamin B3 (mg)	12.92 ± 7.94	(0, 34)	11.66 ± 7.90	(0, 35)	0.5212
Vitamin B5 (mg)	2.75 ± 1.71	(0, 9)	2.41 ± 1.30	(1, 5)	0.3886
Vitamin B6 (mg)	1.11 ± 0.77	(0, 3)	0.93 ± 0.75	(0, 2)	0.3655
Choline (mg)	102.68 ± 79.15	(0, 497)	133.14 ± 113.42	(5, 390)	0.5791

Continued

Table 13 Continued

Folate (mcg)	247.92 ± 170.21	(0, 686)	209.45 ± 138.28	(9, 590)	0.4059
DFE Folate (mcgDFE)	280.11 ± 272.62	(0, 1141)	238.86 ± 213.29	(9, 726)	0.7595
Vitamin B12 (mcg)	3.88 ± 2.58	(0, 13)	3.66 ± 2.24	(0, 8)	0.9112
Vitamin H (mcg)	7.97 ± 33.99	(0, 228)	0 ± 0	(0, 0)	0.0981
Vitamin C (mg)	128.05 ± 94.33	(10, 418)	104.93 ± 90.73	(3, 391)	0.1962
Vitamin D (IU)	97.89 ± 123.61	(0, 711)	68.79 ± 71.43	(1, 261)	0.3701
Vitamin D2 + D3 (mcg)	1.51 ± 2.02	(0, 8)	1.55 ± 1.74	(0, 7)	0.5810
Vitamin E (IU)	4.48 ± 6.31	(0, 36)	4.55 ± 4.27	(0, 14)	0.4167
Vitamin K1 (mcg)	14.97 ± 29.95	(0, 225)	17.48 ± 38.76	(0, 198)	0.5290
Calcium (mg)	896.58 ± 368.90	(275, 1916)	800.31 ± 402.12	(106, 1913)	0.2180
Chloride (mg)	32.05 ± 134.34	(0, 717)	0 ± 0	(0, 0)	0.1816
Magnesium (mg)	110.58 ± 50.29	(15, 252)	105.59 ± 51.89	(21, 279)	0.5488
Phosphorous (mg)	718.51 ± 285.07	(180, 1517)	685.66 ± 354.84	(101, 1631)	0.6803
Potassium (mg)	1383.98 ± 536.56	(395, 2962)	1316 ± 601.81	(201, 2846)	0.6565
Sodium (mg)	2612.40 ± 1259.12	(311, 9001)	2338.03 ± 926.69	(668, 4898)	0.2755
Chromium (mcg)	0.63 ± 3.11	(0, 21)	0 ± 0	(0, 0)	0.2507
Copper (mg)	0.25 ± 0.43	(0, 1)	0.17 ± 0.38	(0, 1)	0.4357
Fluoride (mcg)	101.22 ± 155.71	(0, 821)	119.41 ± 161.34	(0, 519)	0.8606
Iodine (mcg)	4.94 ± 25.08	(0, 187)	0 ± 0	(0, 0)	0.1816
Iron (mg)	11.31 ± 5.11	(3, 24)	11.28 ± 5.86	(2, 28)	0.8506
Manganese (mg)	2.88 ± 16.41	(0, 133)	1.10 ± 0.77	(0, 3)	0.2182
Molybdenum (mcg)	0.77 ± 3.81	(0, 26)	0 ± 0	(0, 0)	0.2507
Selenium (mcg)	39.11 ± 25.20	(5, 117)	40.59 ± 27.33	(5, 102)	0.9057
Zinc (mg)	6.31 ± 3.50	(1, 19)	5.59 ± 3.25	(1, 13)	0.3921

*p-value is based on the Wilcoxon rank-sum test

CHAPTER 4: Discussion

Although a statistically significant association between caries prevalence in children ages 2-4 and their household food security status was not found in this study, other related studies have found a relationship between caries and food security status. One recent study examined household socioeconomic status (SES) and food security status with the prevalence of untreated dental caries in children aged 5-17 [65]. In Chi et al, food security status was measured using the same instrument, the USDA Household Food Security Module (18-item questionnaire), and food security status was determined based on the answers to the survey. However, Chi et al used four levels of food security status instead of two levels (food secure and food insecure). The four levels were high food security (zero affirmative responses), marginal food security (1 – 2 affirmative responses), low food security (3 – 7 affirmative responses) , and very low food security (8 or more affirmative responses). Chi et al determined SES as either higher SES (larger income to poverty ratios) or lower SES and untreated dental caries (no or yes) were determined using the NHANES 2007 – 2008 data. Untreated dental caries was chosen as the outcome measure because it measured disease prevalence at the same time that the predictor variable (SES) and mediator (household food security status) were measured. Log-linear regression models were used to look at SES and untreated caries; food insecurity (low or very low food security) and untreated caries were used to estimate

prevalence ratios. Chi et al found a significant relationship between SES and dental caries among children; food insecurity was not found to be a mediator for SES and untreated caries. Results showed that children who were from low or very low food security households had a significantly higher incidence of untreated dental caries (prevalence ratio= 2.00 and 1.70) compared to children from high food security households. No difference in untreated caries was found between children from marginal food security households and high food security households. Children of higher SES had a significantly lower prevalence of untreated caries (prevalence ratio= 0.77).

Chi et al concluded that future interventions and policies that focus on improving food insecurity may help the escalating problem of childhood dental caries. For instance, S.N.A.P. and W.I.C. could subsidize the purchase of fresh fruits and vegetables and limit the purchase of sugary foods and drinks. Also, Chi et al study was not able to test behavioral factors (food intake and diet quality, exposure to fluoride, and visits to the dentist) that may mediate the food insecurity and dental caries association. The behavioral factor food intake and diet quality that was mentioned in Chi et al was captured in this study through the 24-hour dietary recall. The 24-hour dietary recall collected from the parent provided important information regarding the dietary intake and diet quality of the child, however, typically three 24-hour dietary recalls are collected instead of just one (a day during the week may be different than a day during the weekend). Collecting three 24-hour dietary recalls per participant in this study was not possible because of the time commitment that would be required (which would make the

$15.00 gift card a very limited incentive) and multiple participant interactions that would be needed (multiple recalls would require more than one meeting with the participant). Perhaps a future study that collects two 24-hour dietary recalls (e.g. one week day and one weekend day) would be still be attainable and provide a better representation of the child's dietary intake and diet quality.

Chi et al looked at older children (5-17 years old) and found a significant association between food insecure children and untreated dental caries (food insecure children had a significantly higher prevalence of untreated caries compared to food secure children). This finding in Chi et al shows that food security is an important aspect to children's oral health, but may not be a relevant factor in children under the age of 5. It is reasonable to make this implication because this study's results showed that no significant association existed between the food security status of 2-4 year olds and their prevalence of dental caries. In addition, it has been established that U.S. children ages 0-4 experience the lowest prevalence and severity rate of food insecurity among all food insecure children.

A major strength of Chi et al was that the data looked at was from a nationally representative sample from NHANES and a large number of children were included (n=2206). In comparison, this study's sample size (n=94) was small (especially the number of children without dental caries) and represented only the population from Nationwide Children's Hospital. In addition, this study was limited to English speaking participants, unless an interpreter was available, which was only an option in the DSC

and not the dental clinic. Six parents reported to be Hispanic/Latino and five of them had children with dental caries. A future study may be able to include significantly more Hispanic/Latino parents if the questionnaire was available in Spanish to participants and if an interpretor was present for the 24-hour dietary recall collection. Including more Hispanic/Latino children would provide a more diverse population and a higher prevalence of food insecurity is often seen among people of Hispanic/Latino origin in the U.S. Also, a larger sample size and participants from multiple, diverse locations (e.g. private dentist offices and other hospital dental clinics) may help eliminate this study's limitations that were observed. Because the limited number of children without dental caries (n=28), only two predictors were used in the multivariable model in this study. The predictors were age of the child (included in order to adjust for exposure time to caries) and daily water consumption (included due to being found highly significant). After adding age to the model, the effect of daily water consumption remained significant. Chi et al thought that fluoride exposure may be an important behavioral factor in the food insecurity and dental caries relationship, but was unable to test it. Drinking fluoridated tap water is one way that young children are exposed to fluoride and this study found daily water consumption highly significant. Children with dental caries consumed water less frequently (0-4 times daily) than the children without dental caries who more often consumed water continuously throughout the day. Although parents specified child's water consumption as tap, bottled or both, not all tap water sources are fluoridated, and most bottled water is not fluoridated (but these details were not recorded and these were limitations to this study). A future study could record more details on child water

consumption and determine if the tap water the child drinks is flouridated through collecting the participants' area of residence zip code.

Based on the 99% retention rate of participants, the questionnaire based-design proved to be a strength of this study. Most participants easily understood the questionnaire and answered all questions without difficulty. However, questions 16 and 25 were confusing for some participants. These questions asked were related to receiving balanced meals, and participants were not certain if they understood what a balanced meal entailed. Therefore, in addition to providing the definition of *household food security* to participants while obtaining verbal consent, a future study may benefit from providing the definition of the term *balanced meal* in the verbal explanation of the study and on the study information sheet that is provided to participants as well.

The DSC was ideal for study commencement, recruitment, and overall participation for several reasons. Firstly, primarily just adults were in the waiting room, which provided a quiet environment for participant interviews. In addition, DSC appointments provided parents with an ample amount of free time to participant in this study because a child's appointment lasted approximately 2-3 hours. Conclusively, a future study can rely on high participation and retention rates from the DSC.

In this study, the dental clinic proved to be a more challenging location for participant recruitment and retention than the DSC. Space available to conduct interviews was

difficult at times because of the small area of space in the clinic waiting room, and the surrounding environment was often noisy. Interviews that were conducted right outside of the clinic, in the hallway, proved to be more successful. Thus, a future study that recruits participants and conducts all interviews in the adjacent hallway to the dental clinic, may help control these disruptions.

Dental caries in ages 2-5 continues to rise and is of increasing concern globally. Oral health is important for short and long term reasons. Growth and development can be negatively affected by poor oral health and nonphysical factors like cultural, social, and behavioral factors are influenced by oral health. Individuals and society as whole benefit from good oral hygience, which is why research studies that aim combat tooth decay are important. This study focused on finding underlying factors that may not be currently accepted as impacting dental caries because of the limited information available. But, further studying behavioral, social, and cultural factors has proven to show that child tooth decay is impacted by more than physically visible influences. This pilot study provided valuable information that a future study can utilitze.

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Appendix A: Study Questionnaire

Date: _____

Subject #: _____

A. Parent Demographics

For these questions, please mark your answers (☒ or ☑) or write your answers in the spaces provided.

1. Gender: 1☐ Male 2☐ Female

2. Age: _____ years.

3. Are you Hispanic or Latino? 1☐ Hispanic or Latino 2☐ Not Hispanic or Latino

4. Race: (*Please select one only*)
1☐ Black/African American 2☐ American Indian/ Native American/ Alaskan Native
3☐ White 4☐ Asian 5☐ Other (specify):_____

5. Marital Status: (*Please select one only*)
1☐ Single, 2☐ Married, 3☐ Divorced/Widowed, 4☐ Other (specify)_____

6. Education: What is the highest level of education that you have completed?
1☐ Less than high school, 2☐ High school or GED,
3☐ 1-2 years college, 4☐ Graduated college

7. Employment: 1☐ Not working, 2☐ Work Part-time, 3☐ Work fulltime, 4☐ On disability

8. What is your monthly income? 1☐ Less than $2000, 2☐ $2001-$4000,
3☐ $4001-$6000, 4☐ Greater than $6000

9. Household size:
a) How many children (17 years old or younger) live in your household? _____
b) How many adults (18 years old or older) live in your household? _____

10. Where do you often buy groceries?
1☐ Convenience/corner store (maybe attached to a gas station) or 2☐ Grocery store

11. How far away are you from the grocery store?
1☐ Less than 1 mile 2☐ Between 1-5 miles 3☐ More than 5 miles

12. Do you own a car? 1☐ Yes 2☐ No

13. Which of the following best describes the area you live in?
1☐ Urban (city, town) 2☐ Rural (country) 3☐ Suburban

Nationwide Children's

Date: _____

Subject #: _____

B. Food Security

Below are several statements about people's food situations. For each statement, please mark which answer best applies to you/your household **in the last 12 months.** Please select only one answer for each question.

14. "(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more."
1 ☐ Often true, 2 ☐ Sometimes true, 3 ☐ Never true, 4 ☐ Don't know

15. "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more."
1 ☐ Often true, 2 ☐ Sometimes true, 3 ☐ Never true, 4 ☐ Don't know

16. "(I/we) couldn't afford to eat balanced meals."
1 ☐ Often true, 2 ☐ Sometimes true, 3 ☐ Never true, 4 ☐ Don't know

17. In the last 12 months, since last (name of current month), did (you/*you or other adults in your household*) ever cut the size of your meals or skip meals because there wasn't enough money for food?
1 ☐ Yes 2 ☐ No 3 ☐ Don't know

18. If you answered Yes above: How often did this happen? (Otherwise go to next question!)
1 ☐ Almost every month 2 ☐ Some months but not every month
3 ☐ Only 1 or 2 months 4 ☐ Don't know

19. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?
1 ☐ Yes 2 ☐ No 3 ☐ Don't know

20. In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?
1 ☐ Yes 2 ☐ No 3 ☐ Don't know

21. In the last 12 months, did you lose weight because there wasn't enough money for food?
1 ☐ Yes 2 ☐ No 3 ☐ Don't know

22. In the last 12 months, did (you/*you or other adults in your household*) ever not eat for a whole day because there wasn't enough money for food?
1 ☐ Yes 2 ☐ No 3 ☐ Don't know

23. If you answered Yes above: How often did this happen? (Otherwise go to next question!)
1 ☐ Almost every month 2 ☐ Some months but not every month
3 ☐ Only 1 or 2 months 4 ☐ Don't know

Date: _____

Subject #: _____

Below are several statements/questions about food situations of people's children. For each statement, please mark which answer best applies to your child/children (under 18 years old) living in the household **in the last 12 months.** Please select only one answer for each question.

24. "(I/*we*) relied on only a few kinds of low-cost food to feed (my/*our*) child/*the children* because (I was/*we were*) running out of money to buy food."

1☐ Often true, 2☐ Sometimes true, 3☐ Never true, 4☐ Don't know

25. "(I/*We*) couldn't feed (my/*our*) child/the children a balanced meal, because (I/*we*) couldn't afford that."

1☐ Often true, 2☐ Sometimes true, 3☐ Never true, 4☐ Don't know

26. "(My/*Our*) child was/*children were* not eating enough because (I/*we*) just couldn't afford enough food."

1☐ Often true, 2☐ Sometimes true, 3☐ Never true, 4☐ Don't know

27. In the last 12 months, since (current month) of last year, did you ever cut the size of your child's/*any of the children's* meals because there wasn't enough money for food?

1☐ Yes 2☐ No 3☐ Don't know

28. In the last 12 months, did your child/*any of the children* ever skip meals because there wasn't enough money for food?

1☐ Yes 2☐ No 3☐ Don't know

29. If you answered Yes above: How often did this happen? (Otherwise go to next question!)

1☐ Almost every month 2☐ Some months but not every month

3☐ Only 1 or 2 months 4☐ Don't know

30. In the last 12 months, was your child/*were the children* ever hungry but you just couldn't afford more food?

1☐ Yes 2☐ No 3☐ Don't know

31. In the last 12 months, did your child/*any of the children* ever not eat for a whole day because there wasn't enough money for food?

1☐ Yes 2☐ No 3☐ Don't know

NATIONWIDE CHILDREN'S

Date: _____

Subject #: _____

STOP! Do not write on this page. Please see **Lindsey**.

C. 24-Hour Dietary Recall

Time or Meal	**Food or Beverage Item (Describe)**	**How Much? (Amount/size)**	**How or Where Prepared?**
Such as: morning, mid-morning, lunch, afternoon, evening or late evening	List all foods or a combination food. For example, a taco could be: Corn tortilla Ground beef Lettuce Tomato Cheddar cheese Sour cream 2% Milk	For the taco example it could be: 1 3 oz. ½ cup ¼ cup 2 oz. 1 tablespoon 1 cup	Such as: *Baked* *Fried* *Fresh* *Broiled* *Grilled* *Boiled* *McDonald's*

Date: _____

Subject #: _____

D. Child Demographics

Below are questions about your child here in the dental clinic today. Please mark your answers (☒ or ☑) or write your answers in the spaces provided.

32. Child's Gender: 1☐ Male 2☐ Female

33. Child's Age: _____ years.

34. Is your child Hispanic or Latino? 1☐ Hispanic or Latino 2☐ Not Hispanic or Latino

35. Child's Race: (*Please select one only*)

1☐ Black/African American 2☐ American Indian/ Native American/ Alaskan Native
3☐ White 4☐ Asian 5☐ Other (specify):_____

36. Child's Past Medical History:

Any medical problems? 1☐ Yes 2☐ No
Any handicapped condition(s)? 1☐ Yes 2☐ No
Diagnosis _____
ED Care _____
Specialty Clinic Use _____

Appendix B: Study Information Sheet

NATIONWIDE CHILDREN'S
When your child needs a hospital, everything matters.

Study Title: The Association Between Household Food Security and Dental Caries in Young Children
Principal Investigator: Dr. Paul Casamassimo

1. **Introduction – Why are we doing this research study?**
   We are doing this research to help us study how food security and diet are related to child tooth decay (also called dental caries). Food security is the "access by all people at all times to enough food for an active, healthy life" according to the United States Department of Agriculture (USDA). This study is taking place at the Nationwide Children's Hospital Dental Clinic and Dental Surgery Center. You can expect to complete a questionnaire. One section of the questionnaire involves a face-to-face interview, which is used to collect a 24-hour food record about your child. A food record is a list of all of the foods/drinks that your child eats over a period of 24 hours. The questionnaire will take about 25-30 minutes total.

2. **Participation is voluntary.**
   Participation in this research study is voluntary. You may choose not to participate. If you choose to participate in this study, you are free to withdraw at any time. Whether you choose to participate, not participate, or withdraw from this study, there will be no penalty or loss of benefits.

3. **What are possible Risks/Discomforts?**
   Participation in this study poses a risk for breach of confidentiality, although the likelihood is rare and risk minimal.

4. **What are potential Benefits?**
   Participants will not gain any direct benefits, but may gain indirect benefits. This study may help advance research that involves the prevention and treatment of dental decay. For example, a future intervention study with Motivational Interviewing (MI) that looks at how dietary changes help prevent dental decay may benefit from our study's data.

5. **How will my information be kept private?**
   The records of this research will be kept private. In any kind of report we might publish, we will not include any information that would make it possible to identify a participant. Our research records will be kept securely in a locked file, and only the researchers in this study will have access to these records.

6. **Is there any payment/compensation for participation?**
   You will receive a grocery store gift card in the amount of $15.00 after fully completing the questionnaire. Full completion involves answering all questions and participating in the face-to-face interview.

7. **Who can I contact for additional information?**
   The researchers conducting this study are Dr. Paul Casamassimo (Principal Investigator), Dr. Tanya Mathew (Co-Investigator), and Lindsey Bartkowski (Study Coordinator). You may ask any questions you have now. If you have any additional questions, you may contact the researchers at: 614-722-5651 or paul.casamassimo@nationwidechildrens.org for Dr. Paul Casamassimo; 614-722-6175 or tanya.mathew@nationwidechildrens.org for Dr. Tanya Mathew; 330-524-8933 or lindsey.bartkowski@nationwidechildrens.org for Lindsey Bartkowski. If you have questions, concerns, or complaints about the research; if you have questions about your rights as a research volunteer; if you cannot reach the Principal Investigator; or if you want to call someone else - please call (614) 722-2708, Nationwide Children's Hospital Institutional Review Board (IRB). The IRB is the committee that reviews all research involving human subjects at Nationwide Children's Hospital.

Appendix C: Subject Identification Log

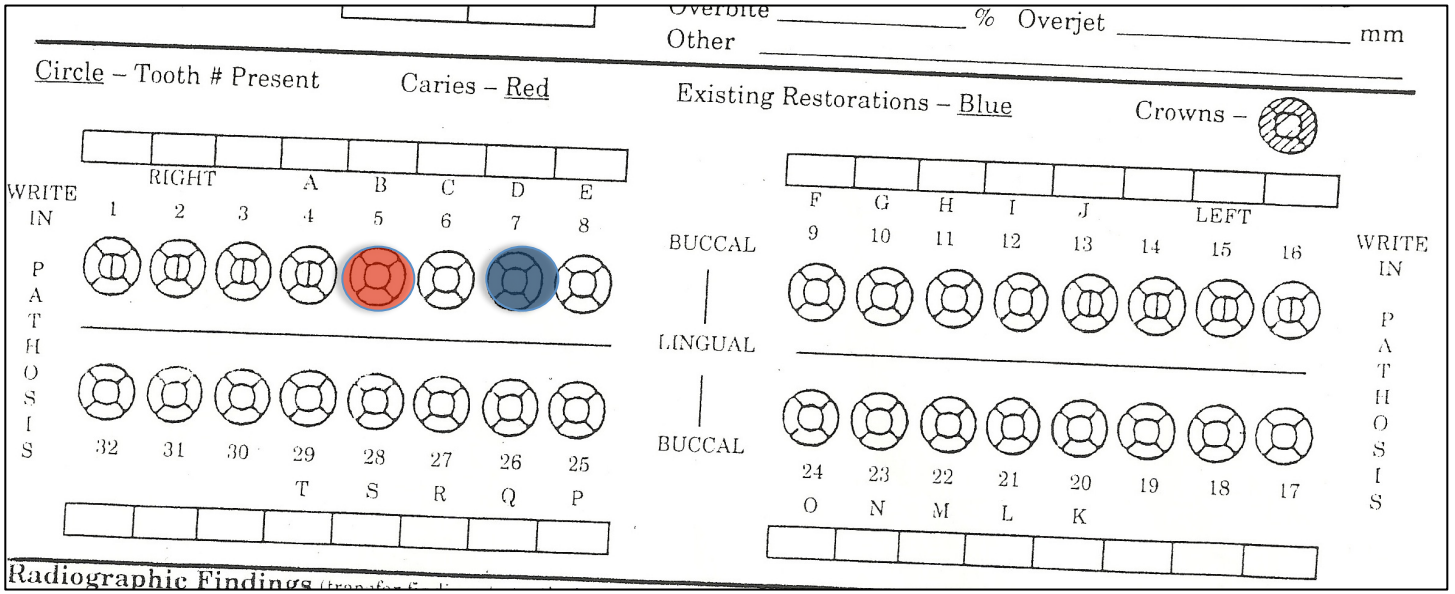
Subject Identification Log

Subject Identification Log							
Clinic/DSC	Subject #	Subject Name	Patient DOB	Patient MRN	Enrollment Date	Dental Caries (Y/N); #	Dental Watches (Y/N); #

Appendix D: NCH Tooth Chart

NCH Tooth Chart – Adapted from Nationwide Children's Hospital "Pediatric Dentistry Summary Sheet Examination Form"

*RED= Cavity; *BLUE= "watch"



Appendix E: IRB-appoved Amendment

Amendment #1: Change the study population by including the Nationwide Children's Hospital Dental Surgery Center patients in addition to the current study population (Nationwide Children's Hospital Dental Clinic patients)

The study population will be modified to include patients from not only the NCH-Dental Clinic, but also patients from the NCH-Dental Surgery Center (DSC). Approximately 47 participants will be recruited from the DSC and 47 participants from the dental clinic. All other inclusion and exclusion criteria will remain the same. Multiple reasons exist for including the DSC patients in this study: 1) Easier participant recruitment and retention; 2) Time and efficiency for completing the questionnaire and face-to-face interview; 3) NCH-DSC patients provide a subset population that could be compared to NCH-Dental Clinic patients.

Recruiting participants in the DSC will be less demanding because firstly, participants will be in the DSC waiting room with no other children present (DSC parents are asked to not bring along any siblings or other children). Also, the DSC parents/legal guardians will have an ample amount of waiting time while their child is in their appointment and they must remain in the DSC waiting room or within hospital grounds. Therefore, high retention and study completion is anticipated. Lastly, the DSC requests that each parent/legal guardian bring along another adult to the visit, which may be beneficial to this study. For instance, if both parents are present for the DSC appointment, then the parent that provides the most caregiving will be the participant for this study, since he/she would provide the most accurate information about their child. NCH-DSC participants will provide a unique subset population because all of the DSC patients ages 2-4 (i.e. 100% of the population) have tooth decay. In comparison, only about 40% of patients ages 2-4 seen in the dental clinic have tooth decay. The DSC population may provide interesting data related to household food security status. For example, perhaps the data analyses will show that the DSC population has a higher rate of household food insecurity; and more children have a poor diet quality and their dietary intake is largely a cariogenic based diet.

Appendix F: USDA Coding Responses

END OF ADULT FOOD SECURITY MODULE
User Notes

(1) Coding Responses and Assessing Household Adult Food Security Status:
Following is a brief overview of how to code responses and assess household food security status based on the Adult Food Security Scale. For detailed information on these procedures, refer to the *Guide to Measuring Household Food Security, Revised 2000,* available through the ERS Food Security in the United States Briefing Room.

Responses of "yes," "often," "sometimes," "almost every month," and "some months but not every month" are coded as affirmative. The sum of affirmative responses to the 10 questions in the Adult Food Security Scale is the household's raw score on the scale.

Food security status is assigned as follows:

- Raw score zero—High food security among adults
- Raw score 1-2—Marginal food security among adults
- Raw score 3-5—Low food security among adults
- Raw score 6-10—Very low food security among adults

For some reporting purposes, the food security status of the first two categories in combination is described as food secure and the latter two as food insecure.

(2) Response Options: For interviewer-administered surveys, DK ("don't know") and "Refused" are blind responses—that is, they are not presented as response options but marked if volunteered. For self-administered surveys, "don't know" is presented as a response option.